

A Case Study on Effectiveness of 4S Implementation in a Machine Shop

Valentine Khumalo

Department of Quality and Operations Management
University of Johannesburg
Johannesburg, 2028, RSA
valentinekhumalo@ymail.com

Kapil Gupta

Department of Mechanical and Industrial Engineering Technology
University of Johannesburg
Johannesburg, 2028, RSA
kapiliiti@gmail.com

Abstract

5S is widely known to be most effective in most industries especially in manufacturing sectors. This paper reports on the effectiveness of implementing 4S in a machine shop. The mentioned 4S are namely; Seiri, Seiton, Seiso and Seiketsu. The 4S are Japanese terms which are translated in English as Sort, Set-in-order, Shine and Standardize. The purpose of this paper is to implement the 4S technique to standardize, improve the working conditions as productivity will improve. As well, to implement the 4S as a continuous improvement technique or tool to improve and promote the machine shop. This study evaluates the conditions of the machine shop from before and after implementing 4S with the use of pictorials. The use of pictorials is another new method of a research tool. Data collection method and the effectiveness of 4S are based on the observations made, when a person is examined through a time study searching for a single tool until found. These observations and times are conducted and recorded before and after 4S is implemented at the machine shop. Collected data on before and after implementation, resulted in greater space utilization, eliminated abnormalities, improved productivity, improved efficiency as time is saved, and pleasant working space.

Keywords

5S; Time Study; Efficiency; Productivity

1. Introduction

The 5S is a Japanese technique or rather method of creating and maintaining a well-organized, clean, effective, safe and efficient working environment (Michalska and Szewieczek, 2007). This paper focuses on the implementation of 4S of the 5S as it is commonly known. The efficiency and improved working conditions of any industry and organization can be achieved successfully by applying the concept of 4S. The 4S is also a philosophy that focuses on simplification of work environment, effective workplace organization, and reduction of waste, while improving safety, quality, and conditions. It allows the enhancement of efficiency and productivity (Chavan et.al, 2017). The 4S engages people through the use of standards and discipline (Maidhili and Meenambika, 2010). 4S is not just for housekeeping as perceived, it is more than that of following the standards and discipline to manage the organization. This paper explores the 4S in machine shop for the purpose of simplifying its conditions. The effectiveness of this 4S is examined through observations of time recorded, before and after implementing 4S. The efficiency on saving time is the scale which the desired results are attained from. The 4S technique is a structured program used to systematically achieve total organization tidiness and standardization in the workplace.

1.1 Introduction to 4S

The 4S represents 4 disciplines for maintaining visual workplace to minimize total loss time searching for tools and unnecessary movements, briefly named as:

1. **Seiri**- Organising the working area by segregating the unnecessary items, for instance, eliminating tools or any materials which do not add value in the workplace.
2. **Seiton**- Maintaining neatness through straightening offices and work areas.
3. **Seiso**- Cleaning plant and equipment to eliminate dirtiness that can hide or obscure variabilities.
4. **Seiketsu**- Location standardization for items, equipment, tools, parts, and materials..

1.2 Research Motivation and Problem Statement

Unsystematic work areas, undefined zones and non-demarcated workstations are to be investigated because of their infeasibility and inefficiency within the machine shop. The unorganized work place, such as the machine shop lead to high waste, non-productiveness, mismanagement, and loss. The 4S are barely applied as a feasible solution in the working places which are characterized by workshops and laboratories and machine shops. Without implementing 4S concept in a proper way, it is difficult to organize the machineries, tools, equipment, instruments and the entire workplace of the machine shop. The scientific arrangement, placement, standardization, and timely cleaning and maintenance are major requirements to enhance efficiency, reduce waste, better functioning, improved appearance and performance. The visibility of unused equipment and materials which are still packaged has occupied unnecessary storage space. Unknown stored tools which are inactive or rather stagnant have occupied storage space for active tools. The background of the study originates from the unplanned setting of the machine shop, the crowded workplace, and from unacceptable working conditions in the workplace.

