

Implementation of Lean Six Sigma

Rupali S. Tupkar¹, Manisha S. Lande², Sagar B. Jawalekar³

¹Asst. Prof, Dept of Mechanical Engg, PCE, Nagpur.

² Asst.Prof, Dept of Mechanical Engg, PCE, Nagpur.

³ Asst.Prof, Dept of Mechanical Engg, PCE, Nagpur.

Abstract - The principles of lean six sigma originating from Motorola production system has spread from manufacturing to the service provided. Lean and six sigma are powerful principles applicable to any area of work. They enable individuals and teams to focus on what constitutes value to their customers, and on how to deliver that as effectively and efficiently as possible. Applied in a continuous way, Lean and Six Sigma can become a way of working and a philosophy for any organization. This case study shows how Lean and Six Sigma were used to identify and streamline the priorities for a global Information Management Service within industrial Research and Development so that it could deliver real and consistent value to its customers.

Key Words: lean six sigma implementation, small scale enterprises, production process advance machineries, working conditions

1. INTRODUCTION TO LEAN SIX SIGMA

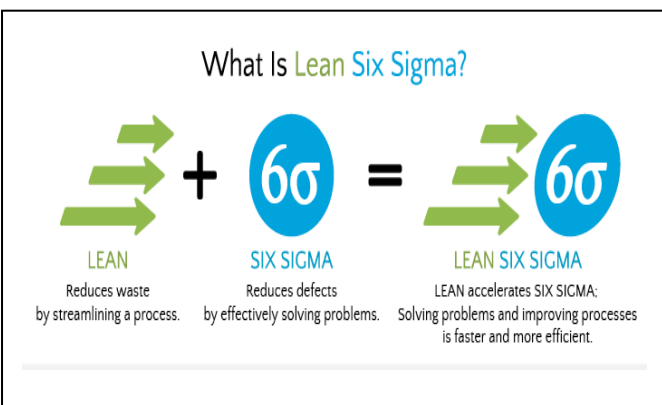


Fig -1: Explaining Lean six sigma

Lean and Six Sigma complement each other. Lean accelerates Six Sigma, delivering greater results than what would typically be achieved by Lean or Six Sigma individually. Combining these two methods gives your improvement team a comprehensive tool set to increase the speed and effectiveness of any process within your organization resulting in increased revenue, reduced costs and improved collaboration.

1.1 Development of Lean Six Sigma

In order to explain how Lean Six Sigma was developed, Upton and Cox (2002) demonstrated the historical development of continuous improvement methodologies as shown in figure 2. The chart exemplifies how Lean Six Sigma was created through the combination of the relatively modern methodologies of six sigma and lean enterprise. Figure shows a historical perspective that exposes how continuous improvement methodologies seem to develop through a process of contribution and combination. New continuous improvement methodology is not usually conceived in isolation from an existing methodology. As figure 2 suggests, methodology creation is a process that consolidates value from various existing methodologies and applies advancements in technology, science, mathematics and creativity to create a new methodology

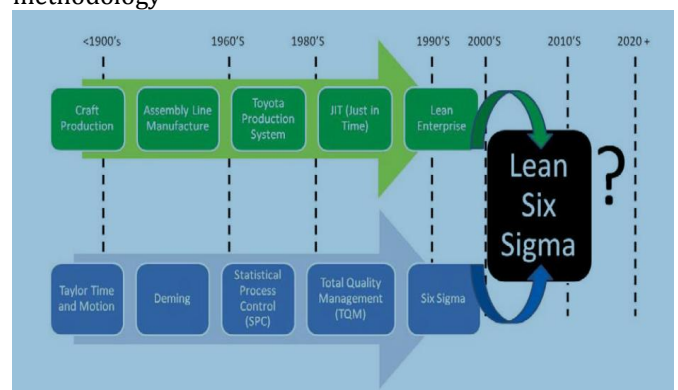


Fig -2: Evolution of Lean Six Sigma

1.2 Waste of lean six sigma

Excess production results in waste because it captures resources too early and retains the value that is added until the product can be used (sold). In today's highly changing society, many items produced before they can be sold to a specific customer often go obsolete before demand is realized. This means that a perfectly good product is often scrapped because it is obsolete. Producing a product simply to keep a production resource busy (either machine, operator or both) is a practice that should be avoided. Delays, such as waiting for raw material, also result in the poor use of capacity and increased delivery time. Raw materials and component parts should be

completed at approximately the time that they will be required by downstream resources

