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Strategy development for lean manufacturing implementation in a selected Manufacturing company

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ABSTRACT

All the manufacturing companies are striving hard enough to achieve their aims, objectives and their capabilities by proper planning and skillfulness, through application of automation and innovative concepts, e.g. lean manufacturing, just-in-time (JIT), total quality management (TQM) and Total productive maintenance (TPM). Among these innovative concepts, lean manufacturing is recognized by the manufacturing companies as a major driver to achieve world-class capabilities. Many large and medium-sized manufacturing companies have adopted lean manufacturing concepts, and experienced reduction in manufacturing lead time and material handling cost, and improvement in quality with other benefits.

Index Terms: lean manufacturing,

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I. INTRODUCTION

Lean is centered on preserving value with less work. Lean manufacturing is a management philosophy derived mostly from the Toyota Production System (TPS) (hence the term Toyotism is also prevalent) and identified as "lean" only in the 1990s. TPS is renowned for its focus on reduction of the original Toyota seven wastes to improve overall customer value, but there are varying perspectives on how this is best achieved. The steady growth of Toyota, from a small company to the world's largest automaker, has focused attention on how it has achieved this success.

Lean manufacturing has been the buzzword in the area of manufacturing for the past few years. The concept originated in Japan after the Second World War when Japanese manufacturers realized they could not afford the massive investment required to build facilities similar to those in the USA. The Japanese, particularly Toyota, began the long process of developing and refining manufacturing processes to minimize waste in all aspects of operations [1]. Lean manufacturing, also known as the Toyota Production System (TPS), was originated by Taiichi Ohno and Shigeo Shingo at Toyota. It is now widely recognized that organizations that have mastered lean manufacturing methods have substantial cost and quality advantages over those still practicing traditional mass production [2].

The goal of lean manufacturing is to reduce the waste in human effort, inventory, time to market and manufacturing space to become highly responsive to customer demand while producing world-class quality products in the most efficient and economical manner[3]. [4] Strongly advocated the elimination of waste and put forth the idea, ‘don’t accept waste as unavoidable’. The basis of lean manufacturing is the elimination of waste. [5] Define waste as ‘anything other than the minimum amount of equipment, materials, parts, space, and time that are essential to add value to the product’. Waste takes many forms and can be found at any time and in any place. There is the waste of complexity, labour (the unnecessary movement of people), overproduction, space, energy, defects, materials, time and transport [6]. Waste uses resources but does not add value to the product (Search Manufacturing 2000). Lean manufacturing combines the best features of both mass production and craft production: the ability to reduce costs per unit and dramatically improve quality while at the same time providing an ever wider range of products and more challenging work [7].

II. BACKGROUND

A. LEAN MANUFACTURING

Our discussion and measurement of lean production is necessarily related to the manufacturing practices that are commonly observed in the literature describing high performance, lean manufacturers. This literature is also rich with descriptions of values and philosophy associated with lean production that are less readily measured than practices. For example, lean production philosophy focuses on avoiding seven cardinal wastes and on respecting customers, employees and suppliers [8]. Although we do not directly address such philosophical positions, we recognize that they are important and believe that they are reflected in the implementation of the lean practices that we do address.

B. STATUS OF LEAN MANUFACTURING IMPLIMENTATION

In the 1950’s, Eiji Toyoda and Taiichi Ohno merged the knowledge and skill of master craftsmen with the standardization and efficiency of the moving assembly line and added the concept of teamwork to create the Toyota Production System (TPS) [10].John Krafcik introduced the term “lean production system” in 1988 in his review of the Toyota Production System, and the term “lean manufacturing” was popularized by [10], in The Machine that Changed the World.Lean manufacturing has many definitions associated with it. Some researchers provide definitions specific to manufacturing processes while others employ a more general definition that could be applied to a variety of industries. For this research lean manufacturing, was defined as the systematic removal of waste by all members of the organization from all areas of the value stream [11].

C. STATUS OF VARIOUS TOOLS AND TECHNIQUES IN LEAN MANUFACTURING

The typology of the seven new tools is presented in terms of the seven wastes as

(1) faster-than-necessary pace;
(2) waiting;
(3) conveyance;
(4) processing;
(5) excess stock;
(6) unnecessary motion; and
(7) Correction of mistakes.

D. CONTINOUS IMPROVEMENT

In mass production, there is a tendency to set up the operation, and if it is working, leave it alone. Mass production lives by the motto. If it is not broke, don't fix it." By contrast, Lean production supports the policy of continuous improvement. Called kaizen by the Japanese, continuous improvement means constantly searching for and implementing ways to reduce cost, improve quality, and increase productivity. The scope of continuous improvement goes beyond factory operations and involves design improvements as well. Continuous improvement is carried out one project at a time. The projects may be concerned with any of the following problem areas: cost reduction, quality improvement, productivity improvement, setup time reduction, cycle time Reduction, manufacturing lead time and work-in-process inventory reduction, and improvement of product design to increase performance and customer appeal.

