

ELIMINATION OF WASTE AND INEFFICIENCIES THROUGH LEAN MAINTENANCE MANAGEMENT IN MINING INDUSTRIES, GHANA

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Abstract

Due to growing global competition, the mining industry has suffered significant share of losses and the mining industry in Ghana is no exception. Lean operations and maintenance is a widely accepted and adopted approach across many industries and this concept has not been tested in a Ghanaian situation. The Process Maintenance section of the Processing Department was studied to identify the successes, failures, and challenges of lean maintenance implementation, in the areas of maintenance system, rework and maintenance cost. Qualitative and quantitative measures were used to document and compare the individual case studies. Both primary and secondary data on the Processing Plant of Newmont Gold Ghana Limited was used to analyze the effects and benefits of the lean maintenance implementation in a pre and post comparison. Findings of the study showed that Newmont Gold Ghana Limited was able to reduce reworks (defects), plant down time, and maintenance cost and all these reductions added to the total improvement in the company's operations. The general observation also revealed the need for a continuous training of workers on ways in improving lean maintenance culture.

Keywords: Financial Cost Reduction, Reworks, Plant down Times, Reduction in Maintenance Cost

INTRODUCTION

Maintenance in every organization has become a management issue, causing an organization to align its objectives of ensuring an incremental of value to its customers. The introduction of lean is caused by reduction in the profit margins of the mining industry as a result of the rising cost associated with the social and environmental demands of sustainable development (Humphreys 2001). To achieve this requires management of the organization and plant & machinery unit to work together in achieving machinery availability during its operating time within a calendar year. Lean Maintenance identifies and eliminates the wastes in the system of a company through continuous improvement (Anderson 2002). According to Teplicka *et al.* (2013), high cost of maintenance is between 15-40 percent of production cost which impacts cost reduction, profit maximization, high job security, reduction of the negative environmental impacts, and equipment reliability and its availability.

In addition, lean maintenance has the goal of making workers conscious and concern about waste, in order to help in its removal or elimination (Levitt 2004,2008,2009) and can be achieved by the involvement of management and staff (Klippel, *et al.* 2008) and this has occurred in other industries like automotive industry (Collard *et al.*, 2007).

Based on observed problems confronting mining companies globally as reflected in the data from 2008 to 2013 which has indicated the rising cost, thus the maintenance cost per ounce of gold produced at the Process Plant has increased from US\$ 250.00 to US\$ 500.00 and the total actual maintenance cost from 2008 to 2013 has increased from US\$ 500,000.00 to US\$ 800,000.00 (Newmont Gold, 2013). This study therefore sought to determine the impact before and after effect of lean maintenance activities such as reworks and plant downtime and also the effect of lean maintenance culture on the general maintenance cost of mining companies.

LITERATURE REVIEW

The success of the Lean Implementation does not just lie on the adaptation of the tools but on the cultural change of the organization, i.e. 'a true culture of continuous improvement'. Lean principles are continuous improvement approaches which rely on small but constant improvements, against the innovative approach which concentrates on quick improvements / changes and it can be agreed by all that the mining work is characterized as dynamic, uncertain, volatile and risky work environment and risk must be reduced as much as possible by reduction in accidents through safety procedures (Lemma, 2008). However, Dunstan, *et al.* (2006), found that there are underlining differences between resource and mineral processing

industry and automotive industry but each characteristic if not properly managed well can lead to potential pitfalls in the lean implementation.

Under Lean Maintenance Implementation on rework, plant downtime and plant availability, Womack & Jones (1996) identified five principles under lean implementation. First, the principle is to identify the specific value required by the customer in terms of the most important features requirement in the global market. High inefficiency will occur if the implementation team fails to identify the required value from onset and the result of which include the undertaking non-value adding activities. Second, the Value Stream represents the entire set of activities of the various department of the organization contributing to the product or service delivery. This represents the end-to-end process that delivers customer value satisfaction. After mapping the activities, then the non—value adding activities can then be modified or eliminated from the process. Third, waste elimination through flow creation is associated with the focusing on process design and establishment of capabilities that will ensure continuous movement throughout the process without any interruption, detour or waiting by eliminating waste. Fourth, the Pull principle ensures that rate of demand by the customers is met without overproducing. The requirement of an activity is carried out when there is the demand for those activities at the downstream and finally pursues perfection removes non-value adding activities from the process as a continuous improvement procedure ensures perfection in the process by constantly striving for improvement in the value specification, the value stream steps and increasing the flow speed.

