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Analyzing the Impact of 5S Implementation in the Manufacturing Department: A Case Study

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Abstract

5S is a systematic approach that helps to organize a workplace for increasing efficiency and reduce wasting of productivity by providing an organized safe environment. The objective of this paper is to emphasize the implementation of 5S principles for the workplace by reflecting a tooling problem of a manufacturing unit. This article examines the challenges experienced in the implementation of 5S methodology to optimize labor and safety in a manufacturing department by showing the gap of productivity caused while not having 5S methodology in workplaces. The time consumption analysis of 5S implementation through shadow boarding demonstrates workers who have been able to perform work more efficiently along with a significant reduction of searching time of tools. The results showed that 5S along with the shadow boarding technique creates improvement in efficiency, workspace, equipment search time, working environment and safety. Consequently, this shadow boarding technique would strongly support the objectives of multinational companies to achieve continuous improvement and higher performance.

Keywords: 5S Lean tool, Lean manufacturing, Shadow boarding foam, Visual inspection, 7 Waste.

1 | Introduction

5S is the introductory method of lean manufacturing which energizes the way industries conduct production. Mainly it consists of 5 steps which are Sort, Set in Order, Shine, Standardize, Sustain. (See Fig. 1) High levels of management and the organizational Systems as well as the Management provision tools have been the two main modules of 5S. 5S is also the segment of kaizen which expedient “Transformation for Finer”. It supports the ideology of Total Quality Management (TQM) as well as the first Lean method which expedites the use of lean techniques in order to enhance the structure’s action. 5S has been one of the successional activities which fabricates in such a way that raises the standard of work environment, sense of responsibility and team commitment which further result in cozy and methodical workspaces. The better equipment reliability along with the reduced work time will boost up the production, the classification, the maintenance of workspace and this will further result in the depletion of cost. Moreover, 5S has always been enhanced the employee’s self-esteem and employee’s commitment.



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All the multinational companies around the globe give prime importance to the quality and productivity of the product they produce, which solely depends up-on accidents, down time in the production, working environment, housekeeping technique etc. On the other hand, in the manufacturing environment, Lean Manufacturing has been considered a dynamic learning method which reduces the wastage and continuously tries to increase utilization of the resources and activities that add value from the customer's perspectives. 5S has always been one of the initiatives which is responsible for the revolution in different types of industries. Different industries such as manufacturing and business sectors have been assigned with devastating stages before the implementation of 5S. Earlier, they have been involved with disorganized tool setting, filthy and unbearable environment with ineffectual process flow. Therefore, a vulnerable situation was created which enhanced the cost of production process due to wastage leading to the increasing of lead time to find the suitable equipment which are required. Complications has been encountered when the company is working on the project having scheduled due date. The purpose of this study has been the implementation of 5S which is the best solution of the given issues. Its further results in healthy environment, minimization of waste and enhancing profit, diminishing non-value adding time, improvement in productivity and quality as well as improvising the efficiency of the process by Shadow boarding. Shadow Boards are equipment that has been used in purpose of systemizing in the work plant which results deterioration of cost by storing the suitable tools in needed locations nearer to workstations so thus reducing waste and enhancing the efficiency of the process. Shadow Board applied basically in the stages of the execution of 5S.

2 | Literature Review

Jiménez et al. [1] showed 5S methodology application in university organiza-tions to create an organizational culture and applied both in the processes related to the students learning, and in the teaching and non-teaching activitie. Phogat [2] presented a theory of organizational culture and management in his paper and also discussed about Lean perspective and possibilities of tracking changes from the implementation of Lean. It turns the problem areas of the company to an improvement of efficiency and value adding through the implementation of Lean in the warehouse of the shipyard.

An industry application of 5S lean technology at a Prefab factory has been pre-sented by Al-Aomar [3]. The process flow at the Prefab facility is not stream-lined due to the wide variety in product specifications, the growing demand, the push production policy. Therefore, 5S lean technology is utilized for developing an infrastructure of continuous process improvement rations. The study by Singh and Ahuja [4] revealed that 5S implementation has improved the employees motivation, which has been demonstrated by significant increase in Kaizen suggested and implemented at workplace, thereby enhancing the value added per employee in the organization. After that the study of Yang et al. [5] explores the relationships between lean manufacturing practices, environmental management and business performance outcomes. It resolves the conflicts between lean manufacturing and environmental performance. On the other hand, the review of the use of 5S in healthcare services is discussed by Yang et al. [5]. The documentation about 5S, Lean, ways to implement 5S in healthcare settings, combinations of 5S and other tools and suggestions have been evaluated. Melton's [6] re-search emphasis on the complete change of the businesses by the implementation of lean which lead to improve the Performance improvements across the whole supply chain thus increase in business performance. The study of Omogbai and Salonitis [7] showed the short run dynamic implications of the sorting aspect of 5S which is investigated using system dynamics. It also showcases some intriguing relationships between 5S and other lean practices as well as system performance.