E. JUST-IN-TIME

The JIT production discipline has shown itself to be very effective in high-volume repetitive operations, such as those found in the automotive industry. The potential for WIP accumulation in this type of manufacturing is significant due to the large quantities of products made and the large numbers of components per product.The principal objective of JIT is to reduce inventories; however, inventory reduction cannot simply be mandated to happen. Certain requisites must be in place for a JIT production system to operate successfully. They are: (1) a pull system of production control, (2) small batch sizes and reduced setup times, and (3) stable and reliable production operations.

F. STANDARDIZATION OF WORK

There are typically four different techniques for standardization

- Simplification or variety control.
- Codification.
- Value engineering.
- Statistical process control.

Today, corporate and public-sector entities are under strong and growing pressure to respond to inherently conflicting concerns: on the one hand, achieving economies of scale through the Dissemination of ‘best practices’ and of standardised routines and procedures; on the other Hand, an increasing demand for individualised services and products [11];[12];[13]. This dilemma is especially acute in the field of service delivery, as [14] reminds us, because high-quality services are Characterised specifically by the perception that they are not standardised but that they are Sensitive to specific customers’ needs [15].

III. AIM AND OBJECTIVE OF PRESENT RESERCH

The main objective of our research work is to identify all the kinds of waste in the industry during different operations and the main aim is to reduce or minimize all these wastes by using cause and effect diagram.

G. ANALYSIS OF WASTE

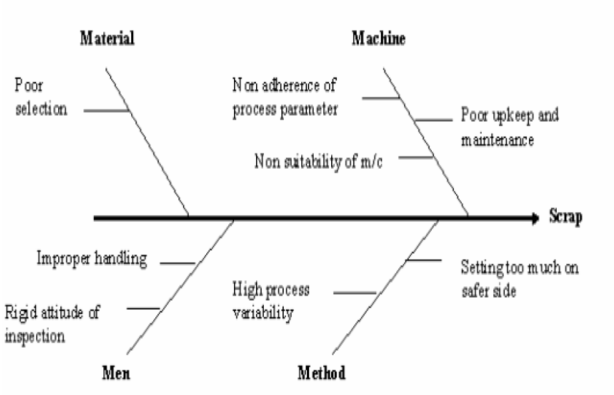
For the purpose of analysis, the waste has been categorized into six different types:
1. Defects
2. Excessive inventory
3. Waste due to unnecessary material movement.
4. Delay due to waiting.
5. Overproduction.
6. Inappropriate processing.

H. ROOT CAUSE ANALYSIS OF WASTES

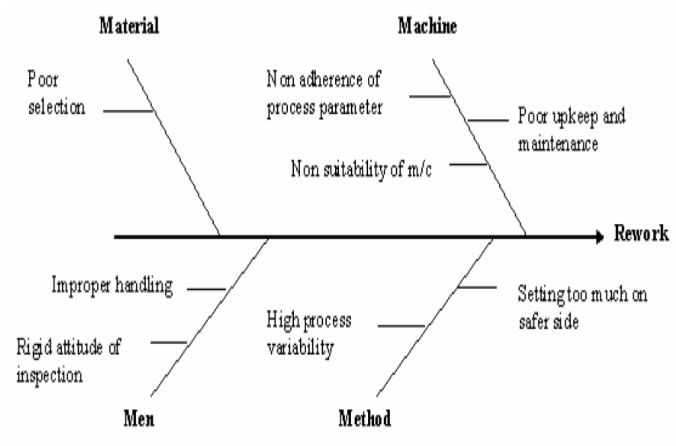
A Cause and Effect Diagram was developed to examine the factors that are contributing to the problem. The Cause -and-Effect Diagram was developed through four steps, namely:

[1] Identify the problem's characteristics.
[2] Brain storm the reasons why the problem is occurring using a causal table (also known as the Why –because technique)
[3] Group the causes by relationship
[4] Create a Cause- and-Effect Diagram

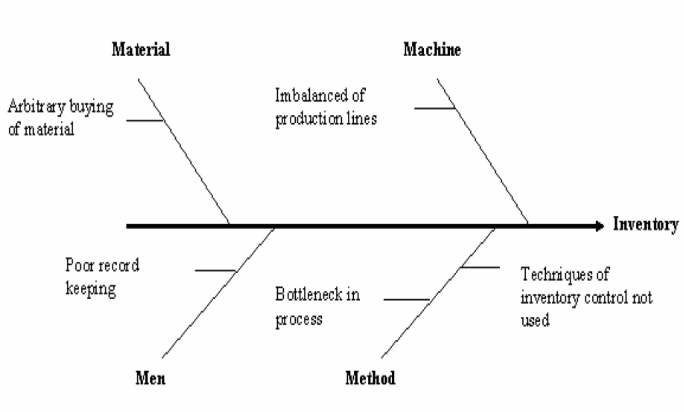
The causes are grouped under the following headings: (1) Men, (2) Machine, (3) Material, (4) Method. The diagram makes it easy to see the many possible root causes of the issues that may be leading to defects.