Waste in maintenance (Bagadia, 2009) is and can be grouped as overproduction, waiting, transportation, process waste, defects and parts inventory. Overproduction is doing non-value adding work in the maintenance environment is considered as overproduction, while waiting which is not a value added activity should be eliminated or reduced as much as possible (Bagadia, 2009). Process waste which is the type of waste occurs when maintenance personnel are under a lot of pressure from production/operations, when carrying out breakdown repairs, thus causing them to improperly maintain the equipment. This occurrence results in a poor repair and recurring problems (i.e. frequent breakdowns). Allowing the maintenance personnel to perform their duties without the pressure from production will help eliminate this process waste, and thus, saving lost production time in the long term. In maintenance, a defect can be defined as leaving equipment in an unreliable condition and there are a lot of causes of defects in the maintenance environment. One cause of defect is poor workmanship as a result of inadequate training, outdated procedures and the use of improper tools to carry out the task. Maximizing the equipment reliability can help to minimize defects. Equipment must be available at all time when demand is required and the necessary are available (Bagadia, 2009; Smith et.

al, 2004). In the mining environment the risk involving repair works or reworks is very high due to potential accident and the relation to cost. It should be noted that in mining, reworks are not just due to work imperfection but also due to the nature of the work. The dynamic and unstable environment at the mining sector introduces constantly and unavoidable possibility for rework. However, this imperfection in the work can be reduced by standardizing procedures and the methods of performing maintenance work, thus assuring work quality.

In spite of the above, lean implementation has its challenges. According to Drew et al. (2004), lean implementation is a radical process because of the changes it introduces into the way of operating or carrying out maintenance activities but caution needs to be taken as Liker (2004) believes many companies have not reaped the full benefits of lean system, because they have embraced lean tools without understanding on what makes them work together in a system. Bicheno & Holweg (2009) states that there is a tendency of sticking to or retreating back to the old ways of doing things during lean implementation and this finding is based on a survey conducted on a large number of manufacturing companies in Canada in the year 2007. According to Nakajima (1994; 1998) one approach is to apply the concept of overall production effectiveness for waste elimination and increase the operational reliability, production quality and maintenance performance through the involvement and engagement of all personnel besides, anything customers will not pay is a waste (Karlsson and Alhstrom 1996). Another alternative towards reducing cost and waste is the outsourcing of departments such as spare parts units. Organizations may expect to achieve many different benefits through effective maintenance outsourcing, although there are substantial risks that may be realized if outsourcing is not successful (Majid, Ahmadreza & Reza, 2012) and if correctly managed, it can help in reducing business expenditures (Levitt 2009). This exercise of outsourcing of maintenance has taken in places like France (EU-OSHA, 2012) but without risk (Frost, 2000) but can be mitigated by lean safety (Huey, 2012), however questions must be asked about lower cost versus reliability (Idhammar, 2013).

RESEARCH METHODOLOGY

This study has exploited various research methodologies (Saunders *et al* 2003) by exploring their contribution toward the best triumph of the anticipated results. Relevant primary (Ghauri & Gronhaug, 2005) and secondary information was collated and analyzed to establish the best maintenance system and practices for the Process Plant Maintenance Section. The objectives of the study necessitated the adoption of a survey method. The instrument of structured questionnaires and interviews were used to collect primary data and document approach was used to collect secondary data from NGGL.

