International Journal of Advanced Technology in Engineering and Science
Vol. No. 12, Issue No. 03, March 2024
www.ijates.com
ijates
ISSN 2348 - 7550

Integration of the 5S Approach for Enhancing Quality Support within Lean Manufacturing Settings

C. Gnanavel [1], T. Gopalakrishnan[2], S. Ajith Arul Daniel[3], Vijay Ananth Suyamburajan[4], M. Ruban[5], S. Sivaganesan[6]

[1,2,3,5]Assistant professor, Vels institute of science, Technology and Advanced studies, Chennai

[4,6]Associate professor, Vels institute of technology, Science and Advanced Studies, Chennai

ajitharul.se@velsuniv.ac.in

Abstract

In the manufacturing sector, failures arise from various factors such as inadequate raw material usage, inefficient resource utilization, and time management issues. The Research and Development (R&D) division continuously strives to enhance production performance through methods like failure analysis, quality enhancement, rework analysis, and time optimization. This research article aims to introduce the 5S quality tool as a complement to standard techniques for improving manufacturing environment effectiveness. Common techniques employed for raw material flow control include Total Productive Maintenance (TPM) and Statistical Process Control (SPC). The 5S quality tool is applied based on the Ishikawa diagram of raw materials, offering an extended approach to reducing production wastage and achieving a lean manufacturing environment.

Keywords: 5S, Lean Manufacturing, Quality Assistance, Workplace Organization, Efficiency, Case Studies.

1. Introduction

The industries are adopting lean practices to compete more effectively against global competition. Through lean manufacturing the non-value adding activities can be eliminated and by that the performance of the system will be improved (Narasimhan et al.). The main concept of lean manufacturing is to increase the customer value by reducing waste (Wahab). This idea is implemented to increase productivity, improve quality, lesser lead time, minimize cost and so on [Karlsson]. Soft production is primarily focused on successfully eliminating seven major types of waste in all manufacturing, over-producing companies; waiting time; transportation; inventory; processing; movements and errors (Parks, 2003).

For adopting the lean concept, various quality tools are initiated to the system, which are developed based on the modern management approaches. The commonly used tools and techniques are Kaizen Rapid Improvement Process, 5S, Total Productive Maintenance (TPM), Six Sigma, Cellular Manufacturing, Just-in-time Production, Pre-Production Planning (3P), Lean Enterprise Supplier Networks, autonomation, and value stream mapping (VSM) [Sharma, Garza-Reyes].

Several researchers have used these tools and techniques in many industries and are studying the barriers to improving soft productivity in a variety of fields. Pugazhenthi and Anthony Xavior used the TPM concept by using the proposed heuristic to reduce the idle time of the machines in the flowshop. As a result, the production rate has doubled. Isaac et al. (2016) addressed the problems of group planning in a hybrid flow shop environment and argued that the complete allocation of sensitive equipment could reduce the lead time of the production facility.

Karam, Al-Akel, et al. had contributed a lean manufacturing tool through a Single-Minute Exchange of Dies (SMED) project to decrease changeover time in the pharmaceutical industry. Priyanka Rai et al. made a data collection using surveying method and distributing questionnaire among general employees of the organizations and initiated a fishbone plot to identity the defects of the organization. Later, 5S methodology was implemented to raise the attitude and performance of the employees. Similarly studied was carried out by Vipulkumar C. Patel et al. to increase the efficiency of all processes in the company and Soumya R. Purohit et al. to increase the productivity and profit levels through daily management practices.

From the literature, it is inferred that the quality tools are implemented to enhance the efficiency of the system through step-by-step guidelines. But still, the intrinsic worth of the standard procedure is neglected in the proposed approaches. In previous study of Gianluca et al., the lean manufacturing approach was adapted with the manufacturing execution systems to improve the rework feasibility and reduced the lead time around 40%. This research article aims to integrate the quality tools/techniques with the standard approach to develop a contemporary approach, which can sustain with merits of standard and global tools. For the experimental illustration, a punching machine shopfloor has been studied with the implementation of proposed contemporary approach.