Then, the paper of Veres et al. [8] exhibited the relationship between 5S evolution and productivity in a local company from Mureş Country, Romania, which operates in automotive industry for over 10 years. Here, 5S method is very significant which have a positive correlation to overall performance of production results. Furthermore, the research paper displayed the methodology action steps, resources required and the target outcomes for the implementation of 7S by Joshi [9].

In the research of S. Singh et al. [10], 5S methodology has been explained and major critical success factors for effective implementation of 5S have come out from the analysis work are file management, Team work, Safety and accidental issues. After that Ramesh et al. [11] presented an application of 5S in technology in a Bio-mass processing unit. 5S lean technology is used for attaining project diagnosing the production process, streamlining the workflow, reducing process waste, cleaning the production environment. Hasan et al. [12] also applied 5S in their research for implementing total quality management in education system of Bangladesh. Alternatively, the implementation of 5S methodology in stores department of an electrical component manufacturing industry to improve the efficiency of all processes and elimination of different losses of the company has been explained by Ankit and Patel [13]. The research work by Lamprea et al. [14] mentioned the positive effects the 5S methodology on quality, productivity, industrial safety, organizational climate of any company. The methods and techniques of 5S which are used to increase the efficiency of all processes in the industry has been described in [16]. The essential thing of this paper is to break the activities on some major steps and to maintain continuous improvement.

The research work by Agrahari et al. [15] dealt with the execution of 5S methodology in the small-scale industry which shows significant improvement in safe-ty, productivity, efficiency and housekeeping as well as stronger work ethic within the management. The research work by Patel and Thakkar [16] has approved out to apply the 5S method of lean developed to solve the difficulty of workshop with the aim of good space exploitation and exclusion of devastate in the workshop. An overview of existing works in the field of 5S in showed in this article (See in *Table 1*).

Table 1. Overview of literatures.

Topic	Research Work
5S methodology application	[1], [3], [11], [13], [15]–[17]
Theory and experimentation Lean implementation	[2], [18], [5], [19]
Effect and outcome analysis of 5S	[6]–[8], [10], [14]
Introduction of 7S	[9]

3 | Problem Statement of Manufacturing Department

A secondary manufacturing unit worker was storing the tooling in tool set away from the production process. They have described how excessive downtime was caused as tools kept mixed up in the tool set and during the shutdown process time was being wasted sorting tools and few tools go missing. Further our observations related to the situation were: frequent tool loss, presence of unnecessary item, tools are not classified thus kept together. As tools are not visual at a glance, searching time of tools kill workers valuable time which leads to waste of waiting time and waste of movement. The current situation of tool set is terrible (See in *Fig. 1*). Furthermore, purchase of new tools cause waste of transportation and expense of tools replacement is also interrelated consequence of it.



Fig. 1. Current situation of tool set.

4 | Systematic 5S Approach to the Solution

4.1 | SEIRI

Ejecting out all redundant items from the workplace which includes damaged tools, raw materials, parts, equipment, and non-comforting stock for the immediate continual operation is called sorting. Therefore, SEIRI minimizes time wastage, unnecessary movement and reduces the pitfall of the workplace. This method reduces the cost and enhance the productivity of searching and collecting items.

4.2 | SEITON

SEITON is the procedure where it always been picked the essential items that are left out after the removal of clutter as well as displayed them in an efficient man-ner. Moreover, the place of every item must be labeled for recognition and placed in a fixed location. Each tool, material, piece of equipment should be kept close to where it will be used which will reduce waiting time for total setting. In addition, error can be easily identified and corrected for which the visual control is important.

4.3 | SEISO

In this stage, a smooth-running clearing is done by removing all the clutter items and unnecessary components. This process is mostly done after the stages of sorting and set in order. During cleaning the goods/items must be in their re-quired places and the work areas must be wiped and examined regularly in order to assist improvement. Moreover, cleanliness will aid to notify the destruction caused on the equipment such as fracture, discrepancy, etc. Here, the cost of maintenance for a machine can be minimized.

