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Analysing the Benefits of Value Stream Mapping in Mining Industry

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ABSTRACT:Mining sector is an important segment of the World Economy. In the recent years, there has been a pronounced growth in the mineral production both in terms of quantity and value and many of the mining companies has focussed on the Process Improvements in order to increase their Productivity, Efficiency, Quality etc., With many companies integrating Lean and Six Sigma methodologies into a single improvement tool kit, value stream mapping has emerged as a preferred tool to identify process improvement opportunities. In this Paper an attempt is made to discuss on the Process Improvement Tools (Value Steam Mapping) which can improve the performance of mining operations.

KEYWORDS:Mining, Value Stream Mapping, Process Improvement.

I. INTRODUCTION

Lean principles have been applied with great success in manufacturing industry. In recent years many of the other industries including mining industry are also started to penetrate implementing the Lean principles as well.When work is compared with automotiveindustry, mining work is characterized as dynamic, uncertain, volatile and risky work environment, but few business processes are common in both industries as follows [1-6]:

- Both rely if effective business processes;
- Both rely on efficiency within the value stream;
- Both strive to maximise operational efficiency;
- Both rely on an extensive supply chain;
- Both sectors have a ruthless focus on safety.

These similarities bring an opportunity to successfully apply lean principles into the mining industry. In this paper, a review on verifying the possibility of implementing Value Stream Mapping method into mining industry, especially underground coal mining is presented.

II. LITERATURE SURVEY

Value stream mapping is a lean manufacturing or lean toolthat employs a flow diagram documenting in high detail every step of a process.Value Stream Mapping provides a high level system view that will enable to apply the right tools in the right sequence and achieve significantly better results, it is usedto identify waste, reduce process cycle times, and implement process improvement [1-6].

Overview of the Process

- Value Stream Mapping is used to plan improvements for the start to end processes (i.e. value stream) for a specific product or service.
- The current state map is a visual display of the process highlighting problems with the major steps and flow of work and information.
- The future state map shows what the process will look like after improvements.
- The implementation plan shows the actions, priority, timing and resources needed to achieve the future state.

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- Value Stream Mapping starts with the macro level.
- Value Steam Map for a mining operation have separate maps and action plans for drill and blast, load / haul, crushing and processing. Each map is "owned" by the manager of the specific area.

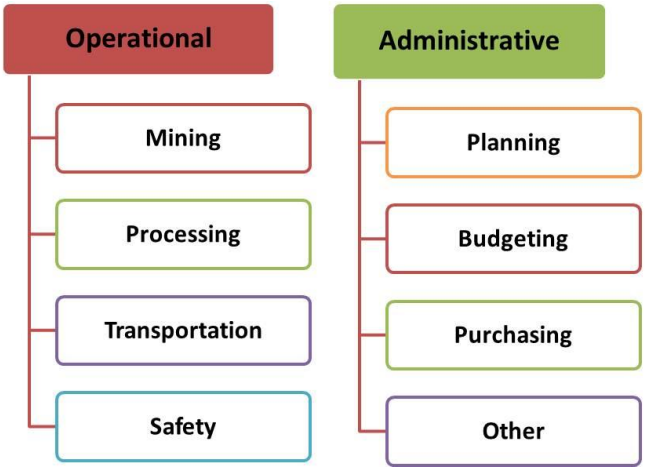

Fig. 1 General Operational and Administrative processes in mining industry

An overview of Operational (Mining, Processing, Transportation and Safety) and Administrative activities involved in mining industry are shown in Fig. 1; in this paper we are focussing on Operational processes.

Using the Method

- Planning and preparation.Identify the target product family or service. Create a charter, define the problem, set the goals and objectives, and select the mapping team. Socialize the charter with the leadership team.
- Draw while on the shop floor a current state value stream map, which shows the current steps, delays, and information flows required to deliver the target product or service. This may be a production flow (raw materials to consumer) or a design flow (concept to launch). There are 'standard' symbols for representing entities.
- Assess the current state value stream map in terms of creating flow by eliminating waste.
- Draw a future state value stream map.
- Work towards the future state condition.
- Develop action (Kaizen) plans and review actions.

