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Implementation of 5S and its Impact: A University Case Study

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Abstract

The Japanese 5S technique is one of the important lean manufacturing tools which can extensively help to enhance efficiency and productivity, reduce waste, and improve organizational culture. This paper reports a case of 5S implementation where one of the labs of a university was unorganized and subjected to inefficiency, long activity time, ineffective use of space, and excess inventory. 5S technique was implemented along with the input of Safety as the 6th S, after having an initial study based on some preliminary data collection, discussion with lab technicians and students, and their analysis. The major objectives were to organize the workplace, remove unnecessary items and manage the inventory, and minimize the time required to perform tasks and activities in the laboratory. The 5S implementation was found impactful and changed the work culture to a great extent with the removal of unnecessary items and a managed inventory, orderliness, cleanliness, significantly lower activity time, and safety enhancement.

Keywords

Lean Manufacturing, 5S, Safety, Time study, Waste.

1. Introduction

In the last decade, the global market has become highly competitive due to improved technologies and increasing customer demand. The industry and academia sectors have witnessed tremendous changes, involving changes in management approach, production processes, relationship with supplier and customer satisfaction as well as competitiveness. As a result of the continuously growing competition, manufacturing industries, both secondary and tertiary are under pressure to change their way of doing things by adopting innovative methods of manufacturing. Non-value-added operations increase the expense of a process or operation while adding no value to the company. Lean manufacturing is a methodology that helps organizations improve their quality and productivity by removing waste or non-value-added activities (Choomlucksana and Ongsaranakorn 2015). Longer waiting times are one of the major causes of employee dissatisfaction and lower morale, which leads to lower productivity. Other factors that contribute

to increased waiting time and decreased productivity are lack of resources, poor planning and management, and a disorganized work environment (Ishijima et al. 2016).
Lean manufacturing is a set of tools and practices for enhancing the performance of a firm or organization (Gupta 2022). Lean manufacturing is a method that may be used by manufacturing and service industries both. Kanban, Kaizen, 5S, and value stream mapping are some of its important tools and techniques. The 5S technique is an organized platform for achieving organizational cleanliness and a standardized workplace in a lean manner. Because of these specialties, applying 5S to various academia and industrial setups, results in enhancing efficiency and productivity. Because 5S is being used to improve activities in every type and size of organization, it necessitates a thorough grasp of the organization's context. 5S is one of the most important measures in establishing a thriving lean culture (Cooper et. al 2007). It is a technique for organizing, setting up, cleaning, standardizing, and constantly improving a work environment. The 5S technique can briefly be summarized as (Gupta 2022]:

1. Seiri (sort)- the first phase is sorting, which entails removing all extra things from the work area that aren't required for immediate operations. The resources, tools, equipment, and necessary information for completing the tasks can be identified by proper categorization.
2. Seiton (set in order)– arrangement of items, tools, materials at their best possible locations.
3. Seiso (shine)– sweeping and cleaning areas or facilities regularly as per the schedules and inspecting tools and equipment.
4. Seiketsu (standardize)- The goal of Seiketsu is to standardize the methods for sorting, organizing, and cleaning the workplace.
5. Shitsuke (sustain)- Maintainability in the application of the previous 4Ss.

The terminology for the study is in Japanese, since they best convey the 5S technique. 5S is regarded as a good beginning point for improving manufacturing enterprises due to its low cost and technologically undemanding features. Literature suggests that most companies still view 5S as just a cleaning or housekeeping concept even though previous studies or research conducted prove that it is more than that. 5S is a continuous improvement process that generates immediate results (Moriones et al. 2010). It is an organized way of insuring quality, safety, and optimum productivity at any organization. It is the first step of implementing lean manufacturing in any organization, and it helps to tackle and reduce waste associated within and between processes in any organization (Makwana et al. 2019). Under 5S, standards are set which lay a foundation for problem solving and continuous improvement (Ablanedo-Rosa et al. 2010). The benefits of implementing 5S in an organization include: Appropriate use of space in the manufacturing area; A clean work environment; Prevents the loss of items; Establishes discipline throughout departments; Improved customer service and communication; Error proofing reduces repetitive errors; A positive work environment with positive human relationships; Reduces workplace injuries and improves safety; Increases productivity (Gupta 2022). Good housekeeping creates an efficient and safe production environment, which boosts employee morale and develops a sense of ownership and pride in their job (Randhawa and Ahuna 2017).

