



A CASE STUDY: HOW 5S IMPLEMENTATION IMPROVES PRODUCTIVITY OF HEAVY EQUIPMENT IN MINING INDUSTRY

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ABSTRACT

This research aims to identify and present key concepts of 5S perspective. These findings link 5S to productivity improvement, which are aligned to an integrated maintenance system rather than maintenance system before. Data were collected from one of mining company in Indonesia. The data is concern in downtime unit, availability and productivity from one of heavy equipment, which is huge dumb truck. Then applying 5S method to decrease downtime unit, increase availability and at the end productivity of heavy equipment is increasing. The result will be compared between before and after 5S implementation. These findings demonstrate the importance of both the technical (visible) and philosophical (invisible) approaches required for each of the 5S components and are discussed in a team rather than cultural framework. The results indicate that 5S implementation may be a source of competitive advantage which can increase heavy equipment performance.



The originality and value of the paper is come from the general understanding of the application of 5S and its use as an improvement tool at the system or process level. 5S within the context identified is the strategic platform for the managerial decisions required for the development of an integrated maintenance system.

Keywords: Mining Industry, 5S Application, Productivity, Integrated Maintenance System

1. INTRODUCTION

Nowadays, in this dynamic and technological world, the secret of surviving for any kind of organization is to be competitive and pioneer in its products or services. Normally, this improvement has been achieved through implementation of best practices, which are chosen to meet a particular objective (SINGH et.al, 2014).

5S programs have been implanted in organizations and the world as a way to improve production values while also improving employee morale and safety. The 5S methodology may be applied to most workplace scenarios in a short period of time due to its simple nature (PATEL; THAKKAR, 2014).

Lean thinking represents a set of principles and techniques for the identification and elimination of waste in manufacturing and administrative processes. 5S is a technique originated from Japan and it was first developed by Hiroyuki Hirano in 1980s. It includes five Japanese words Seiri (Sort), Seiton (Set in order), Seiso (Shine), Seiketsu (Standardize) and Shitsuke (Sustain). The 5S philosophy focuses on simplification of the work environment, effective workplace organization, and reduction of waste while improving safety and quality (KORKUT et.al, 2009).

The 5S concept comes from Japan. The original purpose of the 5S is to make the workplace orderly to improve safety and efficiency, reducing the product defects rate. It is expressed by five Japanese words that express cleaning and order at the company and accepting this as work discipline (PATRA et al., 2005; MORA, 2007).

According to Ravinder (2012) and Khedkar et.al (2012). 5S allows the enhancement of efficiency and productivity. The 5S technique is a structured program to systematically achieve total organization cleanliness and standardization



in the workplace. The benefit of 5S technique is improvement in productivity, quality, health and safety.

Sorooshian (2012) said Through 5S methodology, the management can create an environment where quality work is comfortable, clean and safe in the organization and it can ensure the compliance to standards and will further foster continuous improvement.

In the beginning, 5S methodology was used to develop an integrated management system which developed in the total production maintenance (TPM) (BAMBER et al., 2000). It is aimed to have trouble free machines and equipments without any breakdown and producing components to the quality level giving total customer satisfaction.

Maintenance can be carried out as Preventive Maintenance, Breakdown Maintenance, Corrective Maintenance and Maintenance Prevention. Planned Maintenance is a proactive approach which uses trained maintenance staff to help train the operators to better maintain their equipment.

Objective of Planned Maintenance are to achieve and sustain availability of machines, optimum maintenance cost, improve reliability and maintainability of machines, zero equipment failure and break down and ensure availability of spares all the time (SINGH et al., 2012).

On the other hand, in the West 5S has a minimal use and is associated with an activity of maintenance (BECKER, 2001). At this time, the improvement requirement in different organizations may be affected by different complexity of systems. Furthermore, it is really important to know which method can help us begin the process of continuous improvement in order to achieve increased productivity and safety of the workplace through participation and knowledge of the involved staff.

It is why such university methodologies are considered as essential tools for the development of future professionals, especially engineers (SHEPPARD et al., 2008), and there is no doubt that one of the best ways to assimilate a methodology is through routine use.



The 5S methodology is not seen in the same way in all countries. For example, as you can see in Kobayashi et al. (2008), Japan emphasizes 5S as a strategy for business excellence, requiring participation both at work and in the home; in the other hand, 5S in the UK and US is viewed as a system or tool for the workplace only.