4.4 | SEIKETSU

After the assembling and cleansing of the production area, it is crucial to maintain the perfect hygiene and safe environment of the workplace. Therefore, the organi-zation originate standardized procedures, rules, regularity and presumption for maintaining continuous activity in all the areas time to time. This results in an ef-fective way for implementing the tasks outlined on daily basis. Moreover, all the workers need to be involved in the process on the given workplace so that they can know their own activities.

4.2 | SHITSUKE

The proposition is to sustain clean environment as an existence process and maintaining the uniformity of work as well as standards in a systematic order. This will stimulate the participation of all workers due to consistency in '5S' ac-tivities and will lead to the improvement of 5S principles. This process declines the unorthodox and non-functioning products and increase the internal convey-ance and engagement between the workers in the organization.

The key benefits of 5S:

- *Minimization of scrap.*
- *Better usage of space for storage.*
- *Maintenance upgraded.*
- *Enhanced safety measures.*
- *Improved in production, marketability, quality and efficiency.*
- *More devoted employees.*
- *Hygienic workplace.*
- *Less risk.*
- *Enhancement of communication.*

This study was done in two different steps.

5.1 | Steps of SEIRI

This is the initial step of the 5S method. SEIRI refers to classify the necessary and unnecessary tools, materials, items and remove the items which do not belong in the work area. As a result, a free up production space is created for the new business. Time level is constraint in order to find out the tools which are required. Moreover, through this method the forgotten materials detection for example spare parts and raw materials which will automatically save the reordering costs. Waste material may depreciate by identifying all the barriers and initiating ideas and improvement.

In this method, a list of question will be provided to each of the teams for the pur-pose of guiding. Here, each team will be extended over the whole work area so that the entire workspace is reviewed. The training plans will be given to the teams so that they will know what to do or not. In Addition, Red tags and Sort lists are the prime tools for SEIRI step. This is foremost to buy or make pre- numbered red tags since the number permit the matter to be tracked. Relationship between usage and frequency for listing material in showed in a tabular form (See *Table 2*).

On the other hand, safety devices have been installed properly in order to reduce hazards. In short

- *All employee's involvement in sorting and decision taken of what are needed and remove unnecessary clutter. For red tag techniques, staffs are given red tag and ask to put red tag if the tool is not needed.*
- *Remaining tools, gauges, materials, classified and then stored.*
- *Remove items which are broken, unusable or only occasionally used.*

Table 2. Relationship between usage and frequency for listing material.

Priority	Frequency of Use	How to Use
Low	Less than once per year	Throw away.
	Once per year	Store away from the workplace
Avg.	Once per month	Store together but offline
	Once per week	
High	Once Per Day	Locate at the workplace

Here, talking with the employee, needed and unnecessary item of the manufacturing unit were investigated and found many unnecessary tools example: existing type of T Allen key set of the maker packer set, and other items were classified.

5.2 | Steps of SEITON

This is the second step of the 5S method. SEITON means “to set in order” or position everything in right place. The tools which are constantly used must be accumulated near the work area especially where they belong. Therefore, this reduces litter by storing infrequent-used tools farther away. The items are now easy to conduct by the help of this method.

The handy tools must be piled by dangling them on a tool board over a painted outline in order to recognize easily. Moreover, applying this method expand the productivity by declining the time spent fetching for inaccessible items. In addition, the cost is reduced since the last tools do not need to be re-ordered. Less hazards due to tools are kept in appropriate and ergonomic places so as a result the workers do slight twisting, bending, stretching, uplifting. Furthermore, the workstation is simpler to sterilize since the tools have been gathered in a proper place.

Here in SEITON process we have used shadow boarding for tool standardization.

Shadow boarding Shadow boarding is an outstanding technique for setting the workspace in a well-organized manner and exploit this technique during the primary stage. This is a cooperative tool when implementing and sustaining the process of 5S. Shadow boarding layout the attributes of where the tools, equipment, supplies are stored and permit the employees to recognize from where the tools are missing. It is also commonly used when securing the equipment during travelling. This technique assists to evade losing high-priced equipment and postponed of projects.

Shadow boarding using existing furniture size of the manufacturing unit has been done. (See in *Fig. 2* and *Fig. 3*).