In recent years, 5S has been popular among companies and industries as a way to improve human capabilities and efficiency. To attain a successful result from implementing 5S, each of the five ‘S' must be implemented and must be followed by the previous ‘S' in order to progress to the next level. Each of the five ‘Ss' in the 5S system has its own significance and is linked to the others (Makwana et al. 2019). In a survey conducted by Ferdousi and Ahmed (Ferdousi and Ahmed 2009), practices were improved productivity and quality in garment factories, with 44 percent of respondents using 5S. In an automobile accessory industry, 5S adoption enhanced production by eliminating idle time in several processes and maintaining employee health and safety (Kumar et al. 2007). The contribution of 5S, according to MIkva and Prajova (2017), is to assist eliminate waste in the workplace. After implementing 5S for components’ standardization, they came to the conclusion that standardizing work, provides discipline to an organization's culture and serves as a learning tool that aids in auditing and problem solving. Khan and Siddiqui (2017) reported the positive outcomes of the 5S implementation approach such as reduced cost, increased efficiency and effectiveness of processes, reduced pollution, and increased safety. According to the study, general obstacles to 5S adoption exist, and it takes few months to fully integrate 1S, 2S, and 3S. Choomlucksana and Ongsaranakorn (2015) carried out a study on lean manufacturing practices such as 5S, visual control, and Poka-Yoke. The study's goal was to increase the sheet-metal stamping process's production efficiency by lowering waste and eliminating nonvalue added tasks. The study found that using lean manufacturing principles yielded considerable results, with processing time cut by around 62.5 % and non-value-added activities reduced by 66.53 %. In addition, the cost of overtime had decreased. Not only in industrial set-ups, but also for educational institutes and service sector, 5S technique has been found very effective for workplace

organization, laboratory arrangements, and to make those facilities clean and green (Pita 2020, Khumalo and Gupta 2019, Sari et al. 2017).
As a result, we may conclude that the fundamental goal of 5S is to improve the workspace organization, boost productivity, increase efficiency, enhance safety, decrease waste, increase employee morale, and build a positive organizational culture. In addition, any organization can infer that 5S is the basis and initial step on the lean route. Considering that, we attempted to implement 5S for our university workplace, out of which, a laboratory case study is presented here.

2. Methodology

Unnecessary inventory, scrap, inefficiency, waste production, long set up and activity times and possibility of accidents are all exacerbated by an unorganized workspace. The mechanical laboratory at the university showed a great deal of the above-mentioned issues. The lab was crowded with no space to move and no tasks could be completed within the lab. Students were struggling to find space to complete their manufacturing projects organizing and sustaining the laboratory would be a difficult task. Thus, it generally required the implementation of lean manufacturing tools which in this case was the 5S methodology.

In our methodology, we used a quantitative observational evaluation method. The first step was to observe the laboratory at the University. In our case, the 5 WHYs approach, which is an iterative interrogative technique to determine the underpinning cause and effect links for a problem, was followed as below (Urban and Tochwin 2015, Benjamin et al. 2022):

- Why did this happen? Low storage density, too much clutter and unnecessary inventory, danger to occupants.
- Why did this arise within the lab? No cleaning and storage unnecessary items.
- Why did are the above procedures not being changed? Because there's no standard procedure or set of rules that can be followed to ensure that these problems arise.
- Why has there not been a change to set new standard procedures? Organizing and sustaining the laboratory is a difficult task.
- Why is it a difficult task? Because it requires the use of standard lean manufacturing tools to be successful, which in this case is the 5S methodology?

