Lean Manufacturing And Productivity Improvement In Coal Mining

Er. Manoj Ade,Dr. V.S.Deshpand

Abstract— The economic reforms- Liberalization, Privatization, Globalization, (LPG) started in 1991 in India. The main objective of the government was to achieve high economic growth and industrialize the nation for the well-being of Indian citizens. Thus Indian market became Global and open market. Coal industry was not an exception to this phenomena of globalization. The improvement in productivity has become need of coal industry to take the competitive advantage of global market. The challenge to the coal Industry is to identify the wastes and meet the market price by maintaining a good profit. The only solution is to reduce total production cost. Lean manufacturing is a systematic approach to identify and eliminate the waste through continuous improvements and synchronizing the production process to obtain manufacturing excellence. This can be achieved by Lean thinking (to identify and eliminate wastes) and Lean production (to improve efficiency and effectiveness of equipment). Earlier the lean manufacturing concept was limited to manufacturing organization now it is used invariably in operation industries. In this paper researcher has applied lean manufacturing concept in order to increase productivity and to minimize the production cost of mining.

Index Terms:- Lean thinking, Lean Manufacturing, Lean production, Muri, Mura, Muda, Wastes, Equipment efficiency.

I. INTRODUCTION

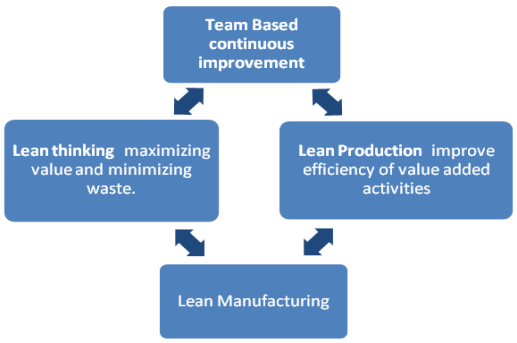
The economic reforms- (LPG) Liberalization, Privatization, Globalization, started in 1991 in India. Productivity improvement through Lean manufacturing means optimization and co-ordination of input resources to minimize the wastes. Improvement in productivity has become need of Coal industry to take competitive advantage in the global market[1].

Productivity = Output / Input

The more the output with minimum input is increase in Productivity. In earlier pricing model the sales price was decided by the producer - Production cost (fixed) + Profit (fixed) = Price (Derived by producer) In the New Globalized Model - Price (fixed by consumer) – Profit (fixed) = Cost (Derived by producer)

1.1 Lean Manufacturing

ean manufacturing in mining is the production of coal using less of everything compared to traditional mass production: less waste, human effort, manufacturing space, investment in tools, inventory, and engineering time to develop a new product[3].



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1.2 Lean Thinking

is an approach to achieving manufacturing excellence based upon the continued value addition and elimination of waste. Lean production utilizes techniques and principles that improve efficiencies of value added activities. Lean Manufacturing- Combines lean thinking and lean manufacturing. It is a way to eliminate waste and improve efficiency in a manufacturing environment. Mining process flow diagram in underground mines is as below[2]:-

In mining process after dressing operation of the face, roof bolting is being done to support the roof. Drilling of face is being done to charge the holes by explosive and blasted to produce coal.

2. PROBLEM IDENTIFICATION-

In search of a critical problem, the identified problems have been categorized according to the capability of group members , the involvement of the management and other external agencies, in three categories, i.e.,

- 'A' category problem – Minimum involvement of other departments in solving them.
- 'B' category problem – Involvement of the other department is a necessity.
- 'C' category problem – Management sanction may be needed in implementing the solution.