2. Methodology

2.1 Study on Standard Approach and Its Demerit

The standard approach is dependent to the specific system and it has its own merits and demerits. Some of the common standard approaches are First-In-First-Out (FIFO), Last-In-First-Out (LIFO), Integrated Executive Manufacturing, etc. Even though the Research and Development (R&D) experts of the organization prefers their standard approach, but still they seeking for improvement through advanced management tools.

Insight of this theme, the R&D experts studies the complete system to identify the cause of the failure/breakdown and spot the possible methods to retrieve/overcome the malfunction in the performance. The commonly used quality tool to estimate the cause for malfunction is Ishikawa Diagram.

2.2 Quality Tools

Among the various quality tools for Quality Improvement (QI) of an organization, the 5S is the appropriate tool to be considered (Randhawa and Ahuja). Since, it works with five simple elements. They are Seiri, Seiton, Seiso, Seikestu and Shitsuke, which means sort, group, remove wastage, standardize and regularize respectively.

2.3 Integrated Modern Approach (IMA)

The proposed contemporary approach is integration of standard or default organization tool with advanced quality tool. This methodology works with three stages, which are analysis, implementation and evaluation. The three stages of IMA are graphically represented in Figure 1.

Stage I - Analysis: In this stage, a detailed report will be generated to collection data about the factors that affect the system and its major responses. Generally, it will be achieved through an Ishikawa diagram.

International Journal of Advanced Technology in Engineering and Science
Vol. No. 12, Issue No. 03, March 2024
www.ijates.com
ijates
ISSN 2348 - 7550

Stage II - Implementation: In this stage, the 5S tool is implemented along with the standard approach of the system. The definite lay of the 5S will not be altered but the track or approach of each element will be integrated by the default or standard organizational approach.

Stage III - Evaluation: The fitness of the solution after *Stage II* will be estimated and compared with the standard approach performance. If the improvement is obtained, the worked out procedure will be sustained to the system. If the result is negative, the element or lay of the *Stage II* will be re-arranged in order to improve the efficiency of the system than the standard approach.