Drawing a Process Map

A process map is a diagram of a business process. It helps to define and understand dependencies and handoffs; it will identify all the possible variation and wastage sources, Fig. 2 shows an example of visual display of Process Map. Typical components need to consider while drawing the Process Map are: Overall Process input(s) and output(s), draw each activity (in sequential order) that contributes to creation of the output(s), Responsible parties, Activity dependencies and Timeline.

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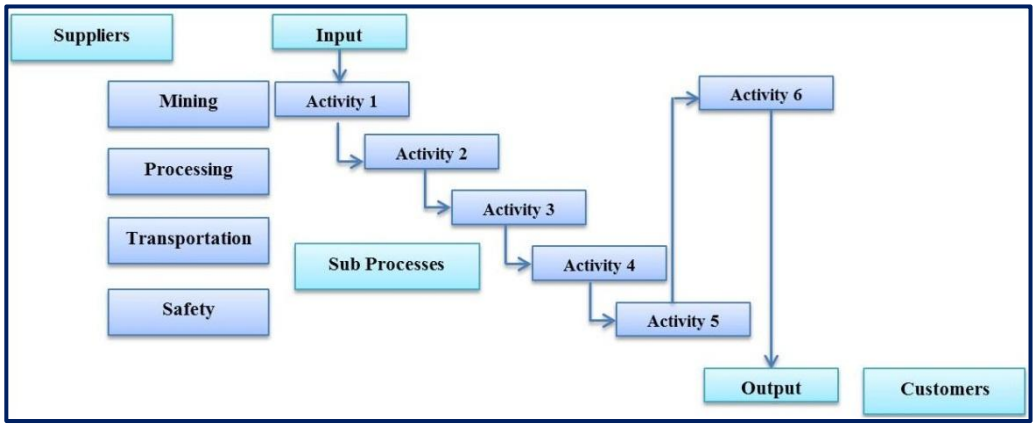

Fig. 2 Example of visual display of Process map

Objectives which can improve performance in mining industry are:

- Improve Safety
- Reduce Cost
- Increase Production
- Enhance Productivity
- Others

There are a wide range of mining process improvement programs, since each company has its own unique goals and characteristics. As a result, companies follow different performance improvement models based on their needs, cultures and styles, while performance improvement programs differ across mining companies, the types of processes they address are similar, within each process, there are a wide range of issues that can be addressed (Table 1).An illustrative example ofUnderground Coal Mining Process is shown in Fig.3. [7-9].

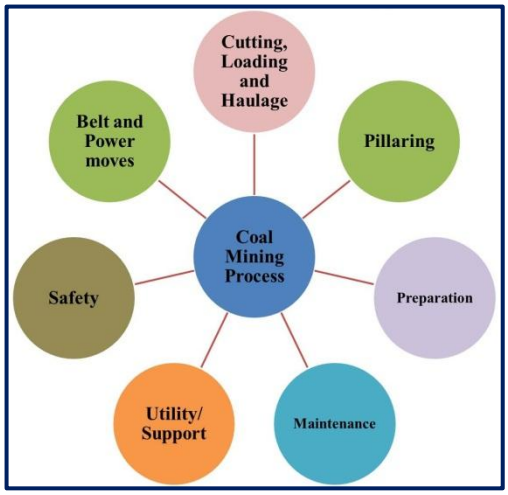

Fig. 3 Process work in Underground Coal Mining

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General Issues	Underground Mining	Surface Mining
• Performance consistency • Cost reduction • Facility-based planning • Communication and teamwork • Standard operating procedures • Organization and staffing issues • Roles and responsibilities • Performance measurement and monitoring • Work schedules • Maintenance planning • Parts and supplies	• Production shortfalls • Loading time lost • Equipment issues • Timing of production and development • Usage of scheduled downtime • Belts • Belt and power moves • Construction planning and management • Drainage management	• Dragline performance • Truck shovel performance • Haulage – coal and overburden • Drilling and blasting • Pit planning • Reclamation • De-watering • Equipment maintenance • Fuel and lube • Heavy haulage