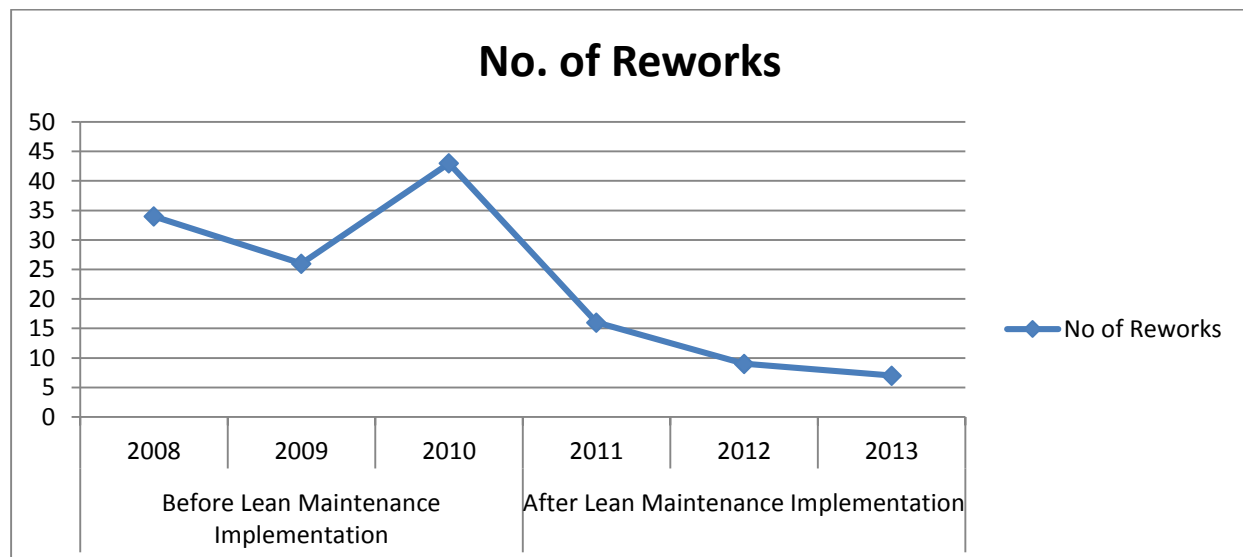
Since it was not economically feasible to reach out to all employees of Newmont Ghana Gold Limited, a simple random sampling of employees, who have witnessed the implementation of lean at the Processing Plant, was obtained. A total of fifty four (54) employees were sampled from both operations and maintenance sections of the Processing Department; 40 junior staffs, 10 senior staffs, 2 management staffs and 2 senior management staffs.

EMPIRICAL RESULTS AND DISCUSSIONS

The Effects of Lean Maintenance Implementation on Rework

The effect of the Lean Maintenance Implementation program has had a tremendous positive improvement on the rework. Before the implementation of Lean Maintenance (i.e. from 2008 – 2010), NGGL was experiencing a lot of reworks (see Figure 1).