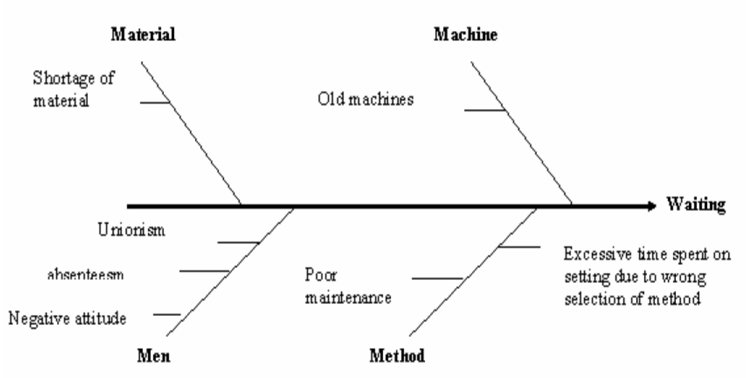
Cause and Effect Diagram of Scrap



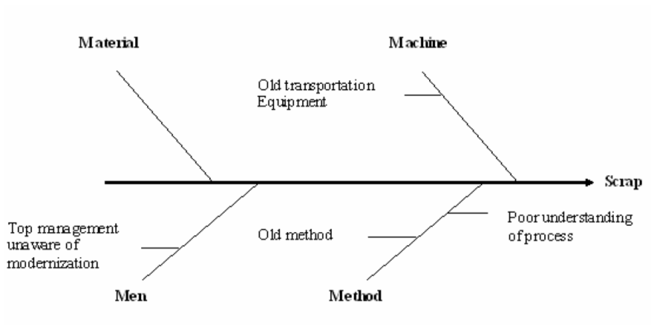
Cause and Effect Diagram of Rework



Cause and Effect Diagram of Inventory



Cause and Effect Diagram of Delay Due to Waiting



Cause and Effect Diagram of Excessive Material Movement

IV. RESERCH METHODOLOGY

This topic covers the overall methodology of the research work including the steps of analysis and tools and techniques employed. A brief description of the industrial unit where the study has been carried out is also given.

BRIEF DISCRIPTION OF INDUSTRIAL UNIT

The selected company was conceived for manufacturing sophisticated components to meet the maintenance need of diesel traction fleet of Indian railways. It is an ancillary of Diesel loco modernization works (DMW) of Indian railways. Diversity of technology involved under one roof at DMW is unmatched not in Indian railways but also in the industrial set ups around the globe. Manufacture of carbon brushes on one hand and the traction gears on the others; remanufacture of traction generators to machine of engine blocks stretches the imagination of even well experienced engineers. To manage such a plant of diverse activities and to maintain the healthy and rhythmic throb of such complex system calls for paramount professional skills. Unlike other production units, DMW does not have an assured captive market for the products. For most of its products, DMW has to compete with other similar type of private and public sectors enterprises that have been supplying these items to zonal railways for decades.

The company has two phases, phase-1 and phase-2.

Following shops are included in phase 1

S. No	Shop	Activity
1.	Carbon brush shop	Manufacturing of brushes for traction machine
2.	Light machine shop	Manufacture spare parts of diesel locomotive
3.	Heavy machine shop	Remanufacture of engine blocks and traction motors
4.	Traction machine shop	Remanufacture of traction machine including manufacturing of coils
5.	Cylinder liner shop	Remanufacture of cylinder liner by chrome plating
6.	Heat treatment shop	Heat treatment of components
7.	Plant maintenance shop	Insulation and maintenance of machine tools and facilities including material handling
8.	Central transport shop	Material handling and transportation
9.	Tool room	Manufacture and maintenance of jigs and fixtures

Phase 2:- Facilities for rebuilding of power packs and diesel locomotives are distributed in the following shops.