2.1 Identification Of Wastes:-

PROBLEMS	CATEGORY OF THE PROBLEM
Coal seam height thin and thick which is very difficult to excavate, and the need of coal does not permit to leave it un-mined.	**C**
Coal spillage and re-handling of the spilled coal.	**A**
Overall Equipment Effectiveness (OEE)	**B**
Pumping system in under ground mine.	**B**
Bottleneck (under ground bunker) of the coal transportation system.	**C**
Proper tool bit profile during re-sharpening process.	**A**
Human energy loss due to heavy working conditions	**C**

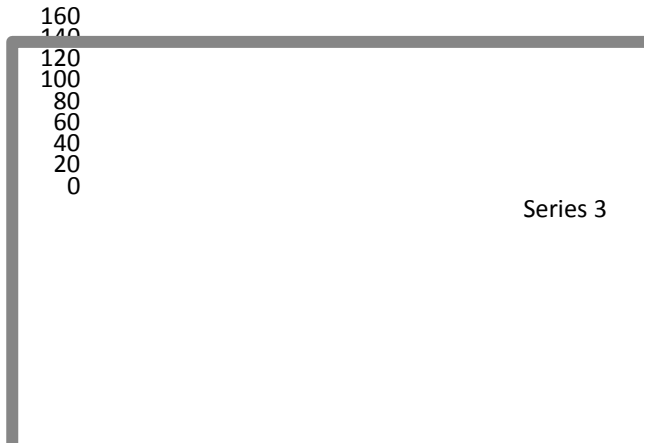
There are two problems are of "A" category which require minimum involvement of other department. We have selected "improper tool bit profile" problem for study. Roof bolting and drilling operations are being done with the use of drill rod and drill bit. In a drill bit **Carbide tip** is brazed on the flank of the drill bit. In a mine, we studied twelve nos. of bits are given to a driller for ten days of working. Each driller has to drill four faces and roof bolting of all the four faces. It was observed that the drillers are facing difficulty in the last two days of the next due to get new drill bits. Consequently they use to send the drill bits for re-sharpening and complete the defined work load. While somebody comes to re-sharpen the drill bit the entire cell of that group becomes idle. There is waiting time for all team members of that cell and that results in loss of production[4].

2.2 Data Collection And Analysis:-

TABLE 1- Analysis of drill bits of five driller gangs in one month.

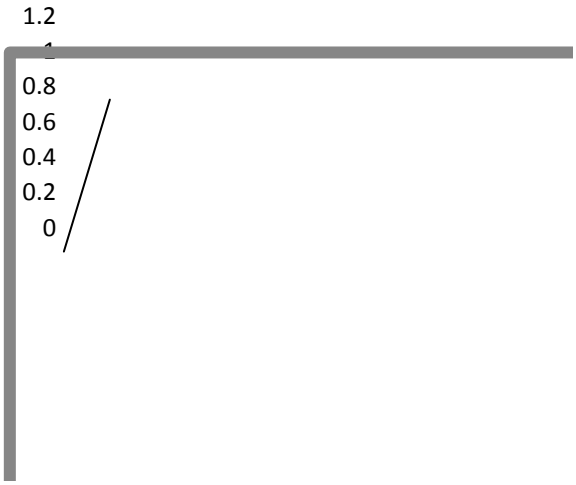
problem	G-1	G-2	G-3	G-4	G-5	Total
Worn our lock	6	3	6	3	3	21
Tip separated	3	3	-	-	3	9
Worn out bit flank	-	-	-	3	-	3
Improper tool profile	24	27	30	30	24	**135 = 75%**
Defective tool	-	-	-	-	3	3
Defective rod seat	3	3	-	-	3	9
Total	36	36	36	36	36	180

2.3 Histogram Of Defects:-



From above it is clear that there is major problem of low output is due to improper tool profile of the drill bits.

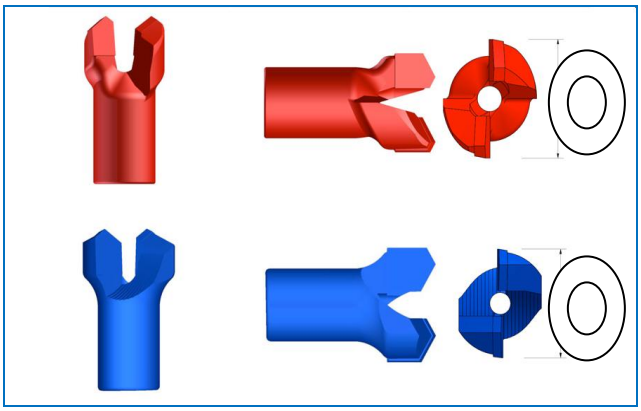
2.4 Parato Chart:-



2.5 Definition Of The Problem:-

Problem - 75% of the DRILL BITS malfunction due to the faulty tool profile during re-sharpening process. It is the critical problem which is to be solved for best output in terms of production.