Movement and transportation should always be kept to a minimum. Material handling is a non-value added process that can result in three outcomes: 1) the product ends up at the right place at the right time and in good condition,



Fig-3: wastes lean Six sigma

2) The Part ends up in the wrong place, and 3) the part is damaged in transit and requires rework or scrap. Two of the three outcomes are no desirable, which further leads to minimizing handling. Because material handling occurs between all operations, when possible, the handling should be integrated into the process, and the transport distances minimized. A poorly designed process results in overuse of manufacturing resources (men and machines). There are no perfect processes in manufacturing. Generally, process improvements are made regularly with new efficiencies embedded within the process. Continuous process improvement is a critical part of Lean Manufacturing. Excess inventory reduces profitability. Today, it is not uncommon for a manufacturer to store a supplier's product at the production site. The supplier, right up until the time that they are drawn from inventory, owns the materials. In many ways this is advantageous to both the user and supplier. Insufficient (or poor) process performance always results in the over utilization of manufacturing resources and a more costly product. There is no optimal process in that improvements can always be made; however, many processes operate far below the desired efficiency. Continuous process improvement is necessary for a manufacturing firm to remain competitive. Excess movement or unnecessary part handling should be the first targets of waste elimination. Poor quality (making defects) is never desirable. Labor and material waste results from producing any defect. Furthermore, the cost of mitigating poor quality (rework) can often exceed the price of the product. A critical balance between processing speed and quality exists. A process should be run as fast as possible without sacrificing acceptable quality. From the above discussion, it should be obvious that waste is a constant enemy of manufacturing. Waste elimination should be an on-going process that focuses on improving a

process regularly. Regular reviews and worker input should be conducted as often as allowable.

2. INTRODUCTION TO DAYALU DAL MILL

Dayalu Dal & Oil Mill a name synonymous for its superior quality worldwide. Established in the year 1971 engaged in activities of Processing best quality Pulses & Rice. Since its inception, Dayalu Dal Mill is successfully manufacturing quality pulses and catering the need of the Domestic consumers needs for the last 45 years. We meet face to face with end user of Pulses at Dayalu Dal Mill & on the basis of feedback received from them, we improve the quality as per customer's choice. Millers/Processors and Exporters of all variety of Process ortex quality Indian split Pulses (Dall) like Toordall ,Masoordall, Chana Dall, Uriddall, Green Moong Beans etc. and the Best Sortex Quality of Indian Parboiled ,Non-Basmati and Basmati Rice.Importers /Distributors and Stockists of Best quality New Crops whole Toor Beans, Pigeon Peas ,Whole Masoor Beans, Chick Peas, Kabuli Chick Peas, Green Moong Beans etc.



Fig-4: Flow process chart of dal mill process

2.1 Methodology

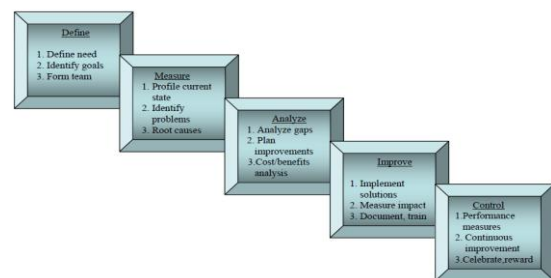


Fig-5: DMAIC methodology for Lean Six Sigma

Simply put, Lean Six Sigma helps you identify the cause of a problem and implement a fix based on facts, rather than assumptions. This produces improved results and success that you and your team, managers and organization can be proud of.