The second step was to implement the 5Ss methodology that is, Seiri (sort), Seiton (set in order), Seiso (Shine), Seiketsu (standardize). Shitsuke (sustain). Following are the implementing steps in our 5S methodology that helped to achieve the overall objectives of this study:

Implementing Seiri (Sort)

The laboratory at the University was described as the manufacturing laboratory where students complete their mechanical projects and also an area where lab technicians plan to fix the Mini Baja cars that were occupying the area. The laboratory depicted a storage area for machines that no longer work and other unnecessary items that were no longer of use by the university such as white boards. The laboratory was unclean, and packed with useless machinery and equipment that cannot be used for anything. As a result, Seiri was a necessity and was implemented as follows:

Step 1

- All items in the laboratory were identified and categorized as either necessary or unnecessary
- All unnecessary items were identified as either heavy meaning that they could not be moved out easily or light meaning they could be removed from the laboratory easily.
- From all this items, there were items that could still be used but did not belong in the laboratory. These items were identified and moved to other storage areas.

Step 2

- All heavy unnecessary items were removed. A request to remove the heavy items was sent to the head of department. Permission was granted and all the heavy items were removed. The pictorial representation for this is given in results and discussion.

Step 3

- All other unnecessary items were removed and disposed. In this process all items were placed outside the laboratory. Only the necessary items were placed back into the laboratory. It is illustrated in results and discussion.

Implementing Seiton (set in order)

This stage entails arranging, and labeling everything in a workspace so that it may be quickly retrieved and returned

to its rightful location. This method was implemented as follows:

Step 1

- With Seiri, locations of items have been fixed with Seiri, this is a basis for implementing Seiton for further action related to items segregation, cleaning, labelling etc.

Step 2: Arranging

- In this process all items are removed from the laboratory. After they are removed, a method of arranging is done. After that the items are placed back into the laboratory taking into consideration how they are going to be used.

Step 3: Labeling

- After the arranging process it is now easier to label all the items in the laboratory. All labels were typed, printed and mounted. Mounting was done to avoid dust all over the labels and tearing of the papers. These labels were then pasted on the items and also the walls.

Implementing Seiso (shine)

Under this, the workplace that has been arranged after the previous stages, should be kept neat and tidy by mopping, dusting, cleaning, properly maintained by regular schedules.

Step 1

- All items are placed outside the lab for proper cleaning. This is done because dirt and rubbish might be left under machines, tools or equipment.

Step 2

- Sweeping takes place

Implementing Seiketsu (standardization)

The continued use of the 3S will assure a high level of workplace organization. Once the 3S are in place, the focus should shift to establishing best practices. The plant must involve the development of processes and simple daily checklists that must be visible in every location.

Step 1

In Seiketsu the main goal is to standardize. The first step is to identify all the jobs that must be carried to ensure that the 3S are performed regularly. Below are the jobs that were identified.

- Inventory check- is all inventory in the lab necessary
- Floor cleaning
- Tables and cabinets cleaning
- Tools and equipment cleaned and put away
- Dusting
- Keep labels unobstructed
- Spraying insecticides
- Conduct 6S Audits

Step 2

- The next step is to determine who is responsible for which task. The laboratory was identified as a manufacturing laboratory wherein students with manufacturing projects can complete. Since the laboratory is not specific to any process. Any person who occupies the lab is expected to complete all the jobs identified other than those that will be completed by the laboratory technician.

Step 3

- In this step, the 5S schedule was developed in the sense that the checklists will be sent to the lab technician and pasted on the walls in the laboratory to make sure that all occupants are aware of responsibilities.

Implementing Shitsuke (sustain)

The fifth S is to make it a habit of keeping the pace of the previous four S in order to ensure the system's longevity and further progress by promoting effective use. Seiri, Seiton, Seiso, and Seiketsu have been effectively implemented, and to sustain that success in Shitsuke, different tactics are used to make the designated laboratory workplace organized and arranged for future work. All of these methods and techniques are covered below:

Training

Step 1

All occupants that require using the manufacturing laboratory must be taught about the importance of sustaining

its current state.

Step 2

Pictures of the before and after 6S implementation must be shown to all occupants. The pictures convey an idea of how the location should be maintained and cared for. These pictures are well discussed in section 6.