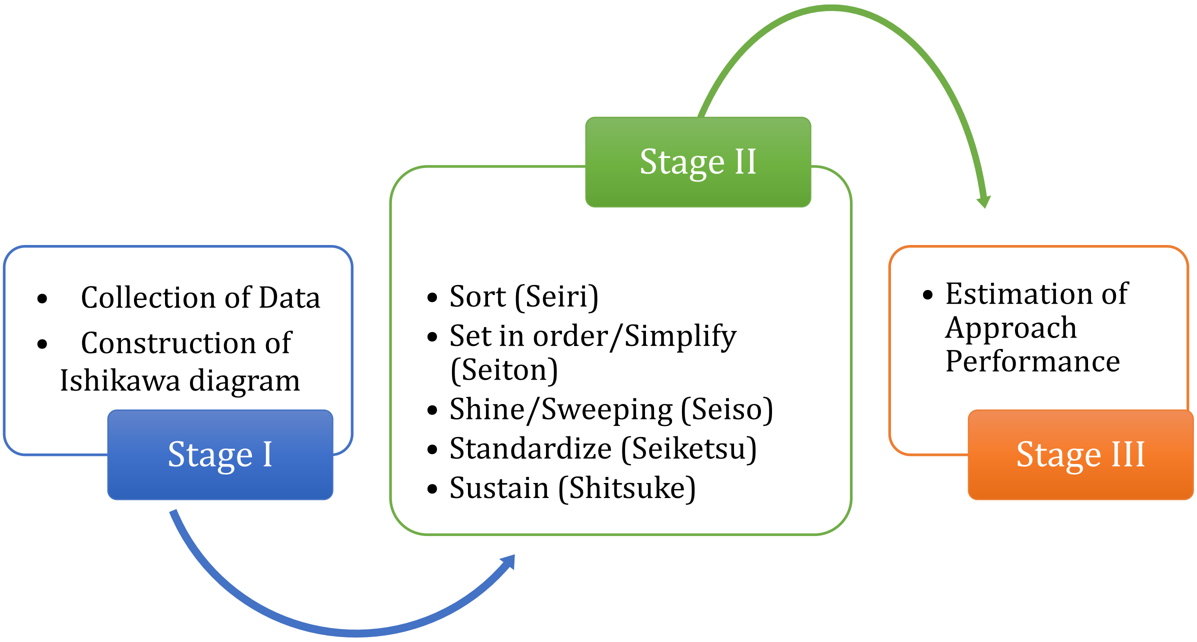


Figure 1 Stages of IMA

3. Case Study - Punching Machine Shopfloor

3.1 General Flowline

For real time evaluation of proposed IMA, the punching operation is selected from ABC industry, which is to form the triangle shaped sheet metals pieces in different sizes. The photograph of the punching machine is shown in Figure 2. The basic flowline of the operation is shown in Figure 3, which starts from inventory loading to quality inspection processes. To study the system, a table of questions has been prepared and a survey taken on it (Table 1).

International Journal of Advanced Technology in Engineering and Science
Vol. No. 12, Issue No. 03, March 2024
www.ijates.com
ijates
ISSN 2348 - 7550

Figure 2 Photograph of Punching Machine

Figure 3 General Flowline of Punching Operation

Table 1 Survey Questions

Question Number & Relevant Stage	Questions	Suggestions
1 – Stage I	Basic details of the company like man power, work area, selected operation, resource availability and emergency measures.	The standard data and procedure will be considered.
2 – Stage I	What are chances of failure and its probability?	Types of failures in samples and its frequency are estimated.
3 – Stage I	What are the throughputs or required outcome?	The response or performance of the system expecting.

International Journal of Advanced Technology in Engineering and Science
Vol. No. 12, Issue No. 03, March 2024
www.ijates.com
ijates
ISSN 2348 - 7550

1 – Stage II	What are types of raw material?	Types of the sheet metals based on the thickness.
2 – Stage II	What are required specifications of sample or product?	Details of the final product.
3 – Stage II	What are the cause and effect of standard approach and IMA?	Analysis of execution process through simulation.
4 – Stage II	What are the remedies possible to avoid failure?	The methodology to be executed to state the probability of failure and to reduce it.
5 – Stage II	What are techniques and approach to be regularized?	The approaches leads to improve the success percentage are to be selected and standardized.
1 – Stage III	What is effect of standardization and percentage of improvement?	Evaluation of performance through the response achieved.
2 – Stage III	What are the merits and demerits of the proposed standardized system?	For further study.

3.2 Implementation of IMA

The stages of IMA implementation in punching operation is graphically represented in Figure 4.

Stage I - Analysis: A detailed study was conducted to collect data about the factors that influence the system and its major responses. Based on the research, the cause and effect diagram are designed for piercing function as shown in Figure 5. Major factors contributing to property damage, measurement error, clearance deviation and tool quality, which influence on material usage.