In some countries, the implementation of 5S methodology is a simple way to comply with the minimum requirements for health and safety in the workplace. This relationship has led to the possibility of extending the scope of the 5S through the incorporation of a new S, 'safety and health' (ZELINSKI, 2005).

Jiménez et.al. (2015), The present research project, developed in a university environment, responds to the continuous improvement process implementation and the need to optimize available resources used in different laboratories for trials and practice.

During the project deployment we have released two initial obstacles which, in addition, have marked the development of the project: (1) How should the improvement be approached, controlling costs and trying to simplify the implementation process? (2) How can the use of resources be increased during the laboratory practice (productivity), with safety and the minimization of risk? For an improvement, it was decided that the basis should be to organize, sort and maintain in perfect condition all the involved resources. On the other hand, the productivity increase in the resources used, and the improvement of the workplace should come through the definition of a systematic management plan that maintains and improves that process.

According Al-Aomar (2014), The 5S's lead to improved processes in terms of many aspects including: (a) Transparent process flow. (b) Clean workplace. (c) Reduced set-up times (d) Reduced cycle times. (e) Increased floor space. (f) Lower safety incident/accident rate. (g) Less wasted labour time. (h) Better equipment reliability.

This paper focus on the results of the case studies carried out as part of a research project in developing and evaluating the checklist audit for the 5S practice in mining industry. However, the lack of knowledge about the real meaning of 5S is the exclusive challenge. Many employees just know 5S only as a motto of the



company but they don't know exactly the strong point its self. So, in this paper will explain 5S base on study literature from many projects and papers around the world. And also, how to implement on the work bench then get the output as productivity improvement. For more specifics, in this project will focus on productivity improvement of heavy equipment by implemented 5S in mining industry.

2. METHOD

Patel and Thakkar (2014), A method commonly used by a manufacturing company to achieve an effective, efficient, and organized work environment, so as to boost productivity, reduce cost, and improve quality standards. 5S include five Japanese word which are seiri, seiton, seiso, seiketsu, and shutsuke.

5S programs have been implanted in organizations and the world as a way to improve production values while also improving employee morale and safety. The 5S methodology may be applied to most workplace scenarios in a short period of time due to its simple nature. The before and after picture are taken for implementation of 5S methodology in a company.

2.1. Seiri (Sort)

Patel and Thakkar (2014), Sorting items which are not necessary and segregating and disposing of goods that are not needed at work systematically. Separation process is helpful in determining the necessary materials at the present or the future and should be stored in a designated storage area. Unnecessary items will be disposed.

The arrangement used for keeping each material in the company at correct place is named as sort. The defective or rarely used material and equipment's in the company cause the demolishment of the workplace's order and decrease in the work efficiency. This leads to fewer hazards and less clutter to interfere with productive work.



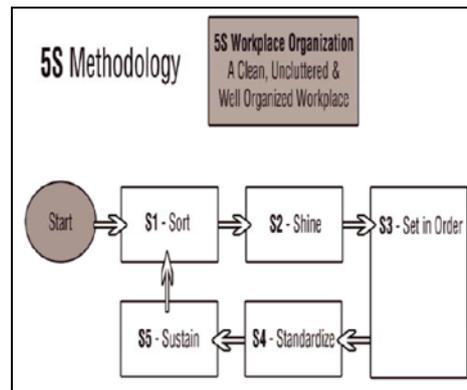


Figure 1: 5S Methodology

Sorting necessary and unnecessary materials is called “sort”. The arrangement used for keeping each material in the company at correct place is named as Sort (Mora, 2007). The defective or rarely used material and equipment in the company cause the demolition of the workplace’s order and decrease in the work efficiency (SARICOBAN, 2006).

Therefore, the necessary and unnecessary materials available in the workplace should be sorted and classified. In order to improve the availability of the working machine and hardware; some workstations such as the machines, tools, hand machines, materials to be used etc. should be kept available in an order and at places where can be easily accessed (CELEBI, 1997; KOCAALAN, 1999).

For this reason, when this first basic principle is well applied, the problems and complaints through the work flow will decrease and the communication between the personnel will be simplified. In addition to this, since serious savings will be obtained in the size of the required working environment, important drops will be observed in the operation cost (SARICOBAN, 2006).