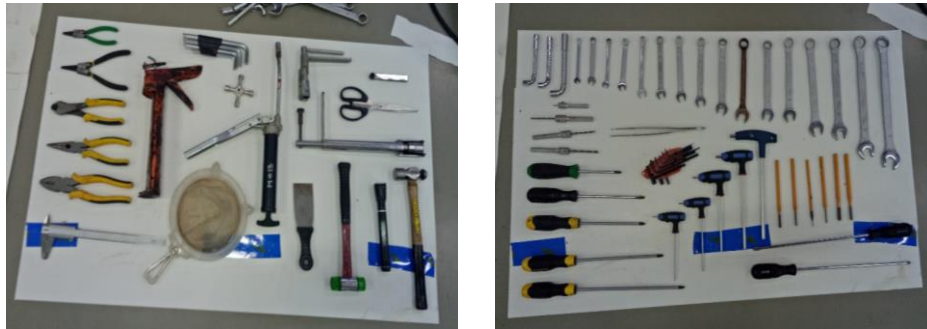
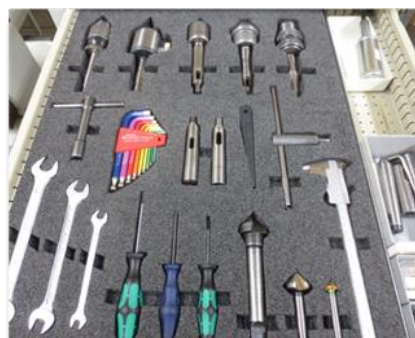


Fig. 2. Shadow boarding of 1st drawer (frequently required item) and 2nd drawer (not frequently required item).

Steps involved for shadow boarding:

- I. We took classified tool from previous step and spread them in two white sheets. One for the frequently required item and other for the occasionally required item. These two sheets were of exactly same dimension of the drawer / furniture size.
- II. Taking a pencil/marker all the items are traced carefully keeping required clearance in all side.



(a)



(b)

Figure 3. Implementation of shadow boarding concept in final design and construction of the tool set (Vertical and Horizontal).

5 | Time Consumption Analysis of the Industry

According to employees of secondary manufacturing unit of the industry, a worker needs minimum of 3 tools in an hour. On the other hand, the industry incorporates 3 shift each day and 155 people work in each shift. A worker is carefully observed while searching tool from existing tooling set and further shadow board is also made to use by the same worker for this research work. Afterwards, time study shows that worker took more time while searching in existing tooling set than the shadow boarding system. A comparison of Requirement of searching time of tool in existing tooling set and shadow boarding is also done (See in *Table 3* and *Fig. 4*).

Table 3. A comparison of requirement of searching time of tool in existing tooling set and shadow boarding.

Tool	Existing Tooling Set	Shadow Boarding
Spanner	24 second	8 second
Screwdriver	18 second	5 second
Drill bit	17 second	5 second
Total time	59 second	18 second

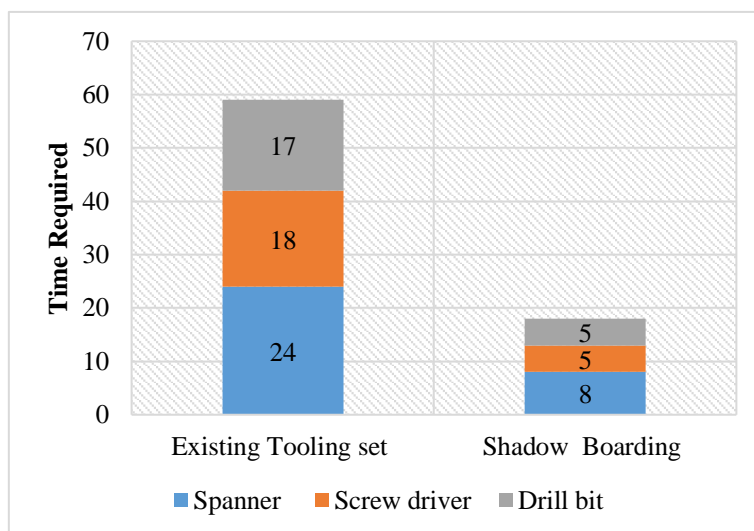


Fig. 4. A cluttered diagram showing direct comparison of time consumption study of existing tooling set and shadow boarding.