2. Literature Review

5S is a Japanese concept which originated in 1970s, when it was introduced by Takashi Osada (Deshpande, et al., 2015). The 5S methodology was first utilized by Toyota in 1970's to enable Just-In-Time (JIT) manufacturing.

Various studies on 5S have been used as a lean tool to eliminate waste, to improve productivity, for continuous improvement and for other factors which will lead to a better working environment.

2.1 Review of Past Work on 5S

A recent study conducted by (Sukdeo, 2017) based on the expansion of 5S to 6S methodology, adding "safety" as the 6th "S". This methodology simply added the safety as one of the important pillars to the 5S.

Khamis et al. (2009) developed a checklist to evaluate the effectiveness of 5S implementation. They reported successful use of 5S for overall continuous improvement.

Gapp et al., (2008) conducted a study on 5S within a Japanese context where he used some data from companies where 5S was already implemented, for wider dissemination via a website. Vaidya et al. (2017) conducted a study on implementation of 5S in a workshop and scored the implementation effectiveness. A proper survey of the workplace which includes measuring the whole place according to their different zones was done. The areas of interests are presented with pictures before and after implementation. The improvement of the implementation lead to, better usage of the working area, minimized waste, reduced search time for documents, equipment, stationery and eliminate duplication of unwanted materials.

2.2 Objectives of the Present Research

- To standardize the machine shop by classifying and coding materials and any tools in place,
- To measure efficiency while reducing toll search time,
- To ensure any variability is eliminated from the machine shop,
- To implement the 4S fully, so that the desired conditions are attained,
- To ensure easy access to all the tools and materials that allows easy take and easy to return structure.

2.3 Research Gaps

The following research gaps have been identified:

- Implementing 4S technique in the machine shop fully.

- There are limited graphical data presentations of before and after implementation in most studies.
- Another gap observed is that even if 4S or 5S can be implemented successfully, most of the previous work do not focus on continuous improvement and do not offer sustainability aspects of 4S or 5S.
- As observed from the limitedly available graphical data presentation, the use of before and after implementation pictorials is limited. Some studies are only reported theoretically.

3. Methodology

A decent housekeeping indicates effective working environment, well organized working area, clean and safe workplace. It was found that due to poor housekeeping, the workplace of the machine shop and offices was completely unorganized and unsystematic. There are instances whereby tools are misplaced and incorrectly stored, haphazard placement of unnecessary equipment and materials, which caused obstructions and time wastage looking for a single tool. The absence of systems and regulations of how to handle the workshop, laboratories and offices led the workshop and cabins in a messy and unruly state.