Figure 1: Effect Before and After Lean Implementation on the Number of Reworks

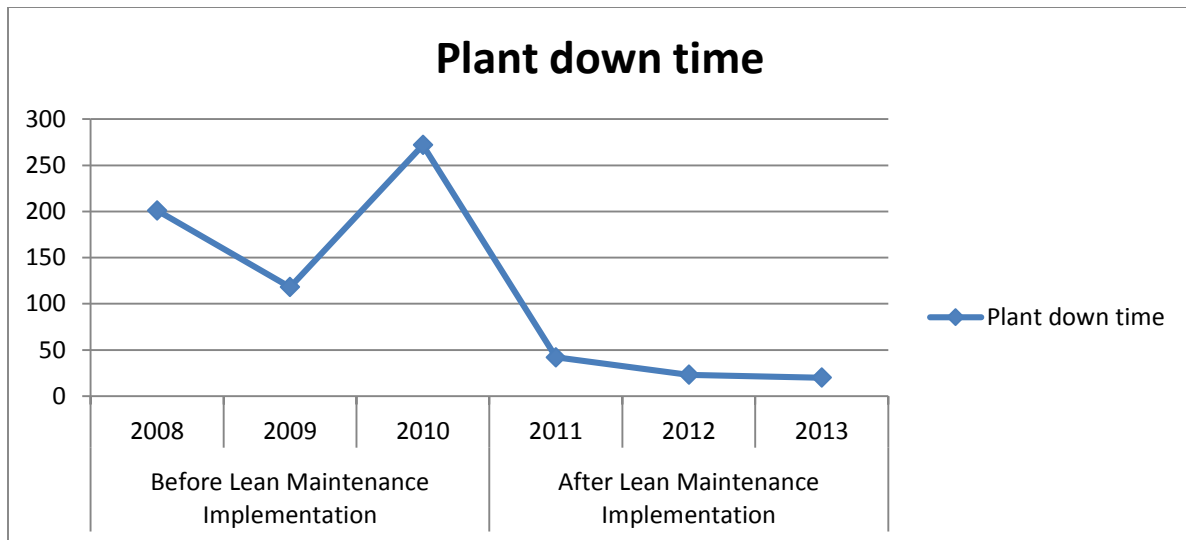


These reworks were due to a number of factors that have been addressed after the lean maintenance implementation. Some of these factors include unavailability of overall equipment maintenance parts; lack of Standard Task Procedures; Lack of Training for employees; insufficient precious instruments for the installation of equipment; etc. With the successful implementation of Lean these reworks significantly reduced as also shown in Figure 1. To express the effect in mean percentages terms and converting the pre and post lean implementation reworks into average means, the authors found a drastic reduction of 69 percent in the number of reworks from the pre implementation to the post implementation time frame.

The Effects of Lean Maintenance Implementation on Plant Downtime

The effect of the Lean Maintenance Implementation program has had a tremendous positive improvement on plant downtime. Before the implementation of Lean Maintenance (i.e. from 2008 – 2010), NGGL was experiencing plant down time (Figure 2). Some of the factors causing plant down time include lack of training for employees and insufficient precious instruments for the installation of equipment. These unplanned downtimes of an equipment drains a lot of resources both human and materials of the company. A further effect causes the production of gold not to meet revenue and production targets. With the successful implementation of lean these unplanned downtimes has significantly reduced as also shown in Figure 2. To express the effect in mean percentages terms and converting the pre and post lean implementation reworks into average means, the authors found a drastic reduction of 86 percent in the number of hours of plant down time from the pre implementation to the post implementation within the time frame.

Figure 2: Effect Before and After Lean Implementation on the Plant down Time Hours

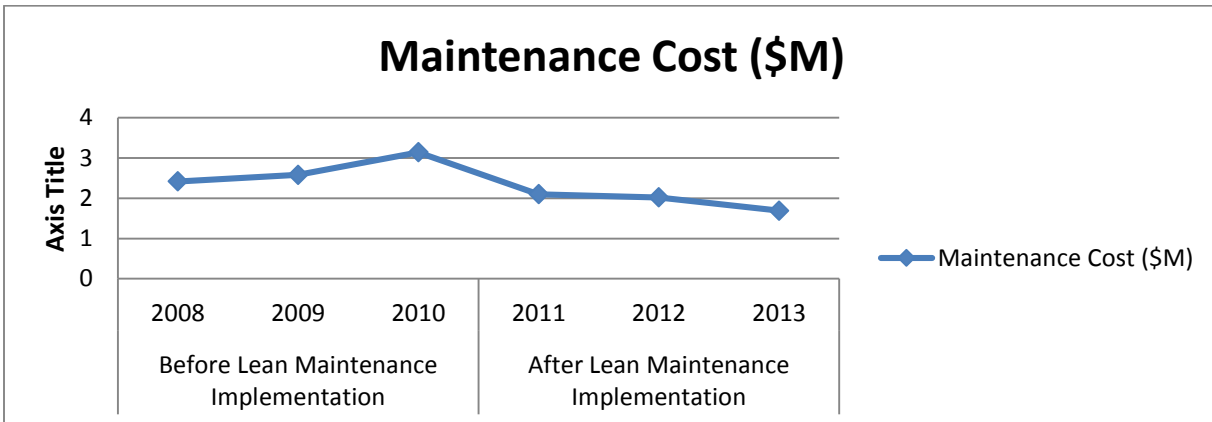


The Effects of the Implementation of Lean Maintenance on the Maintenance Cost of NGGL

The maintenance cost before the implementation of Lean Maintenance at the Process Plant was above the budget as shown in Figure 3, and this was due to bad practices and inconsistency in the performance of maintenance activities. Since the inception of Lean Maintenance, the maintenance cost is being well managed as shown in the Figure 3 below. With the reduction of reworks and unplanned downtimes, the cost of maintenance has improved and cost has reduced to an acceptable level per the maintenance budget. Duplicated tasks

were contributors to the maintenance cost, since there was no consistency in the way of completed tasks were recorded into the Maintenance System. The human resources of the company were not utilized as expected since works already completed were done again and again, thus causing financial loss to the company.