Step 3

They must then be handed the checklist/6S schedule which they have to look through or mark after they have used the laboratory.

Table 1. The 5S schedule

5S jobs/tasks	Daily	Weekly	Monthly	Quarterly
Inventory check- is all inventory in the lab necessary				
Floor cleaning				
Tables and cabinets cleaning				
Tools and equipment cleaned and put away				
Dusting				
Keep labels unobstructed				
Spraying insecticides				
Conduct 5S Audits				

Cleaning schedules

The cleaning schedule can be derived from the 6S schedule described in Seiketsu. Below are the activities that occupants need to follow or complete after using the laboratory. These activities can be done by occupants depending on how they use the lab i.e. if they use the lab for the whole week they have to complete both daily and weekly activities and if they use the laboratory for a day they can only complete the daily activities.

- Floor cleaning - daily
- Tables and cabinets cleaning - daily
- Tools and equipment cleaned and put away - daily
- Dusting - weekly
- Keep labels unobstructed – daily

Digital cameras for pictography and videography and stopwatch, were used.

Plan-do-check-act (PDCA) is a continuous improvement project implementation technique that is fit for all industrial environments due to ease of implementation and hybridization with other techniques (Sukdeo et al. 2020). The adopted plan-do-check-action (PDCA) approach for this study is shown in Figure 1.

The laboratory in which this study was conducted did not have any specific process being carried out in it or any assembly line. It is simply used for any manufacturing or mechanical projects by university students and some laboratory technicians. It was having simple activities such as fetching a trolley which students can use depending on the equipment they need for their specific project, fetching oil containers and so on. All the activities mentioned are transport activities. A time study to carry out these activities was conducted to analyze the impact of 5S implementation, whose details are given in the next section.

Implementing Safety

Some previous work is there on safety as the 6th S after 5S implementation (Sukdeo et al. 2020). Although some work has focused on implementing 6S in higher education, their main focus has usually been on libraries and offices. In this project safety (6S) was also included while implementing this methodology within the laboratory. Although the 6th S is included while formulating Shitsuke, as per the past studies, it can be implemented after the successful implementation of the 5S methodology.

In this study, the best approach to ensuring safety all occupants, was to use insecticides and use proper ventilation. But since this study did not have a budget to purchase insecticide and ventilation machines. Occupants need to keep the door open to avoid dust that can be harmful to their respiratory systems and also sweep the lab to remove any material that can or might attract insects. This sweeping process could help remove present insects. Protective gears while performing these activities were vital.

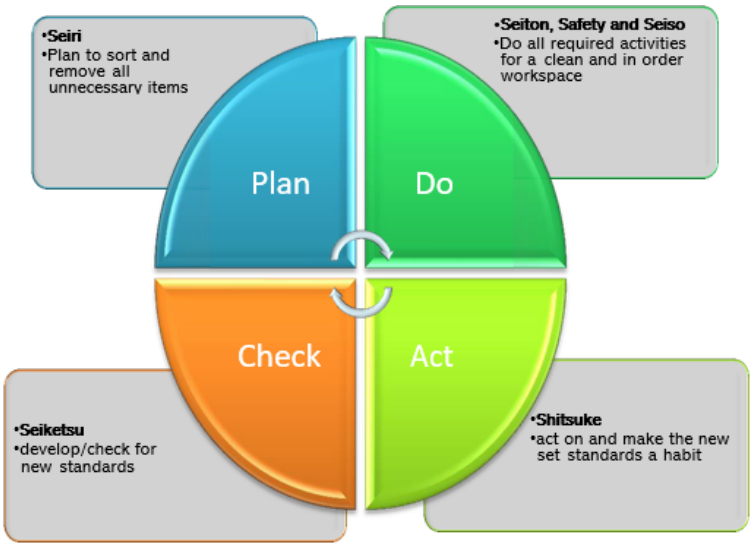

Figure 1. PDCA approach for the current study

3. Results and Discussion

While observing university laboratory before 5S implementation, the major issues identified were: not enough space to complete tasks; great deal of unnecessary inventory; parts and machinery that no longer work occupied the work space; dust and insects that can be a danger to occupants' health were identified; there were no labels; parts, tools and machinery were scattered all over the work space; there were leaves and dirt all over the ground and the work space was cluttered making it harder for occupants to reach for required items. After following the plan-do-check-act technique, the drafted schedule, and Ishikawa diagram, the stepwise, implementation procedure results are discussed here as under.