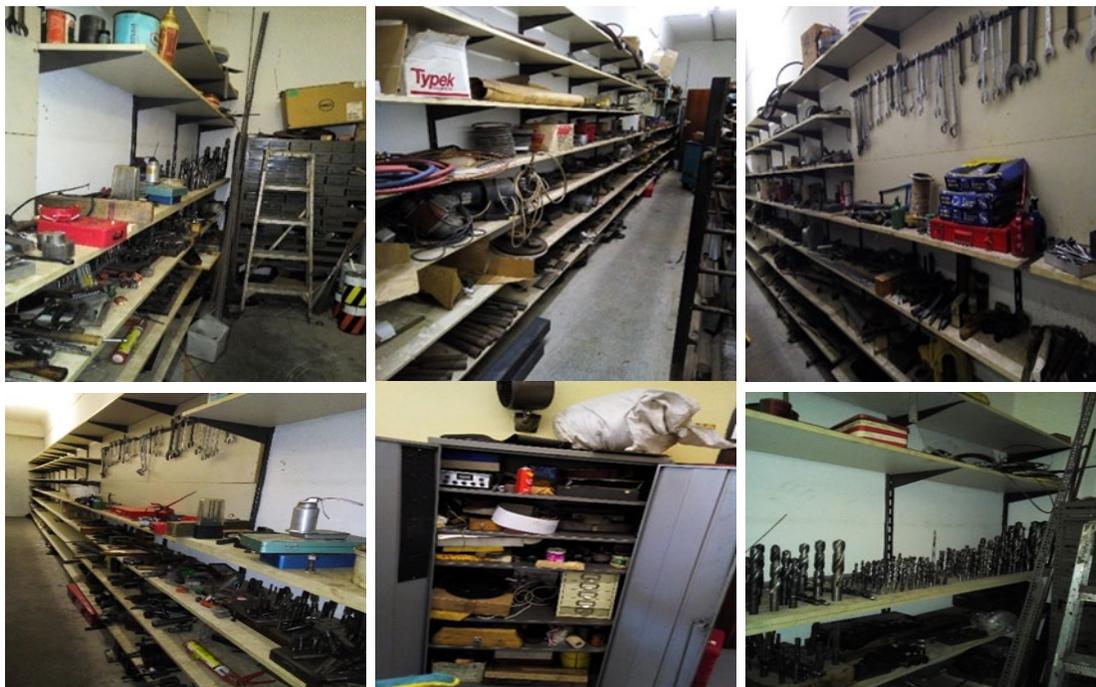


Figure 1: Machine shop facility actual condition before 4S Implementation.

3.1 4S Implementation in the machine shop

3.1.1 Implementing Seiri

This S focuses on segregating the unnecessary from the necessary items. As the state of the machine shop is unpleasant, the first step taken was to get rid of all unwanted items. All the items in the machine shop were separated in order of importance. The development of different locations and zones for placing different tools and materials is essential. Those locations are then used to place wanted, important and unimportant materials. Each zone named 'unsure/least' necessary and 'very important'.

3.1.2 Implementing Seiton

To implement Seiton, everything has been placed in its own place in order to avoid future inconveniences to separate further.

All spanners are shifted to a different area; and wrenches, hammers, clamps, specimens and all tools now are separated to other different areas. The locker cabinets are set-in-order for the purpose of classifying the useful and useless items.

Each set of tools and materials from the locker cabinet are separated further and placed in different zones

Now that the tools and materials been placed separately it is clear that some of the materials and tools were just occupying storage space for nothing. All these are then labelled for easy placement in the later stage.

3.1.3 Implementing Seiso

In Seiso phase, the shelves, the locker cabinets, the whole work area was cleaned to perfection to eliminate all kinds of dirt that was in place. The items cannot be reverted in a dirty unorganized place, hence cleaning every area was very vital. Even the items are cleaned before being placed back to avoid clustered dirt.

The cleaning materials are organized first and that proper chemicals are used since the shelves were subjected to store oil cans which have leaked. With the dust, oil and other forms of dirt crowding the workshop, a cleaning technique and schedule has been developed, because the place has to look and remain shiny for a prolonged period of time.

The appropriate cleaning materials and detergents are in place. The cleaning staff who were actually responsible for cleaning that area, had taken more responsibility in cleaning the workshop thoroughly. At the completion of the cleaning procedure, the place is completely different, in such a way that the whole workshop is clear and suddenly white. Cleaning has brought a new perspective in the workshop, hence no dust in place, no stains, pleasant smell and more cleaned space. The state after cleaning is presented as:



Figure 2: Cleaned Shelves

3.1.4 Implementing Seiketsu

The procedure to standardize is rather different from how it is usually conducted. This step involves allocating a place for every item that is in place, that is still in use, and not only allocating a place, but standardizing that area and place. The materials involved in implementing Seiketsu: Plastic Bins/store-bins which are used as storage for tools such as bolts, nuts, screws, and the like tools. Plastic tapes for demarcation of the rack hanger and to demarcate the shelves have been used. Colourful Paper dividers, for the purpose of name tagging everything in the workshop are used.

The items which are out of place meaning the unknown materials are then identified and marked, so that they are relocated in rightful places.

In this step schedules are formulated such as work schedules, cleaning schedules, rules and instructions. Work flows and work cycles, visual controls and most importantly the 4S cycle on display for every individual who enters the workshop. The visual controls have empowered the staff to know exactly the type of zone and location they are in and clear rules are visible for them to adhere.