2.6 ORIGINAL TOOL PROFILE:-



2.6 Current Situation Of The Problem & Its Impact

a) **Existing output** As per prevailing practice drill bits allotted to one gang is 12 nos./10 days. There are eight nos. of working faces in the mine in each shift. Considered 350 days of working during one year There will be 35 times tool bits will be allotted.
= 12 bits x 8 gangs x3 shifts x 35 times in a year
= 10080 bits/ year consumption,
= 10080 x Rs 120 = Rs. 12,09,600.00/yr for 4 faces / gang / day in a year..

b) **Manpower cost** of waiting time when the tools becomes blunt and a person moves for re-grinding of tool bits at surface and coming back Minimum 1 hr.x 10 persons x 8 gangs x 3shifts x 35 = 8400 hours 8400hrs/8hrs = 1050 man days EMS @ 1050 x Rs. 1695 = Rs. 17,79,750.00/year

c) **Grinding wheel consumption** is @ 1 wheel in three days.Earlier 120 nos. grinding wheels were required. @300 Rs. = 36,000.00/year

d) **Energy consumption** by 1KW motor of the grinder = 1KW x 3.5hrs/shift x 3 shifts x 360 x 9.15 = Rs. 29646.00/ year

3. ANALYSIS OF PROBLEM:-

There are two flanks of each tool bits and on each flank has carbide tip, brazed from the factory. It's tool profile shows that when it is rotated there are two different diametric tip contact occurs. It works on two concentric circles and gives path to the drilled material to flow out with the helix of the drill rod. However the grinder operator ignores the tool profile of the drill bit. It makes easier and time saving for his leisure to make equal angle and equal flank width. Grinder operator wants to finish his work in easier manner at the cost to the company. While working with these drill bits-Both the flanks rotates in the same path and drilling chips of the material does not get its way to come out through helix of the drill rod. Both flanks run in the same circle and drill chips generates heat due to excessive pressure and friction consequently drill bits becomes blunt. Extra manual efforts are to be applied for the same quantum of output. More time required to drill the same quantum of output. Lower tool bit life for the same output. Re-sharpening is required and waiting time of the cellular manpower can be saved. Loss of production is possible with same inputs and hence there is increase in productivity[5].

3.1 Implimentation Programme:-

Objective-

I. We must train people about working of tool bits.
II. We must train the Grinder operator and driller about significance of the tool profile
III. Importance of correct working and their contribution in saving organization's money.
IV. Importance of their job and motivation for correct and effective working.

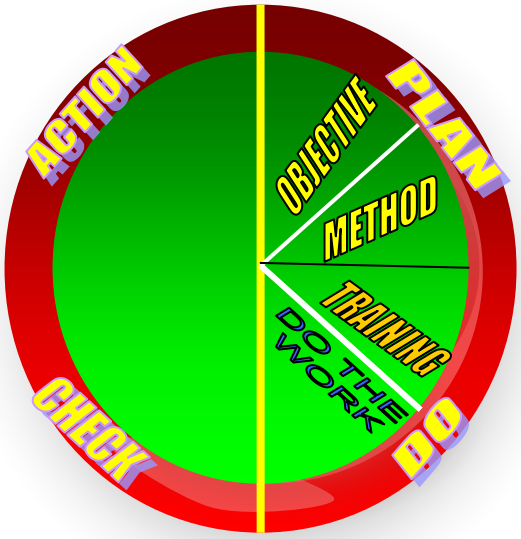


FIG 1: PDCA CYCLE

Method-

1. Templet of tool profile has been made and directed to match the profile while re- sharpening of drill bits.
2. On job demonstration of the working of tool bit and life deterioration of the bits.

Training-

1. Educate Mining sardar, Driller and Grinder operator of all three shifts about importance of correct tool profile of the tool bits.
2. Telling their importance and they are asset and contribute in progress of the company by minimizing consumption of tool bits and better production.
3. Less labour work is required for the same output of production.