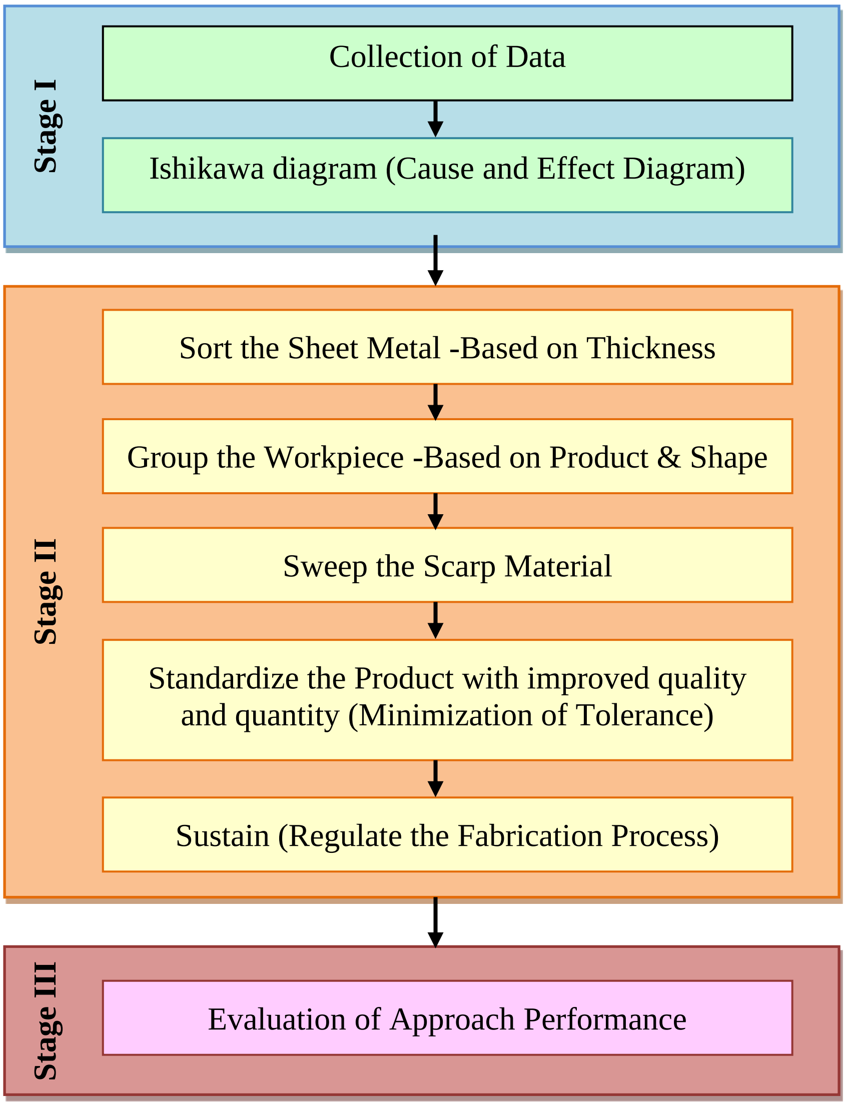


Figure 4 Flowchart Representation of IMA Implementation

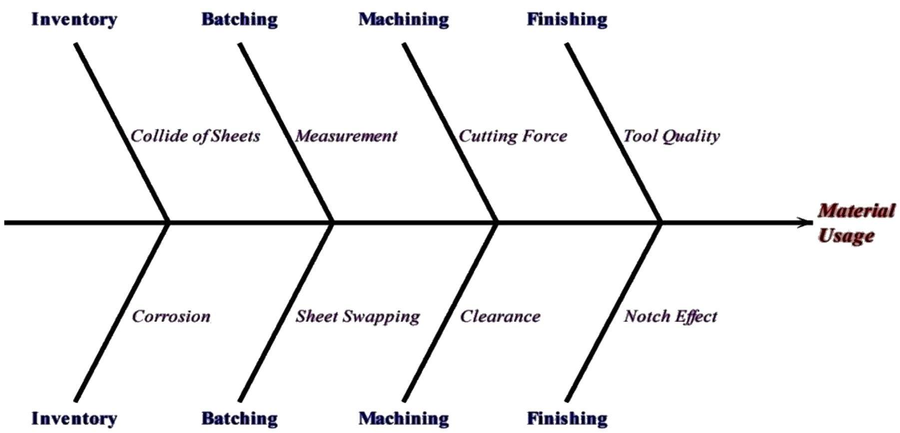
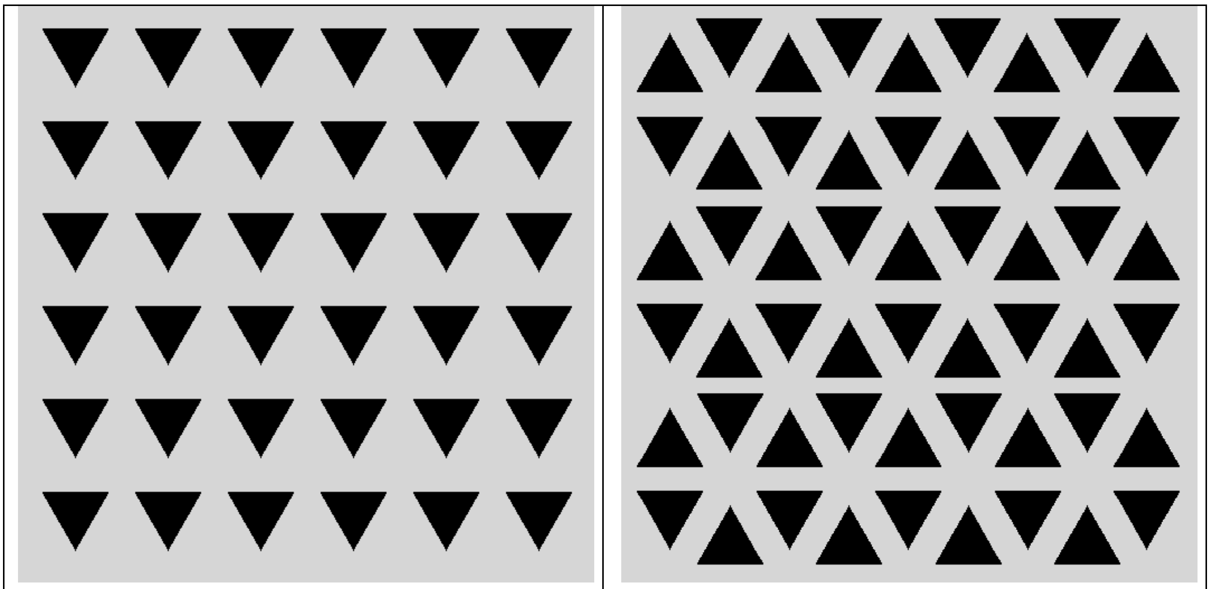