3. TOOLS OF LEAN SIX SIGMA

3.1 Control charts

Control charts have two general uses in an improvement project. The most common application is as a tool to monitor process stability and control. A less common, although some might argue more powerful, use of control charts is as an analysis tool. The descriptions below provide an overview of the different types of control charts to help practitioners identify the best chart for any monitoring situation, followed by a description of the method for using control charts for analysis.

3.2 Identifying Variation

When a process is stable and in control, it displays common cause variation, variation that is inherent to the process. A process is in control when based on past experience it can be predicted how the process will vary (within limits) in the future. If the process is unstable, the process displays special cause variation, non-random variation from external factors. Control charts are simple, robust tools for understanding process variability.

3.3 The Four Process States

Processes fall into one of four states : 1) the ideal 2) the threshold 3) the brink of chaos and 4) the state of chaos (Figure 6). When a process operates in the ideal state, that process is in statistical control and produces 100% conformance. This process has proven stability and target performance over time. This process is predictable and its output meets customer expectations. A process that is in the threshold state is characterized by being in statistical control but still producing the occasional nonconformance. This type of process will produce a constant level of nonconformances and exhibits low capability. Although predictable, this process does not consistently meet customer needs. The brink of chaos state reflects a process that is not in statistical control, but also is not producing defects. In other words, the process is unpredictable, but the outputs of the process still meet customer requirements. The lack of defects leads to a false sense of security; however, as such a process can produce nonconformances at any moment. It is only a matter of time. The fourth process state is the state of chaos. Here, the process is not in statistical control and produces unpredictable levels of nonconformance.

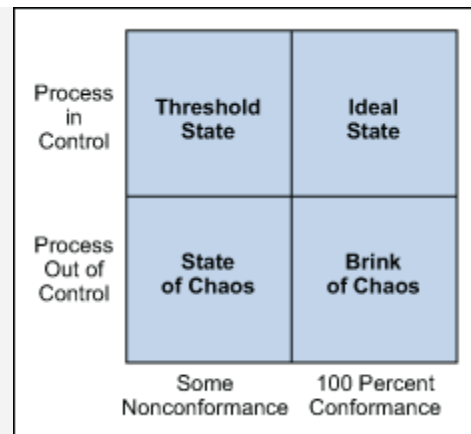


Fig -6: Four Process States

Every process falls into one of these states at any given time, but will not remain in that state. All processes will migrate toward the state of chaos. Companies typically begin some type of improvement effort when a process reaches the state of chaos (although arguably they would be better served to initiate improvement plans at the brink of chaos or threshold state). Control charts are robust and effective tools to use as part of the strategy used to detect this natural process degradation as shown in Figure 7.³

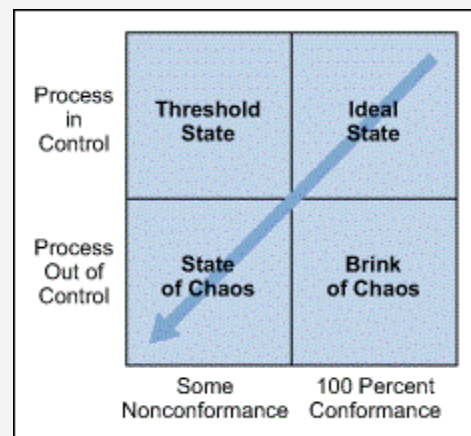


Fig -7: Natural Process Degradation

4. ELEMENTS OF CONTROL

There are three main elements of a control chart as shown in Figure 8.

1. A control chart begins with a time series graph.
2. A central line (X) is added as a visual reference for detecting shifts or trends – this is also referred to as the process location.

- Upper and lower control limits (UCL and LCL) are computed from available data and placed equidistant from the central line. This is also referred to as process dispersion.