Figure 3: Effect Before and After Lean Implementation on the Maintenance Cost of NGGL



Due to the integration of maintenance department and other supporting departments like Supply Chain, Learning & Development, and Operations, as a result of lean implementation in the company parts are purchased and delivered on time; the required trainings are organized for the technicians, and operator-performed maintenance inspections are carried out to ensure that equipment availability and reliability. According to Teplicka et al. (2013), high cost of maintenance is between 15-40 percent of production cost and the results of this research has shown an improvement of 28.6 percent on maintenance cost which by inference will impact NGGL profit maximization, high job security, reduction of the negative environmental impacts, and equipment reliability and its availability .

General Observations of the Performance of the Maintenance Unit

Observations from interview undertaken from the staff of the plant maintenance unit of the company showed that the company lacked sufficient maintenance records from the day of its establishment and due to that it was difficult to obtain the data of each machine at the process plant. Even the maintenance was only performed after the equipment had broken down and this was during the period when lean maintenance philosophy had not been introduced. However, during post lean maintenance implementation, each of the equipment had its history and well-kept records to enable the company to perform its activities without any obstacles. Further to the above, it was also observed that the company had all the necessary safety equipment and

policies, but staff still lacked adherence to the safety rules which created a lot of near misses but further down the line in the post lean implementation, there were some indication of better management which led to low accidents. Finally, there was evidence of lack of theoretical background among the maintenance personnel to investigate and diagnose problems and solve them and the authors recommended that training of the employees should be enforced per the company policy. The skills of the workers cannot be increased if there are no trainings (both on the job and off the job).

CONCLUSIONS AND RECOMMENDATIONS

This research has been conducted and written in relation to the implementation of Lean Maintenance System in the Process Plant of Newmont Ghana Gold Limited at the Ahafo Mine site, Ghana. The study concluded that the high rate of unplanned and premature failures still exist to an extent in the Process Plant and this were attributed to the equipment condition; operator negligence; inexperience maintenance technicians; and non-existence of spare parts. Another contributing factor of the unplanned breakdowns is the poorly managed preventive maintenance system of the industry. The study also supports that the Process Plant was losing its expensive machinery for the fact that low quality, low cost and rebuilt spare parts for the maintenance activities without proper inspection of their condition due to lack of work standards. Lack of training or insufficient training, contributes to equipment failure due to mistakes on the part of the maintenance technicians. With current trend of high production and low gold price, it can be concluded that the company may fold up or phase out unless some sustainable actions are implemented. In order to alleviate the current situations of the maintenance system adopting and implementing lean maintenance is the way forward. To enhance the day-to-day activities of the maintenance personnel four major areas of maintenance management are recommended. They are inspection management, failure management, work management, and spare part management. This idea is for the company to rely on the continuous improvement, employee empowerment and standardization of every activity in order to minimize their execution times.

To reduce cost, utilize resources and also ensure the availability of equipment, and also executing maintenance work in day-to-day activity were a few recommendations suggested. First, the activities of the maintenance department should be considered as a necessary evil, and also not to be considered as a separate and isolated function that makes repairs that leads to high cost. It should rather be considered as a potential competitive advantage area over other companies and if this is not done, equipment will fail to the disadvantage of the company at a higher cost. Second, continuous empowerment through trainings should be the priority of the company in order to ensure sustainable implementation of Lean Maintenance and achievement

of its objectives and finally standardizing the maintenance activities will ensure that equipment inspections, overhauls, repairs, etc. are performed effectively and efficiently.

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