Figure 5 Cause and Effect (Ishikawa) Diagram

Stage II - Implementation: In this stage, the 5S tool is implemented along with the standard approach of the system. The adaptations in each element are tabulated in Table 2.

Table 2 Adaptation of 5S Tool with Standard Approach

Seiri	The sheet metals from warehouse are selected with fixed dimensions and fine quality.
Seiton	The sheet metals are grouped based on the thickness and product requirement.
Seiso	A new pattern of punching is designed to reduce the material waste compared to standard punching pattern (Figure 6)
Seikestu	The proposed approach is standardized based on the selected procedure, which improves quality and quantity with minimized tolerance (Super finish).
Shitsuke	The standardized IMA is regularized to estimate the durability and accuracy.



(a) **(b)**

Figure 6 Punching Patterns (a) before and (b) after IMA Implementation

Stage III - Evaluation: The responses of the standard approach and IMA are compared in Table 3. A scatter chart is plotted in Figure 7 to identify the surface area of the triangle samples. It reveals that the increase in samples after 5S implementation has increased the

International Journal of Advanced Technology in Engineering and Science
Vol. No. 12, Issue No. 03, March 2024
www.ijates.com
ijates
ISSN 2348 - 7550

tolerance deviation of the samples. By this effect, the additional finishing requirement is increased to 9.3 % from 5.5 %, even though the material utilization is increased about 11 % approximately.

Table 3 Responses for Before and After Implementation of 5S

S.No	Description	Implementation of 5S	
		Before	After
1.	Number of Samples/Slot	6	9
2.	Total of Sample	36	54
3.	Material Utilization	22.45%	33.67%
4.	Probability of Sample Damage	2.7%	1.85%
5.	Additional Finishing Requirement	5.5%	9.3%