2.2. Seiton (Set in Order)

According to this purpose, a localization order is designed for easily accessing to the necessary materials at required times and the materials are put their own places again after utilization (PATRA et al., 2005). As a result of the arrangement performed at the work stations (machines, tools, hand tools, materials to be used, etc.), these should be kept at a place where can be accessed easily due to the case of requirement (KOCALAN, 1999).

The place where the operation is actually realized, material transition paths and the storage method are the points that should be considered in this step. Some

points that can be controlled during regulation can be summarized as following (CELEBI, 1997): (i) Stock areas should be used at top level. Solutions such as a shelf order in proportion to the height of the classified material and drawers instead of big sized cupboards and boxes can gain efficiency in terms of stocking. (ii) In cases where “First in first out” principle is used, it should be avoided that stocking is deep. (iii) The stock areas, shelf and drawers as well as materials should be labelled. (iv) In case if the dimension and kind of the product change, then special vehicles may be used in machine adjustments.

Especially important is visualization of the workplace in order to focus on the need for the workplace. Tools, equipment, and materials must be systematically arranged for the easiest and the most efficient access. The main objectives of Seiton are forming a regular workplace, avoiding time loss while searching the material and mistake proofing work (PATEL; THAKKAR, 2014).

2.3. Seiso (Shine/Sweep)

In order to realize effective tasks, it is essential to create a clean and regular working and living environment (PATRA et al., 2005). This is because dust, dirt and wastes are the source of untidiness, indiscipline, inefficiency, faulty production and work accidents (ANON, 2007).

We can handle cleaning practices as a two-stepped approach; “general cleaning of workplace and availability of dirtiness sources” and “machine, hardware, tool cleanliness” referred as detailed cleaning (CELEBI, 1997).

In case of detailed cleaning, some advantages can be obtained. These can be summarized as following (KARABULUT, 1999): (i) Dirt and dust causes bad operation, corrosion and early demolishment of machine and its components. Therefore, dirt and dust sources are removed. (ii) As a result of making the workplace more proper to the working conditions, the morale of the personnel improves. (iii) The abnormal cases such as lubricant leakage, wastes, etc. are recognized immediately. (iv) As a result of psychological impact, the reactions and performances of the personnel get better. (v) Through providing a safer working environment, the danger contained works decrease. In order to realize shining through an effective system, the names of the personnel who are responsible from



the cleaning of each zone, each department and each point of the factory should be clearly determined and written at the proper places.

The shining time should be very short in order to obtain effective utilization. The best times for cleaning are the beginning of shift, end of shift or after meal. All personnel should be well trained about cleaning and participate in cleaning.

Point out the need and necessity of clean and neat work place. Cleaning should become a daily activity. The dust, dirt and wastes are the source of untidiness, indiscipline, inefficiency, faulty production and work accidents. There for Work place should be cleaned at regular intervals. Every tool and equipment should be restored at their own places after their use (PATEL; THAKKAR, 2014).

2.4. Seiketsu (Standardize)

Following the application of first 3S principles, the necessary systems are formed in order to maintain the continuance of these good practices at the workplace. In order to do this, these activities should be written according to the procedures and the memorization of these procedures by the personnel as well as the functionality of the rules should be obtained.

Providing the visual control that will enable the revealing of the problems that may negatively affect the conducted cleaning and the order is very important here. The methods which can be recognized by anyone at the workplace, not only by the relevant person, should be developed. It will be appropriate to write down performance monitoring labels, control lists, tables and some procedure for visual understanding on TPM board that will be formed in order to control the activities.

Following the visual control, the following activities are realized in standardize (CELEBI, 1997; KOCAALAN, 1999): (i) Allocation of workplace in terms of area or machine based regions. (ii) Determination of representatives for each region. (iii) Identification of points required to be controlled in each region (formation of cleaning-order lists). (iv) Removal of negativities recognized as a result of controls. For full application and development of the standards, the participation of all personnel is required.



Therefore, standardization means to make correct attitude and behaviours as daily habits and assure their full application in order to get over the handicaps in the first three basic principles.

Establishing the standard rules to maintain the perfect hygiene and safe environment at the workplace. The goal of this step is keeping, standardize, and preventing from this present order and regularity. The necessary systems are formed in order to maintain the continuance of these good practices at the workplace. Standards should be very communicative, clear and easy to understand. Regarding this during preparation and improving, it should be involved all participants of the process on the given workplace, it means direct workers (PATEL; THAKKAR, 2014).