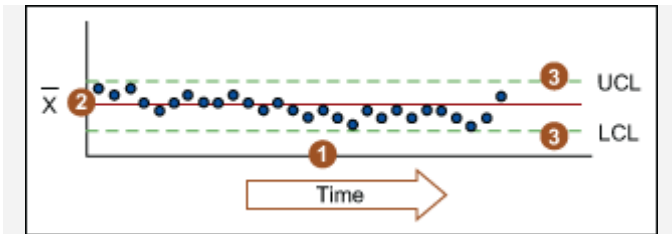


Fig- 8: Elements of a Control Chart

Control limits (CLs) ensure time is not wasted looking for unnecessary trouble – the goal of any process improvement practitioner should be to only take action when warranted. Control limits are calculated by:

1. Estimating the standard deviation? of the sample data
2. Multiplying that number by three
3. Adding (3 x ? to the average) for the UCL and subtracting (3 x ? from the average) for the LCL

Mathematically, the calculation of control limits is

$$CL = average \pm 3 * \hat{\sigma}$$

(Note: The hat over the sigma symbol indicates that this is an estimate of standard deviation, not the true population standard deviation.) Because control limits are calculated from process data, they are independent of customer expectations or specification limits. Control rules take advantage of the normal curve in which 68.26 % of all data is within plus or minus one standard deviation from the average, 95.44% of all data is within plus or minus two standard deviations from the average, and 99.73% of data will be within plus or minus three standard deviations from the average. As such, data should be normally distributed (or transformed) when using control charts, or the chart may signal an unexpectedly high rate of false alarms.

4.1 Controlled Variation

Controlled variation is characterized by a stable and consistent pattern of variation over time, and is associated with common causes. A process operating with controlled variation has an outcome that is predictable within the bounds of the control limits.

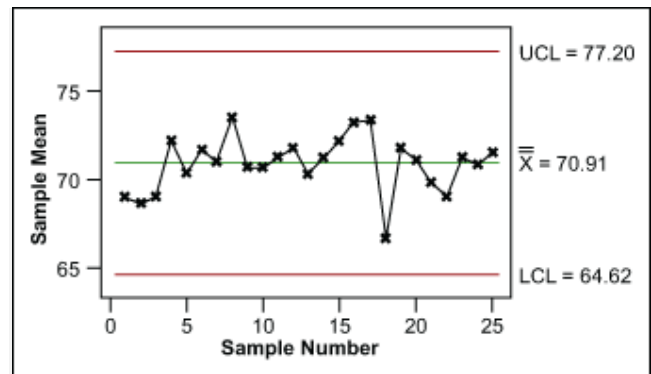


Fig-9: Example of Controlled Variation

4.2 Uncontrolled Variation

Uncontrolled variation is characterized by variation that changes over time and is associated with special causes. The outcomes of this process are unpredictable; a customer may be satisfied or unsatisfied given this unpredictability.