6 | Result and Discussion

Above time consumption study shows that a worker can save up to 41 second in an hour which is wasted in searching the tool in existing tooling set. Also, in every search time consumption has been lesser than the previous one. Considering all workers working in a day and searching time is reduced in each hour, time save is 152520s which is approximately 2 days. This time reduction will allow for extra productive time for employees to work meeting customer demand, being more efficient, and productive. An outcome model of shadow boarding of tooling set of manufacturing unit is outlined (See in Fig. 5). Ejection of all the redundant items from the workstation and keeping only the essentials documents as well as accessories in manufacturing unit has ensured effective utilization of workplace by SEIRI step of 5S. Penetrating hour of sorting raw materials, parts, tools, and document is contracted which ensured finer economical work outflow. Backlog cost of redundant items is declined.

Alternatively, by the application of SEITON step. The required items are properly arranged which reduce the time for piercing. Location of all essential items are labelled for recognition will establish a constructive and methodical storage concept among employees and an upgrade of protection from tool missing is ensured by the step as error can be easily recognized and corrected by visual control. Implementation of shadow boarding process for designing and construction of the new tooling drawer has:

- I. Improved quality as error decreases due to the calibration of time and position as well as arrangement are easily done.
- II. Reduction of time as the necessary tools are stored on the shadow board so the time is preserved by not probing for tools and tackle. Moreover, shadow board is kept close to the areas of use in order for the reduction of time spent going to and from the storage areas.

- III. Minimization of safety hazards as tools and equipment are not scattered around the work areas.
- IV. Loss of damage prevention as shadow boarding assign an accessible storage place for equipment, tools and supplies and as a visual aid the missing tools are clearly detected. This exercise assists to keep the items in satisfactory state.
- V. Increase in productivity since the workers become well-organized and productive, therefore, they are getting more production time than before. So, the plant achieves a great profit.
- VI. Accountability and traceability as shadow boarding stimulate accountability and support the process of detection losses. The visual aspect aids the customers to get back their property from the workforce since the tools are marked and it does not take such a long time in order to notify those particular items.
- VII. Organized storage as shadow boarding constructs an organized storage within a definite place for definitive items. As a result, making items facile to locate when required.

5 | Conclusion

Regardless of the ease in 5S method, implementation of the system often results in failure. Not only that, but implementation barriers also lead to failures such as lack of management support, not enough time, resistance to change poor communication, the poor training and awareness of 5S.

For effective housekeeping and maintaining health and safety standards, necessity of 5S implementation is unavoidable. Elimination of unused, unwanted material from the shop floor is the main priority of 5S Sort stage to reduce clutter. Set in order aims for allocation of space for components, materials and tooling in organization results in reduction in searching time. As a result of changes, employees become self-disciplined and effects are visible in short span of time. In this paper, we have worked on the implementation of 5S in standardization of tooling set. First two steps of 5S are applied in manufacturing unit and afterwards shadow boarding execution is evaluated by time consumption study. Further outcome model of shadow boarding implementation was established from the results.

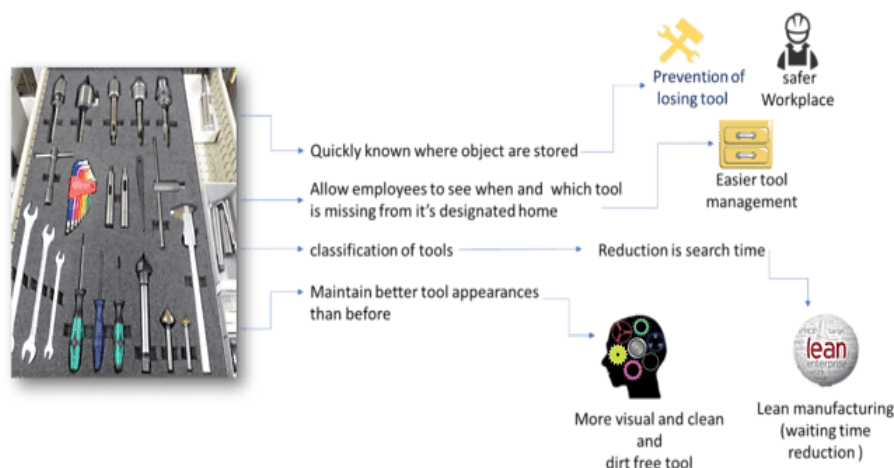


Fig. 5. Outcome model of shadow boarding of tooling set of manufacturing unit.

Future work will evaluate the methodology implementation process in other departments along with safety as the 6th S. A longitudinal study can be conducted to understand the long-term effect of changes due to 5S. The presented outcome model of 5S implementation also reveals interesting relationship between 5S and other lean tool such as 7 waste concepts. This outcome model can be examined, and performance can be evaluated.

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