Processing	Transportation	Safety
• Plant availability shortfalls • Feed rates • Linkage to mine operating plans • Sampling • Refuse disposal • Mobile equipment productivity and management • Magnetite usage • Coal losses • Coal quality compliance	• Priority/Effectiveness of load out operations • Integration of mining, processing and loading • Delay tracking • Load out maintenance • Utilization and maximization of track/load out capacity • Manual processes • Railroad issues	• Training • Awareness • Communication, coordination and teamwork • Safe operating procedures • Supervision • Monitoring and enforcement • Accident investigation • Repeat incidents • Root cause analysis • Analysis e.g. injury types and categories

Table1. Operational Issues by Process in Coal mining industry (In this paper we are focussing on Operational Processes for Coal mining)

Underground mining processes can be complex, especially when one considers the relationship between development and production. Add to that other variables such as shaft scheduling, delivery of materials, drilling and blasting

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schedules, mucking, the movement of men and machinery, etc., and the interdependency of related tasks further complicates the situation.
Examples of waste that can be noticed in a mine [1-6]:

Motion—inefficient truck paths, People moving, Shovels making too many passes
Waiting—information or materials not complete or ready to go, idle equipment and resources, Trucks may be waiting at a dump site
Over Production—Large batches, ignoring customer demands, mining capacity may outstrip the plant's ability to process ore
Processing—Processing ore to a better grade than the customer is willing to pay; drilling more holes than necessary, adding more value than the customer wants, unnecessary process steps
Defects—incorrect action, out of standard, requires remediation and costly rework
Inventory—keeping too much or the wrong stock
Transportation—Moving mined ore many times before it reaches its final destination, unnecessary movement and shifting, extra handling

III. PROSPECTS FOR IMPROVEMENT

Mine performance optimization is all about the loss elimination. An improvement made in one part of the process would not improve the overall system performance if there was a constraint downstream from the improvement.

Prospects for Improvement

- Lack of procedures and standards
- Inconsistent section set-up
- Inconsistent/non-existent cut cycle
- Poor teamwork within crews and across shifts
- Large amount of loading time lost
- Cable damage
- Frequent emergency breakdowns
- Poor preparation for following shift
- Violations and accidents
- Belt and power moves disrupt loading time

Solutions

There are frequently many options to address the problem areas that have been identified, and these options need to be identified, evaluated and narrowed down before the best solutions can be selected. By selecting right processes like: creating continuous process flow, using the Pull system, levelling the workload, Standardization, using the visual control and the reliable tested technology can produce the right results.

Potential Current Performance Measures	Potential Early Warning System Measures
• Tons mined • Operating cost per ton • Cost versus budget • Productivity • Accidents and violations • Other	• Ability to remain on cut cycle • Time to start loading at beginning of shift • Section ready for next shift • Loading time lost • Completion of planned maintenance work • Belt and power moves completed effectively

Table 2. Measure and Track Performance for Underground Coal Mining

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Measuring and tracking performance which are shown in Table 2 are key steps to help identify potential changes and sustain improvements. Performance measures for the underground coal mining process can include current performance levels and an early warning system.

IV. CONCLUSION

In applying lean principle into mining industry, one should understand that lean principle is an operating philosophy in its original context (automotive industry) that had particular values, needs and characteristics. Standardization is critical foundation in lean principle, as TaiichiOhno said; "Where there is no standard, there can be no Kaizen". In mining, standardization is a difficult task as a work in mining is very much depends on the uncontrollable factors [1-6].

Lean principles have the potential to be successfully applied in the mining industry; however there are challenges that need to be considered and overcome. Think of lean not just as a change of process but also a change in company culture. It is a slow process and one that will require total devotion. Applied correctly, lean principles could have some seriously positive impacts on business.

Lean principles are not purely about cost saving; instead, it focuses on working smarter to reduce or eliminate the nonvalue-adding work people do each day. Lean thinking is not complex but requires detailed understanding of the process, it can save time, money and effort – and empower the workforce to increaseproductivity, efficiency and morale.

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