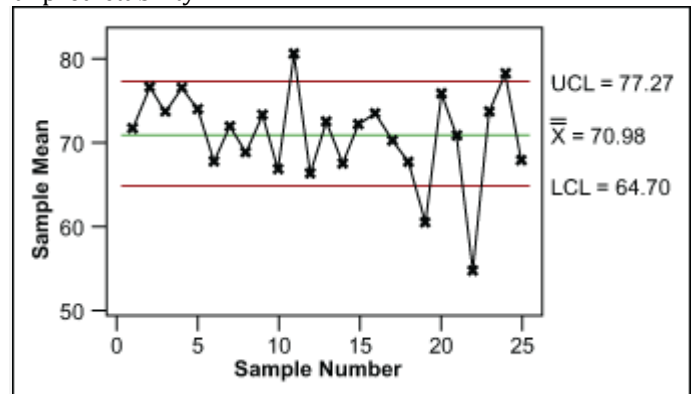


Fig-10: Example of Uncontrolled Variation

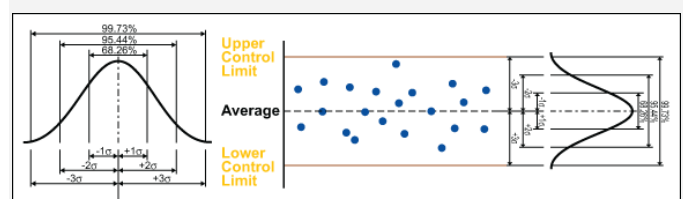


Fig-11: Relationship of Control Chart to Normal Curve

5. CONTROL CHARTS FOR COUNTINEOUS DATA

5.1 Individuals and Moving Range Chart

The individuals and moving range (I-MR) chart is one of the most commonly used control charts for continuous data; it is applicable when one data point is collected at each point in time. The I-MR control chart is actually two charts used in tandem (Figure 12). Together they monitor the process average as well as process variation. With x-axes that are time based, the chart shows a history of the process. *The I* chart is used to detect trends and shifts in the data, and thus in the process. The individuals chart must have the data time-ordered; that is, the data must be entered in the sequence in which it was generated. If data is not correctly tracked, trends or shifts in the process may not be detected and may be incorrectly attributed to random (common cause) variation. There are advanced control chart analysis techniques that forego the detection of shifts and trends, but before applying these advanced methods, the data should be plotted and analyzed in time sequence. The *MR chart* shows short-term variability in a process – an assessment of the stability of process variation. The moving range is the difference between consecutive observations. It is expected that the difference between consecutive points is predictable. Points outside the control limits indicate instability. If there are any out of control points, the special causes must be eliminated. Once the effect of any out-of-control points is removed from the MR chart, look at the I chart. Be sure to remove the point by correcting the process – not by simply erasing the data point.

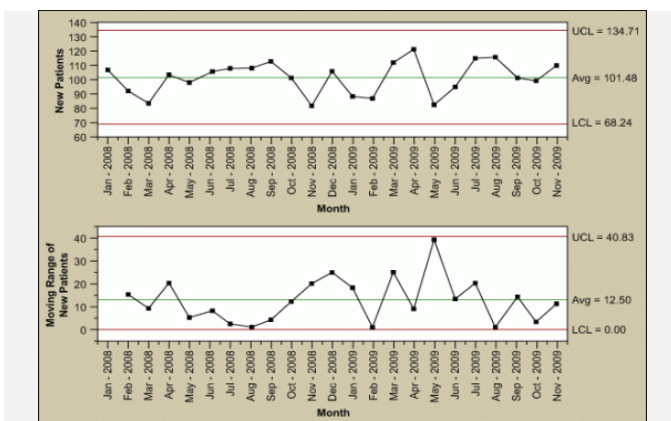


Fig-12: Example of Individuals and Moving Range (I-MR) Chart

The I-MR chart is best used when:

1. The natural subgroup size is unknown.
2. The integrity of the data prevents a clear picture of a logical subgroup.
3. The data is scarce (therefore sub grouping is not yet practical).
4. The natural subgroup needing to be assessed is not yet defined.

5.2 X bar-Range Charts

Another commonly used control chart for continuous data is the X bar and range (X bar-R) chart (Figure 13). Like the I-MR chart, it is comprised of two charts used in tandem. The X bar-R chart is used when you can rationally collect measurements in subgroups of between two and 10 observations. Each subgroup is a snapshot of the process at a given point in time. The chart's x-axes are time based, so that the chart shows a history of the process. For this reason, it is important that the data is in time-order. The X bar chart is used to evaluate consistency of process averages by plotting the average of each subgroup. It is efficient at detecting relatively large shifts (typically plus or minus 1.5 σ or larger) in the process average. The R chart, on the other hand, plots the ranges of each subgroup. The R chart is used to evaluate the consistency of process variation. Look at the R chart first; if the R chart is out of control, then the control limits on the X bar chart are meaningless.