2.5. Shitsuke (Sustain/Self-discipline)

The last step of 5S program covers the improvement of the methods directed to the adaptation of 5S as habit by all personnel. The task here is undertaken by the leader directors. The directors should explain the importance of 5S to the personnel through various trainings and the knowledge of the personnel about 5S should be kept. Updated through the 5S boards to be formed at the workplace.

Through various campaigns with easy participation, the dissemination of 5S should be targeted (CELEBI, 1997). The objectives of these studies can be summarized as following (KARABULUT, 1999): (i) Formation of a disciplined company. (ii) Removing small faults through the aid of cleaning. (iii) Providing the execution of visual control. (iv) Granting the responsibility of the machine to the worker. (v) Providing the performance of protective activities. (vi) And granting the responsibility of the workplace to the personnel.

Always Practice (Shitsuke): Train employees disciplined for practicing 5S system continuously so that the habits and culture within the organization. This is by far the most difficult S to implement and achieve. People tend to resist change and even the most well-structured 5S plan will fail if not constantly reinforced. It creates an educating, co-operating, discipline system and inspection for protecting the best present situation (PATEL; THAKKAR, 2014).



3. 5S APPLICATION

According to last research by Al-Aomar (2014) about applying 5S Lean. It is often simple to talk about how lean approaches work and about 5S in particular. However, the implementation of lean tools on the floor is totally different. This is because 5S is not just a methodology; it is a culture change that involves all parties to drive the organization towards effectiveness and continuous improvement. Thus, we had to first make it clear to all project parties why we are adopting the 5S lean technology.

The diagnostic study conducted at the Prefab plant revealed the following issues that collectively call for 5S application in the plant to identify process and improve layout and flow: (a) Space is crowded with parts and tools. (b) Unneeded items are stacked between workers. (c) Excess inventory on the floor. (d) Excess items and machines make it difficult to improve process flow. (e) Equipment is dirty and a collection point for miscellaneous materials. (f) Needed equipment such as tools are difficult to find.

Based on the diagnostic study, the 5S lean technique is adopted for process identification and workflow improvement at the Prefab factory for the following reasons: (a) 5S facilitates process definition by cleaning, sorting, and setting in order. (b) 5S provides the infrastructure necessary for plantwide improvement. (c) 5S is essential for streamlined process flow and layout redesign. (d) 5S is essential for worker motivation and increased loyalty. (e) 5S is the key for clean production environment. (f) 5S is essential to deploy safety measures and reducing accidents. (g) 5S is key to waste reduction: Minimizing waste and reusing waste materials, minimizing effort and time wasted in searching, removing excess material and inventory (AL-AOMAR, 2014).

It is also worth mentioning that 5S is not a list of action items that has to be reviewed at some interval of time. Instead, it has to be practiced consistently in all times. Thus, a practical step-by-step approach should be followed to make 5S attain a successful implementation. The followed project steps are summarized in the following: (a) Process structure and identification (layout and flow). (b) Awareness and training on 5S approach. (c) Overall plant inside and outside clean-up. (d) Applying 5S to 10 plant departments. (e) Utilizing checklists for 5S implementation



and auditing. (f) Waste reduction (less waste and reused materials). (g) Space utilization (clearing main aisle, providing space for reused items, clearing plant floor, providing space for material handling). (h) Cleaner and safer work environment. (i) Setting a basis for labour incentives. (j) Achieving a better labour morale (AL-AOMAR, 2014).

In this project, plant department is responsible for heavy equipment maintenance. As shown in figure 2, there are 4 areas separated based on its function such as; workshop area, washing area, welding area and workshop. Everyday, mechanic walk from workshop to warehouse and welding area to take spare part and get the welder then ask him to come to workshop for welding activity.

At that time, there is no clear boundary lines in workshop area. It is also hard to move materials from one area to another. Only one crane is used to lift heavy materials and parts then move them from one area to another. Workstations are dirty and flooded with excess inventory and rusty tools. The improved layout shows cleared main aisle, no flow obstacles, marked in/out areas, and more space for reusing items and material handling. These plant areas are organized and the main plant aisle is cleared and marked.