Do the work –

1. Initially on job training of the driller and Grinder operators monitoring .
2. Mining Sardar are advised to keep watch and contribute in savings.

Check –

1. Check the drill bits with the profile of the tamplet.
2. Check that the grinder circumference is uniform.

Action-

1. Measure with standards
2. If deviations observed analyze and take corrective action.

4. COST BENEFIT ANALYSIS

4.1 Tangible Gains : In modified condition –

a) More faces drilled and more coal produced –Drill bits are now given as per the desired profile the Consumption of the tool bits can produce 25% more faces with the same quantity of bits. = 10080 bits /year makes 5 faces, There is 10080 no. of faces more drilled per year. The coal produced per face is approximately 12 Tons/blast. There is increase in coal production = 12 x10080 =1,20,960 tonnes. The present rate of the coal is 1890.00 Rs./ ton then the total more revenue generated.= Rs. 22,86,14,400.00./year.

b) Less consumption of drill bits- By providing drill bits of proper tool profile daily one more face can be drilled and hence there will be reduction in the drill bits by 25% Total 2520 bits will be saved Cost of bits saving is = 2520 x 120 = Rs. 3,02,400.00

c) Less Grinding wheel consumption = There were 120 grinding wheels consumption during one year. As there is reduction in tool bits by 25% consequently there will be reduction in grinding wheels. = 30 x 300 = Rs. 9000.

d) Power consumption- There will be substantial saving in power consumption. As there is no. of bits are 25% less than the previous consumption hence there will be savings of power consumption. 29646 * 25% = Rs. 7411.50

e) Effective manpower utilization- As there is no waiting time during re-sharpening process of drill bits therefore no waiting time is required. Saves human cost of the organization. Minimum 1 hr. x 10 persons x 8 gangs x 3shifts x 35 = 8400 hours

8400hrs/8hrs = 1050 man days

EMS @ 1050 x Rs. 1695 = Rs. 17,79,750.00/year

TOTAL SAVINGS = (a + b + c + d + e)

= (Rs. 22,86,14,400.00+ Rs. 3,02,400.00+ Rs. 9000+ Rs. 7411.00+ Rs. 17,79,750.00)

= Rs. 23,07,12,961.00 ONLY.

(Rs. Twenty three crores seven lacs twelve thousand nine hundred and sixty one rupees only).

4.2 Intangible Gains :

a) For Organisation

- Easy operation and more productivity with less efforts.
- Improvement in housekeeping.
- Improved work culture.

b) For Individuals

- Same work load can be obtained with less efforts
- Improved self confidence.
- Job satisfaction.
- Familiar with QC tools and their usage.
- Improved listening, writing and presentation skills.
- Exhaustive human labour is reduced
- Sense of acceptance is increased

5 CONCLUSION:-

Application of Lean philosophy in a segment of production process i.e. elimination of waste activities and overall effective use of resources by less number of drill bits, grinding wheels, electrical power, human energy and more coal production to wheel the development of the nation. It is value addition process, elimination of wastes and improvement in productivity. There is always scope of improvement and lean manufacturing is the basis towards this journey.

"Quality Circle is a journey, not a destination."

REFERENCES:-

1. Taichi Ohno "Toyota Production System"
2. Groover M.P. Automation, Production Systems and Computer Integrated system, Prentice Hall, New Jersey.
3. Womack James P, Daniel T Jones ; 'The Machine that Changed the world. 'The story of lean production and lean thinking; banish Waste' and 'Create wealth in your organization.'
4. The story of 'Lean Production and lean thinking: Banish Waste' and 'Create wealth in your Organization'.
5. Journal AUG 11, of Indian institution of Industrial Engineering 'Lean manufacturing' by N.C. Dutta.
6. *Int. J. Logistics Systems and Management, Vol. 6, No. 3, 2010* Lean mining: principles for modelling and improving processes of mineral value chains J.G. Steinberg* and G. De Tomi

WEB REFERENCES-

1. Web sites of Coal India 'www.coalindia.nic.in'.
2. www.6sigma.com