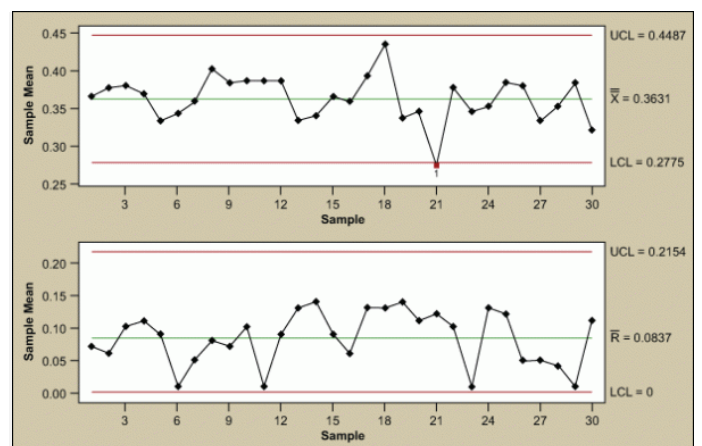


Fig-13: Example of X bar and Range (X bar-R) Chart

Table 1 shows the formulas for calculating control limits. Many software packages do these calculations without much user effort. (Note: For an I-MR chart, use a sample size, n , of 2.) Notice that the control limits are a function of the average range (\bar{R}). This is the technical reason why the R chart needs to be in control before further analysis. If the range is unstable, the control limits will be inflated, which could cause an errant analysis and subsequent work in the wrong area of the process.

Table 1: Control Limit Calculations

	LCL	UCL
Xbar chart	$\bar{X} - 3 \frac{\bar{R}}{d_2}$	$\bar{X} + 3 \frac{\bar{R}}{d_2}$
R chart	$D_3 \bar{R}$	$D_4 \bar{R}$
I chart	$\bar{X} - 3 \frac{\bar{R}}{d_2}$	$\bar{X} + 3 \frac{\bar{R}}{d_2}$
MR chart	0	$D_4 M\bar{R}$

6. SELECTION OF CONTROL CHART

Although this article describes a plethora of control charts, there are simple questions a practitioner can ask to find the appropriate chart for any given use. Figure 13 walks through these questions and directs the user to the appropriate chart.

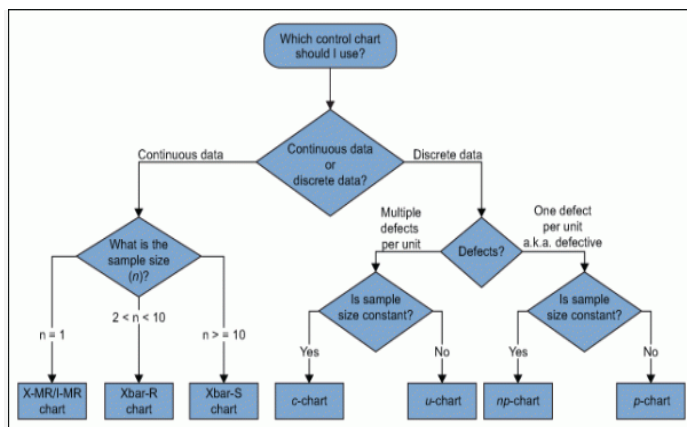


Fig -14: How to Select a Control Chart

A number of points may be taken into consideration when identifying the type of control chart to use, such as:

1. Variables control charts (those that measure variation on a continuous scale) are more sensitive to change than attribute control charts (those that measure variation on a discrete scale).

2. Variables charts are useful for processes such as measuring tool wear.
3. Use an individual's chart when few measurements are available (e.g., when they are infrequent or are particularly costly). These charts should be used when the natural subgroup is not yet known.
4. A measure of defective units is found with u - and c -charts.
5. In a u -chart, the defects within the unit must be independent of one another, such as with component failures on a printed circuit board or the number of defects on a billing statement.
6. Use a u -chart for continuous items, such as fabric (e.g., defects per square meter of cloth).
7. A c -chart is a useful alternative to a u -chart when there are a lot of possible defects on a unit, but there is only a small chance of any one defect occurring.