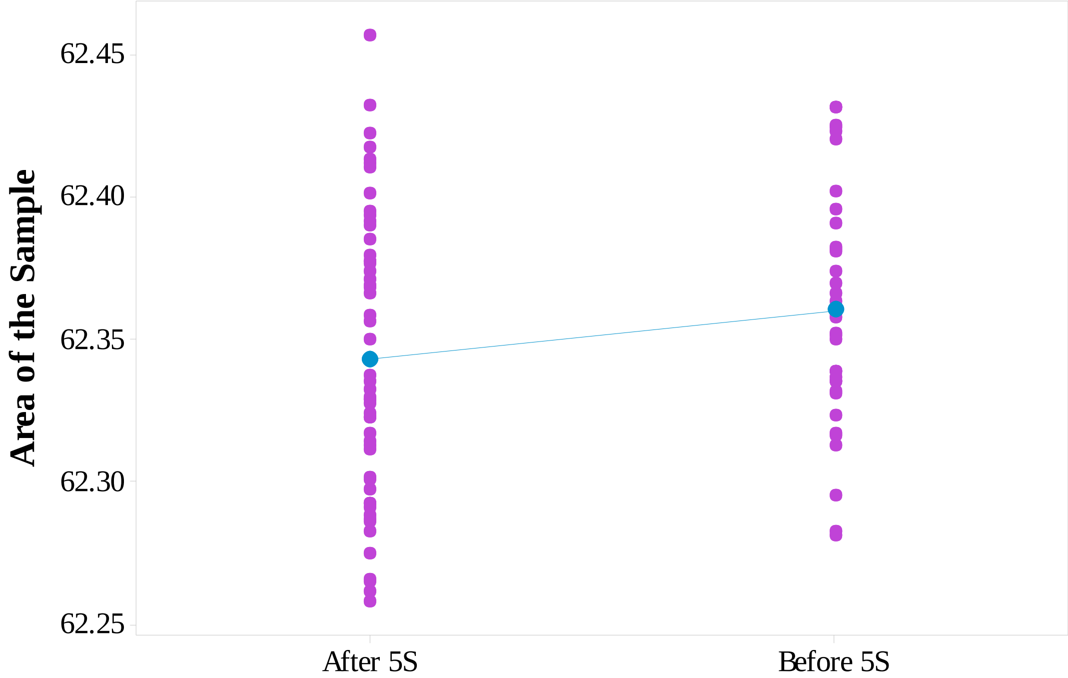


Figure 7 Scatter Plot of Sample Surface Area before and after IMA Implementation

3.3 Estimation of Approach Performance

The fitness of the approaches are evaluated through final product i.e. sample dimension, finish and quantity. To examine the approaches, first the samples are analyzed through normal probability plot and histogram plot as shown in Figure 8. It states that the failure or rejection of samples is not evidenced. All the samples are accepted for analyses, since only the frequency of super finish requirement is raised.