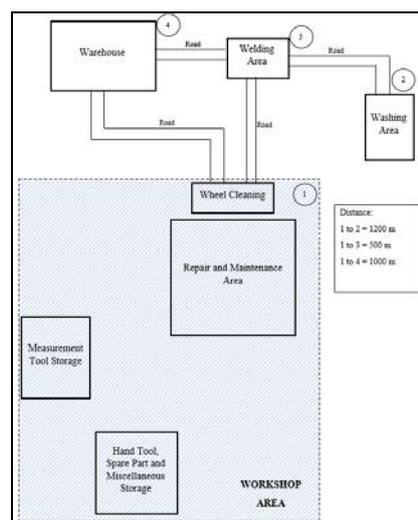


Figure 2: Layout Plant Area Before 5S Implementation

First, identifying the problem on maintenance flow and process. After that, find alternative solution to fix them by using 5S method in order to improve the productivity of the heavy equipment. Then 5S is implemented at the 4 areas in plant department.

An action plan is set and followed as a practical guide for translating 5S method and principles into specific actions that mechanics can easily understand and sustain. This implementation is huge challenge as a project team. The team has to work with general labour and mechanics on a cultural change.

They have to believe in the actions taken in 5S application in order to make tangible and sustainable changes on the floor then improve the productivity. To this end, the team focused the 5S implementation effort on one plant area to create labour awareness in the 5S method and to provide tangible evidence that can convince labour to cooperate with the changes and believe more in the 5S value and benefits.

The team started with sorting, ordering, and cleaning the workstation. Many obstacles come from cultural change, have enough time to receive the change. Great commitment has to invest on mechanics body and believe them. This is one from many ways to be greater day by day.

We started to explain to mechanics that this work is simply to clean and organize their workplace, it doesn't mean to add their job, and the cleanest and tidiest workstation will be rewarded and good for their carrier step. As a result, mechanics start to help in 5S implementation at the workshop area first. Mechanics that work on repair and maintenance area is trained on what exactly need to be done to keep the area clean and organized. The 5S procedure form, motivation words and PIC picture posted at the work area.

Figure 3 shows the layout of plant area after 5S implementation, it is results of 5S application to the plant area. It is more efficient with less movement and speed up the maintenance downtime and the actual status of the workstation that the 5S application has resulted in a clean and organized work area. Aisle passes through the area is cleared to allow for easy access of material handling.

Few days later, everybody at the plant noticed that the workstation area has become cleaner, tidier and more organized. The morale and the productivity of the area workers have also improved. It was the right time to explain and approach to all to keep 5S application at plant areas. In 5S application to workshop, it was important to develop a 5S checklist based on the 5S practical guidance discussed before.



The check list helps identifying opportunities and techniques for 5S successful and comprehensive application. The project deliverables to plant and a detailed layout is summarized in a 5S table as summarized forms to develop each area. Results collectively revealed a better process flow and a cleaner work environment. Specific actions on the floor were taken to save space, create and label storage areas, mark aisles and increase safety.

A new layout is developed, the plant significantly looked greater. We make an integrated workshop which completed with washing and welding area. Hand tool is being collected then make into one mechanic one toolbox. To guarantee for condition of hand tool, mechanic have to responsible for it and make any report to their team leader if there is broken or missing tools.

Then reduce significant unnecessary movement, and make a new Kanban to keep with minimum-maximum number of spare part that should be control by team leader. The Kanban is really useful, especially to reduce the daily walking to workshop and waiting for the spare part. We make good planning for service unit then prepare all the material regarding the service level. So, mechanics do the service better and faster.

As the result the break down time for unit that caused by service and maintenance can be minimized. At the end, the unit availability is increased and create high productivity for unit.

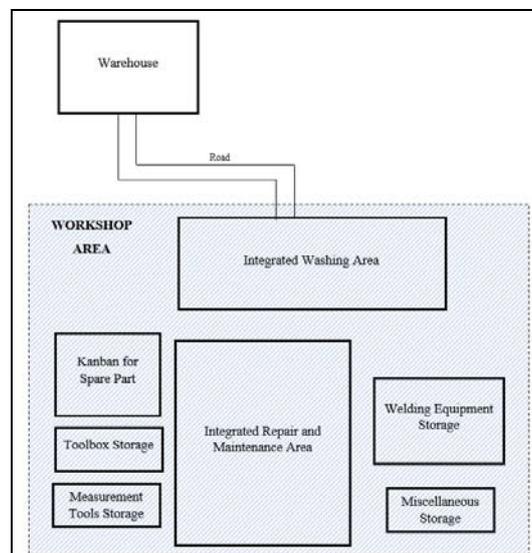


Figure 3: Layout Plant Area After 5S Implementation

4. 5S BENEFITS AND KAIZEN

“Kaizen” literally means “change for the betterment”. Kaizen involves small improvements and is carried out on a continual basis and involving people of all level in the organization. The principle behind Kaizen is that "a very large number of small improvements are more effective in an organizational environment than a few improvements of large value”.