7. KANBAN

Kanban is A Japanese term. The actual term means "signal". It is one of the primary tools of a Just in Time (JIT) manufacturing system. It signals a cycle of replenishment for production and materials. This can be considered as a "demand" for product from on step in the manufacturing or delivery process to the next. It maintains an orderly and efficient flow of materials throughout the entire manufacturing process with low inventory and work in process. It is usually a printed card that contains specific information such as part name, description, quantity, etc. In a Kanban manufacturing environment, nothing is manufactured unless there is a "signal" to manufacture. This is in contrast to a push-manufacturing environment where production is continuous

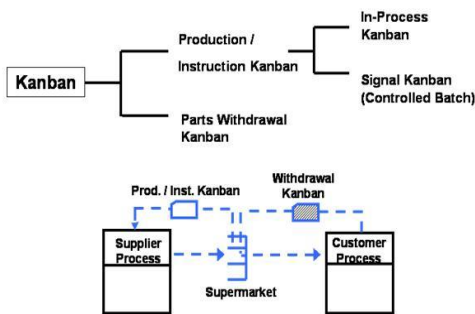


Fig-15: Kanban System

7.1 Kanban System

The Kanban System was developed (more than 20 years ago), by Mr. Taiichi Ohno, a vice president of Toyota, to achieve objectives that include [4]:

1. reducing costs by eliminating waste/scrap
2. try to create work sites that can respond to changes quickly
3. facilitate the methods of achieving and assuring quality control
4. design work sites according to human dignity, mutual trust and support, and allowing workers to reach their maximum potential.

7.2 Why Kanban

Dramatic changes away from high product throughput and high capacity loads towards the new idea of lower production times and work-in-progress have led to the idea of incorporating Kan-ban Systems in manufacturing industries (most notably in automotive industries). These systems are most commonly used to implement the pull-type control in production systems with aims at reducing costs by minimizing the W.I.P. inventory. This allows an organization the ability to adapt to changes in demand, and therefore production more quickly. A pull-type production line is a sequence of production stages performing various process steps on parts where each stage consists of several workstations in tandem. The flow of parts through the overall facility is controlled by a combined push/pull control policy, which is established by the Kan-bans. A push-type policy is used for producing parts within each individual production stage. However, parts are pulled between the production stages in accordance with the rate at which parts are being consumed by the downstream stages.

7.3 Types of Kan-bans

The two most common types of Kan-bans used today are:
 1. Withdrawal (Conveyance) Kan-ban
 2. Production Kan-ban

7.3.1 Kaizen Definition

We can define kaizen very simply from its original Japanese as meaning “change for the better”, but what does this actually mean as a kaizen philosophy?

7.3.2 Japanese Kaizen

Kaizen began its life shortly after world war 2 when the US sent a number of advisers to help the Japanese rebuild their economy, one of these advisers Dr. Deming is often credited with the ideas behind Kaizen due to his 14 points for management, point 5 stating; “Improve constantly and forever the system of production and service, to improve quality and productivity, and thus constantly decrease costs.” The training within Industry (TWI) organization also had a training program that promoted the continual improvement of processes through using workforce suggestions (“how to improve war production methods”, later becoming “how to improve production methods”) and this is credited by Masaaki Imai as being the origin of kaizen also. Masaaki Imai wrote the book “Kaizen: The Key to Japan’s Competitive Success” which very much reintroduced the ideas back to the west. He describes Kaizen as being daily incremental changes to the process for the better. Kaizen as seen by the Japanese (especially Toyota as part of the Toyota Production System TPS) is a method of involving the workforce to come up with many ideas for improvement, each employee is expected to come up with (and implement) 3 to 5 improvement ideas each and every month. The power of this method is not in the individual small improvement but in the combined power of many hundreds of small improvements moving the business forward constantly. These ideas and the many improvements are expected in every area of the company from suppliers through to customer delivery and from cleaner upwards to CEO. Every area and every process requires to be constantly improving if a company

is to constantly cut costs, improve quality and produce products and services quicker and thus win and keep business.

7.4 The need for Kaizen continuous Improvement

Typically a consumer will want a product or service that is the “best” quality, lowest price and available when they want it (more often than not “right now.”) If you are the market leader today but fail to continually improve your product and service eventually a competitor will both make it quicker, better or cheaper and take your business. 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.



Fig-16: Flowchart of KAIZEN

CONCLUSION:

The preceding information all led to the result of this project, the value stream map for Dayalu Dal Mill Company, which follows in Figure 4. From the map, the researcher Evaluated where waste occurs in the process and will be making observations and Recommendations on how to make processes.

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