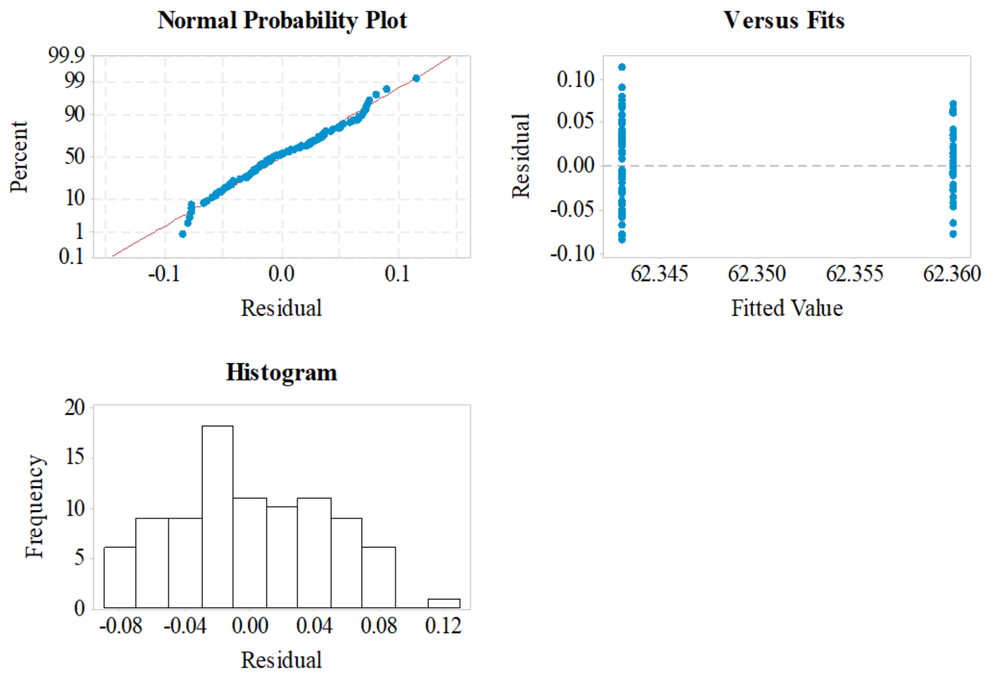


Figure 8 Residual Plots for Surface Area of Samples

Analysis of Variance (ANOVA) is carried out for the 2 types of samples and tabulated in Table 4. It includes determination of Sequential Sum of Squares (Seq SS), Adjacent Sum of Squares (Adj SS), and Adjacent Mean Square (Adj MS) for all sets. In all sets, the probability (P) value of the variance is less than the F-statistic (F) value and also it is less than 0.05 i.e. the level of significant is 95%. It states that the sampling is adequate and the null hypothesis is accepted (Baradeswaran et al)

Table 4 Analysis of Variance (ANOVA)

Source	Seq SS	Adj SS	Adj MS	F-Value	P-Value
Factor	0.006207	0.006207	0.006207	2.82	0.0097
Error	0.193694	0.193694	0.002201		
Total	0.199901				

The box plot is constructed for mean surface area of sample before and after IMA implementation to punching operation as shown in Figure 9. It evidence that the quantity of the samples has been raised by the IMA but simultaneously the requirement of additional finishing is raised. As overall, the quantity is raised about 150% and additional finishing requirement is raised about 3.8%. Therefore, the IMA is significant to accept and adapt to the system.