Shops and their activity for phase 2

S. No	Shop	Activity
1.	Power pack shop	Stripping, assembly and testing of diesel power brake
2.	Bogie shop	Stripping reconditioning and assembling of loco bogie
3.	Traction repair shop	Rebuilding and testing of auxiliary machine and electrical equipment
4.	Loco rebuilding shop	Striping and rebuilding of locomotive
5.	Air brake shop	Reconditioning testing and assembly of air brake equipment

METHODOLOGY

- Cam shaft section has been chosen for the detailed study of status on lean manufacturing implementation. The steps of camshaft machining are as follows.
- Cut length of 46.7” of raw material (Alloy Steel) using a band saw.
- Face end center at both ends.
- Turn bearing dies. Also turn pilot, flanges and form grooves in the remaining length.
- Drill oil hole by a gun drill.
- Drill and ream indicating hole, on the flange end by a radial drilling machine bench and deburr. Drill three oil holes.
- Milling of the camshaft making exhaust, air, and fuel cam.
- Bench and deburr and relieve stresses by heat treatment.
- Harden the cam and bearing to required hardness by induction hardening process up to a case depth of about 4.5-5.5mm.
- Rough grind bearing diameters on a grinding machine.
- Lathe work
- Flange drilling on the radial drill.
- Finish grind bearing diameters on the cam grinding machine
- Inspection

V. RESULT AND DISCUSSION

A. SUMMARY OF RESERCHED WORK

The research work was undertaken for analyzing manufacturing industry with an aim to design strategies. For developing and implementing lean manufacturing in manufacturing industry first of all, different type of wastes was identified using appropriate techniques. Then all wastes were reduced one by one according to the priority given to the waste by the implementation plan as well as improvement in performance was done . The study has been carried out in phased manner. Root cause analysis was also done using the Cause and Effect Diagram for the different type of wastes.

B. RESULT OF RESERCHED WORK

The following results were drawn from the study;

- Average monthly rejection of part before the conduct of study was 3.6%.
- The raw material usage is only 26% of the available inventory each month.
- The company has a high WIP inventory which is 87% of what is actually required.
- The finished goods stock inventory is as per requirement.
- In the existing layout material movement is very high and will be reduced by at least 75% by changing to the new layout. In the new layout, the material movement distance has been reduced to 131.5 meters compared to 537.45 meters in the existing layout.
- The cycle time will reduce by about 23% at each station.
- The setup time will reduce by about 24% at each station.
- The break down will reduce by about 3% at each station.
- The absenteeism will reduce by about 5% at each station.
- The operator missing from work station will reduce by about 24% at each station.
- Over production is not very common in this industry as the parts are made against actual order.
- If the raw material diameter is reduced from 120 mm to 115 mm the saving in the raw material requirement is 59%.
- 80% of the rework products are rejected.

VI. CONCLUSIONS

1. Wastes identified after implementation of lean manufacturing principles serve as a starting point for bringing in improvements in any manufacturing facility.

2. The waste can be classified into the following categories
- Defects
- Inventory
- Waste due unnecessary material movement
- Delay due to waiting
- Over production
- Inappropriate processing

3. For bringing an overall improvement in the work **particles/PLACES** and also to implement lean manufacturing principles, elimination of causes of the wastes as indicated above is necessary.
4. For reducing the wastes, the provisions or control to be evolved would be engineering controls related to equipment etc. in 80% to 100% of the cases. Administrative controls and work simplification would be of a very limited use.
5. The waste associated with defects and inappropriate processing can be reduced with a small effort in a short time frame with low cost.
6. Problem related to inventory can be solved by engineering controls. Most of the control can be implemented in a short period of time and with a small effort and low cost.
7. The excessive material movement and delay due to waiting can be reduced by higher cost and small effort in reducing breakdown, absenteeism.
8. The implementation plan of the provisions after the detailed analysis has been divided into three phases starting from less expensive, less effort involving, more productive and simpler provisions. This will

facilitate feedback and correction, and will provide immediate and encouraging results for reducing waste for continuing with the implementation process of the subsequent phases.

9. The provisions or controls suggested in phase 1 are, in general, less expensive, easy to implement, results in immediate gains in productivity or other related parameters.
10. The provisions undertaken for implementation in phase 2 are slightly more difficult to implement, involves higher initial capital investment.
11. Phase 3 includes provisions, which are more related with hard-core technical changes in machinery or tooling. Large capital investment will be necessary, although it must be pointed out here that maximum productivity gains will come after implementation of these provisions.

VII. D. FUTURE ASPECTS

Following are some of the areas where detailed research can be taken up.

- The present study has been concentrated on waste identification in large manufacturing unit in north India making camshaft for diesel loco motives. The work can be extended to carry out generalized studies covering all other categories of industries such as process industry, engineering industry, and service industry.
- The present study has suggested provisions and generalized approach for organizations operating in Indian working conditions and the work is fully in Indian context. The approach may be generalized for use in all types of work conditions.

Present work is concentrated only on the waste identification and reduction. Further research work must be carried out on other compliance of lean manufacturing.

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