This pillar is aimed at reducing losses in the workplace that affect our efficiencies. By using a detailed and thorough procedure we eliminate losses in a systematic method using various Kaizen tools. Objective of Kaizen is achieved and sustain zero loses with respect to minor stops, measurement and adjustments, defects and unavoidable downtime (SINGH et al., 2012).

The most frequently occurring concepts were: cleaning (seiso and seiketsu), improvement (kaizen) and arrangement (seiri and seiton); all three concepts were strongly linked to each other. These concepts were followed by place, management and activity, place and activity were closely linked and management existed in its own right. The fifth S shitsuke was emphasised as training, which was linked to the concepts of method and workplace (GAPP et.al, 2008).

In this project, we can calculate the benefit after 5S implementation which effects the heavy equipment productivity. Availability is well established in the literature of stochastic modelling and optimal maintenance. Barlow and Proschan (1975) define availability of a repairable system as "the probability that the system is operating at a specified time".

Blanchard (1998) gives a qualitative definition of availability as "a measure of the degree of a system which is in the operable and committable state at the start of mission when the mission is called for at an unknown random point in time”.

Productivity describes various measures of the efficiency of production. A productivity measure is expressed as the ratio of output to inputs used in a production process, i.e. output per unit of input. Productivity is a crucial factor in production performance of firms and nations.

Increasing national productivity can raise living standards because more income improves people's ability to purchase goods and services, enjoy



leisure, improve housing and education and contribute to social and environmental programs. Productivity growth also helps businesses to be more profitable. There are many different definitions of productivity and the choice among them depends on the purpose of the productivity measurement and/or data availability (GOLLOP, 1979).

The study identified a major emphasis for Japanese 5S organisations, that being “to create a better workplace.” An implication in this finding is that the implementation and management of 5S in the Japanese organisations studied. Availability measures are classified by either the time interval of interest or the mechanisms for the system downtime. After that, we can calculate the availability with formula below:

$$\text{Availability} = \frac{\text{Schedule Time}}{\text{Schedule Time} - \text{Breakdown Time}} \times 100\%$$

After that we can calculate the productivity based on availability data with formula below:

$$\text{Productivity} = \frac{\text{Production}}{\text{Availability} \times \text{Utilization}}$$

If the time interval of interest is the primary concern, we consider instantaneous, limiting, average, and limiting average availability. From all formula above, by reducing breakdown time. On way to reduce breakdown time is reducing service and maintenance time. By making better workstation by using 5S method to reduce breakdown time of heavy equipment.

After implementation, mechanic can speed up repair and maintenance time with better result and then impact high availability. With high number of availability, it will also increase the productivity. Table 1 and 2, describing comparison from 5S implementation related to availability improvement.

Table 1: Maintenance Activity Lead Time Before and After 5S Implementation

Before			After		
No	Maintenance Activity	Duration (minutes)	No	Maintenance Activity	Duration (minutes)
1	Receiving Unit (Pre-Inspection)	10	1	Receiving Unit (Pre-Inspection)	10
2	Washing Unit	40	2	Washing Unit (Integrated)	30
3	Wheel Cleaning	15	3	Prepare Tools	10
4	Waiting Spare Part	30	4	Repair and Maintenance (Integrated with welding activity)	40
5	Waiting Welder	15	5	Reporting	10
6	Prepare Tools	15			
7	Repair and Maintenance	60			
8	Reporting	10			
Total		195	Total		100

Table 2: Availability and Productivity of Heavy Equipment Before and After 5S Implementation