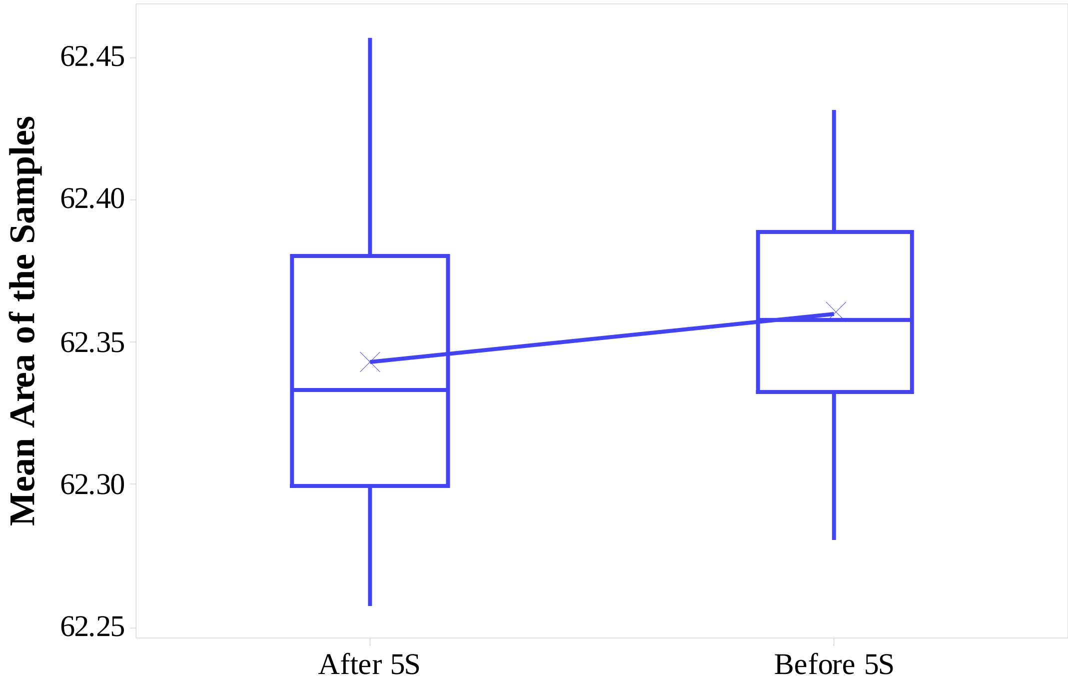


Figure 9 Box Plot for Mean Area of Sample before and after IMA Implementation

Conclusion

The modern method called Integrated Modern Approach (IMA) has been successfully proposed to integrate the organization's standard approach with a 5S quality tool. A case study was conducted in the call center to assess the effectiveness of the IMA. Research is being done to understand the cause and effect of a common approach in the system. From that the major influencing factors, which influences on material usage are identified along with the remedies. The implementation 5S tool along with the standard approach of the system has improved material utilization around 11 % compared to standard approach; even though the additional finishing requirement has been raised to 3.8%. Overall, the proposed IMA works best in transforming the system into a reduced production environment. In addition, these types of methods need to be tested directly on the system.

References

1. Narasimhan, R., Swink, M., Kim, S. W., Disentangling Leanness and Agility: An Empirical Investigation, Journal of Operation Management 2006.24:440.
2. Karlsson, C., Ahlstrom, P., Assessing Changes Towards Lean Production, International Journal of Operations and Production Management 1996;16:24.
3. Sharma, Kshitij Mohan, and Surabhi Lata. "Effectuation of Lean Tool “5S” on Materials and Work Space Efficiency in a Copper Wire Drawing Micro-Scale Industry in India." Materials Today: Proceedings 5.2 (2018): 4678-4683.
4. Priyanka Rai, Abhinav, Effectiveness of 5s implementation on organizations performance, Journal of Research in Management Technology, 2016, Vol. 5.
5. Vipul kumar C. Patel, Dr. Hemant Thakkar, Review on implementation of 5s in various organization, International Journal of Engineering Research and Applications, 2014, Vol. 4, pp.774-779.
6. Soumya R. Purohit, V. Shantha, Implementation of 5S Methodology in a Manufacturing Industry, International Journal of Scientific & Engineering Research, Volume 6, Issue 8, August-2015, pp. 225-231.
7. Pugazhenthi, R., and M. Anthony Xavior. "A heuristic to minimise the idle time of the rental/critical machine in a flowshop." International Journal of Services and Operations Management 22.4 (2015): 395-412.
8. Issac, R. Franklin, R. Saravanan, R. Pugazhenthi, and R. Raju. "A Heuristic for Group Scheduling the Multi-stage Hybrid Flow Shop Problems." Bonfring International Journal of Industrial Engineering and Management Science 6, no. 4 (2016): 152.
9. Wahab, Amelia Natasya Abdul, Muriati Mukhtar, and Riza Sulaiman. "A conceptual model of lean manufacturing dimensions." Procedia Technology 11 (2013): 1292-1298.
10. Karam, Al-Akel, et al. "The contribution of lean manufacturing tools to changeover time decrease in the pharmaceutical industry. A SMED project." Procedia Manufacturing 22 (2018): 886-892.
11. Garza-Reyes, Jose Arturo, Vikas Kumar, Sariya Chaikittisilp, and Kim Hua Tan. "The effect of lean methods and tools on the environmental performance of manufacturing organisations." International Journal of Production Economics 200 (2018): 170-180.

12. Baradeswaran, A., A. Elayaperumal, and R. Franklin Issac. "A statistical analysis of optimization of wear behaviour of al-al2o3 composites using taguchi technique." Procedia Engineering 64 (2013): 973-982.
13. D'Antonio, Gianluca, Joel Sauza Bedolla, and Paolo Chiabert. "A Novel Methodology to Integrate Manufacturing Execution Systems with the Lean Manufacturing Approach." Procedia Manufacturing 11 (2017): 2243-2251.
14. Randhawa, J.S. and Ahuja, I.S. (2018) 'An evaluation of effectiveness of 5S implementation initiatives in an Indian manufacturing enterprise', Int. J. Productivity and Quality Management, Vol. 24, No. 1, pp.101–133.