Seri implementation results where removal of heavy items under step 2 and segregation of necessary and unnecessary items for the laboratory under step 3 are shown below. Figure 2a depicts this process before removal and Figure 2b depicts the process after removal. Figure 2c shows the arrangement of items outside and within laboratory after following step 3 in Seri implementation.

The significant benefits of Seiri were identified as below:

- Moving products was easier and safer.
- Access to products was easier, enough space to move
- Greater storage density

Figure 3 illustrates the arrangement of items in the laboratory as per their usage, after following Step 2 arranging in Seiton. For easy identification, the labelling was done under step 3, and the labelled items are shown in Figure. 4.

The important benefits of Seiton were identified as:

- The time spent on fetching a tool or equipment is reduced, resulting in increased productivity.
- Parts/tools are easier to find
- More space for manufacturing projects

Figure. 5 presents the difference in the condition of lab before and after sweeping has taken place in Seiso.

The identified benefits of Seiso are as below:

- Clean and comfortable work environment
- No tools and machinery clogged with dirt and dust particles.

(a) Before removal of heavy items (b) After removal of heavy items

(c) unnecessary items kept outside the laboratory

Figure 2. Results of Seri implementation

There is clear evidence that the first 3Ss have been implemented. All items are sorted and set in order according to their names. The floors are clean which shows that the shine method successfully implemented. The next S (4th S) is Seiketsu which means setting standards and specifications, for which, the occupants were trained and 5S schedule was followed to ensure that the 5S implementation is kept in place by, ensuring that the items were put back to their rightful locations (as shown by the labels) after use, keeping floors and items clean and keeping unnecessary tools and equipment's away from the laboratory. The next S (5th S) is Shitsuke which means that the occupants must perform ongoing work of maintaining the 5S procedures. For that, trainings were conducted and the lab technicians and occupants were motivated to follow the schedules.

Figure 3. Results of arranging in Seiton

Figure 4. Results of labelling process in Section

We also conducted a time study where we compared the time taken to do a set of activities before and after 5S implementation. Table 2 presents the results of the time study and it is evident that for most of the activities, the time taken was extensively higher, due to the unorganized workplace, before 5S implementation. At a small level, we also attempted to implement the 6th S 'safety' to make sure that the laboratory is safe for occupants. Following the daily 5S schedule will help ensure that the workspace is safe and there are no dust particles or insects that can possibly harm the stakeholders occupying the workspace there.

(a) Before Siso

(b) After Siso

Figure. 5 Condition before and after Seiso implementation

Table 2. Results of time study

Activity	Before (sec)	After (sec)
Fetching trolley 1	210	48
Fetching trolley 2	215	53
Fetching oil containers	96	36
Fetching planks	430	36
Reaching to the cabinets	102	15

4. Conclusion

The main purpose of this research was to apply the concept of lean manufacturing to obtain a sustainable university. The lean manufacturing tool that was studied is the 5S methodology. From the findings and observations, it can be concluded that the laboratory that was not a safe space for occupants, have become organized, clean, and safe that greatly reduced the activity time, waste, and productivity and efficiency indirectly. The results of time study show that the activity time has been drastically reduced upto seven times, after 5S implementation. Implementing the 5S together with the 6thS which is safety has resulted in, elimination of unnecessary inventory, improved work flow and work performance, safety for occupants and an organized work space and a bigger storage density. Due to a great deal of insects and dust particles within the laboratory it can be recommended that the laboratory makes use of proper ventilation and effective insecticide. This study has shown that 5S is an excellent strategy to solve the problems within the university work area such as laboratory and workshop. For future work, in the planning stage, the implementer

could plan on having a budget for the implementation. To purchase ventilation equipment, cleaning products and other products necessary within the area of implementation.

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Biographies

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