Before					After				
No	Serial Number	Description	Availability May 2017 (%)	Productivity May 2017 (Tons/Hour)	No	Serial Number	Description	Availability June 2017 (%)	Productivity June 2017 (Tons/Hour)
1	1601	Huge Dumb Truck	85	210	1	1601	Huge Dumb Truck	88	218
2	1602	Huge Dumb Truck	88	215	2	1602	Huge Dumb Truck	91	227
3	1608	Huge Dumb Truck	87	213	3	1608	Huge Dumb Truck	92	230
4	1609	Huge Dumb Truck	91	225	4	1609	Huge Dumb Truck	95	235
5	1611	Huge Dumb Truck	90	222	5	1611	Huge Dumb Truck	93	231
6	1710	Huge Dumb Truck	93	231	6	1710	Huge Dumb Truck	96	237
7	1712	Huge Dumb Truck	85	210	7	1712	Huge Dumb Truck	88	218
8	1715	Huge Dumb Truck	87	213	8	1715	Huge Dumb Truck	90	224
9	1802	Huge Dumb Truck	86	211	9	1802	Huge Dumb Truck	92	229
10	1803	Huge Dumb Truck	91	225	10	1803	Huge Dumb Truck	94	232
11	1805	Huge Dumb Truck	90	222	11	1805	Huge Dumb Truck	95	234
12	1907	Huge Dumb Truck	85	210	12	1907	Huge Dumb Truck	89	219
Average			88,17	217,25	Average			91,92	227,83



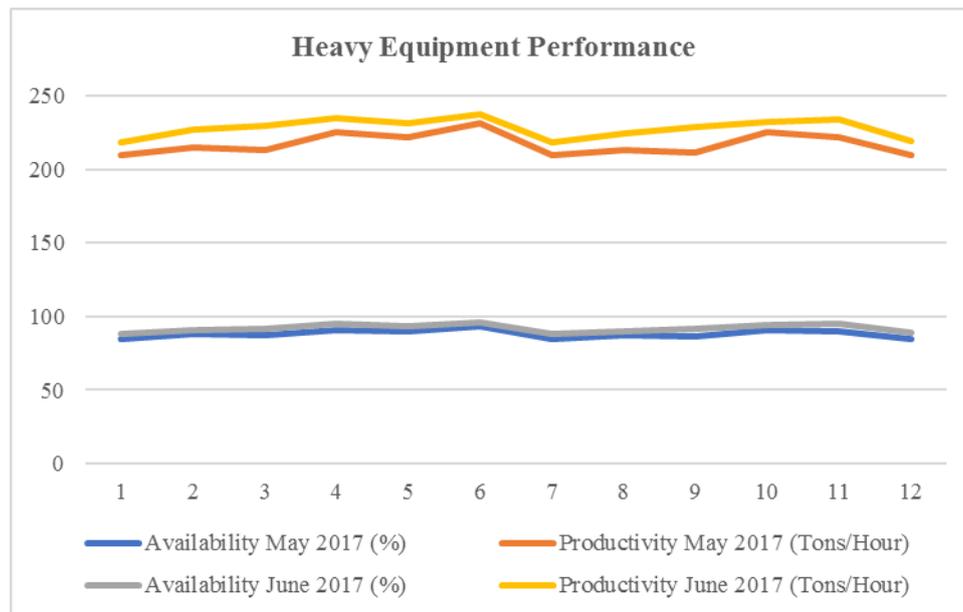


Figure 4: Heavy Equipment Performance May and June 2016

5. CONCLUSION

Due to implementation of 5S, there was improvement in space utilization, reduce unnecessary movement, creating integrated maintenance system, reduce time to find the tools and material, increase safety of the employees, decrease scope of error, increase productivity, and improved inventory system, also increasing of machines' efficiency, maintain the cleanness of tools and material, maintain the workstation cleanness, easy to check, quick informing about damages (potential sources of damages) and improve working environment.

The result of implementation of 5S is 400m square space saving in the plant department, much movement of men, material is reduced. Awareness of the 5S concept indirectly improved the morale of employees with better working environment. Periodically 5S scorecards should be checked and 5S auditing should be carried out for long term benefits to the organization.

Repair and maintenance of heavy equipment activities are performed in less time and with a considerable decrease in the cost, with an increase in available space dedicated to the equipment. After that, it also decreases the preparation time, maintenance costs, the anomalies identification time and the accident rate.

A clean workplace, well-organized and with visual indications of risks, is a safe workplace. The boards and labels installation allows workers to know at all times what the potential risks are. First result is reducing maintenance activity until



95 minutes faster than before. And give impact to the second result with increasing in the degree of equipment availability 3.75% average and productivity 10.58 tons/hour equals to 253.92 tons/day.

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