To avoid complexities in the workshop, visual management is given more attention in a sense that everyone understands the process, the procedure and all the techniques and methods used. To ensure better understanding of the standardized system, training is provided based on the system. As the visual management is in place at this stage, the workshop is sorted, set, shines and shows the following satisfying results as shown in the pictures given in Figure. 3:

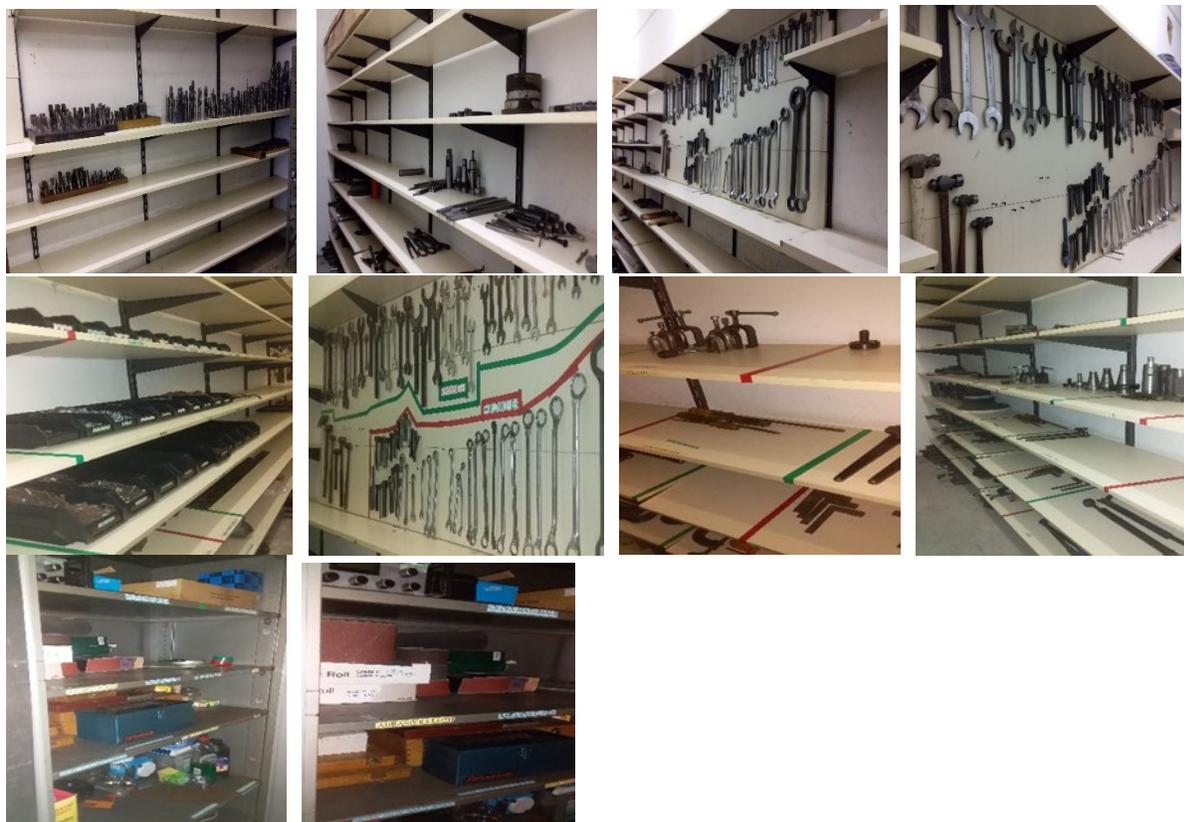


Figure 3: Pictorial presentation of the machine shop upon 4S Implementation

4. Findings

Before 4S implementation, the chaotic state of the machine shop had caused unnecessary time wasted searching for tools needed for the machines. It is found that most of the time is spent looking for a certain tool or material, therefore a time study method is applied to study the time each person searching for tool. Time study has been conducted by following a standard procedure. Table 1 below presents observed time taken by different workers for searching various tool types. One of the objectives of this study is to decrease efficiency in tool search time i.e. no time should be wasted looking for a single tool. Therefore, the following times are recorded before 4S is implemented in the machine shop:

Table 1: Observed Times Before Implementing 4S

Observed Times								
No.	Name of Tool	1	2	3	4	5	Total Time Obs.	Time Saving Efficiency (%)
1	Spanner (5/8)	7.23	6.20	6.40	7.40	7.10	34.33	98.09%
2	Allen screw	6.50	6.25	7.0	6.10	5.3	31.15	89.00%
3	Hammer	7.10	7.0	6.40	6.41	6.23	33.14	94.69%
4	Combination wrench	5.26	7.25	7.15	6.30	6.0	31.96	91.31%
5	Plier	5.0	5.55	6.10	6.0	6.16	28.81	82.31%

6	Clamp	4.50	4.25	6.30	6.50	6.0	27.55	78.71%
7	Chisel	7.26	7.25	6.20	6.45	4.40	31.56	90.17%
Total Efficiency							218.50	76.48%

To measure the efficiency obtained on time saving, firstly, all the times observed have been recorded. The Total Time Observed for a Spanner in 5 observations accumulated to 34 minutes and 33 seconds in a randomly selected day. The same method applies to the other tools in minutes and seconds. The efficiency for the tools is obtained through the total number of observations (product of 7 tool types and 5 observations) which is 35, divided by one hundred to have standard percentage. All the tools are calculated using the same technique and method to get final TSE. 76.48% is a lot or higher percentage of time to search for a tool, it is unfavourable and unacceptable that so much time is wasted looking for a tool in machine shop.

Time Saving Efficiency (TSE), is a percentage from time observed, it is the efficiency of time saved, or the percentage of saving time efficiently. It is obtained from the observed time. It is calculated based on the observed times including TTO. From all the observed times which amount to 35 times from spanner to chisel then the TTO is divided by 35 and multiplied by 100 to have full percentage. The efficiency involves rating how well or unwell an employee can perform his/her task within the specified time limit and the performed task is completed within time range and schedule.

With the new condition of the machine shop, it is easy to identify all tools and materials, and also easy to know which materials are active and inactive or permissible to the workshop. In the before status of the workshop, so many abnormalities are visible, and the efficiency of time saving is sky-high which gives a disadvantage to the workshop, as the aim and objective is to decrease tool search time. In the before implementation data, the yielded results amounting to 76% for overall time efficiency for the selected searched tools. To have complete data and have comparative results of before and after implementing 4S in the machine shop, it is better to conduct and collect secondary data for after implementation purposes. In the Table 2 below are the times observed after the 4Ss were implemented:

Table 2: Observed Times After Implementing 4S

No.	Name of Tool	Observed Times					Total Time Obs.	Time Saving Efficiency (%)
		1	2	3	4	5		
1	Spanner 5/8	2.10	2.14	2.11	1.50	2.15	10	28.57%
2	Allen Screw	2.15	3.10	3.15	3.20	2.05	13.65	39%
3	Hammer	3.09	3.15	2.16	2.20	1.25	11.85	33.86%
4	Combination wrench	3.0	2.06	2.05	2.50	1.35	10.96%	31.31%
5	Plier	3.4	2.14	2.34	2.19	2.18	12.52	35.77%
6	Clamp	2.14	2.43	3.33	3.24	2.15	13.29	37.97%
7	Chisel	1.17	1.08	2.02	2.13	2.20	8.6	24.57%
Total Efficiency							80.87	28.30%

With the recorded times and time efficiency of 28.30% in the after implementation, the results have changed or rather improved drastically. Before implementing 5S in the workshop, it took about 78% of time efficiency searching for tools in a random selective day.

The results are then summarized using the Anderson darling normality test in further analyzing them. According to Anderson Darling Normality Test, the times obtained are shown in a histogram summary below.

4.1 Summary Report: Before Implementing 4S

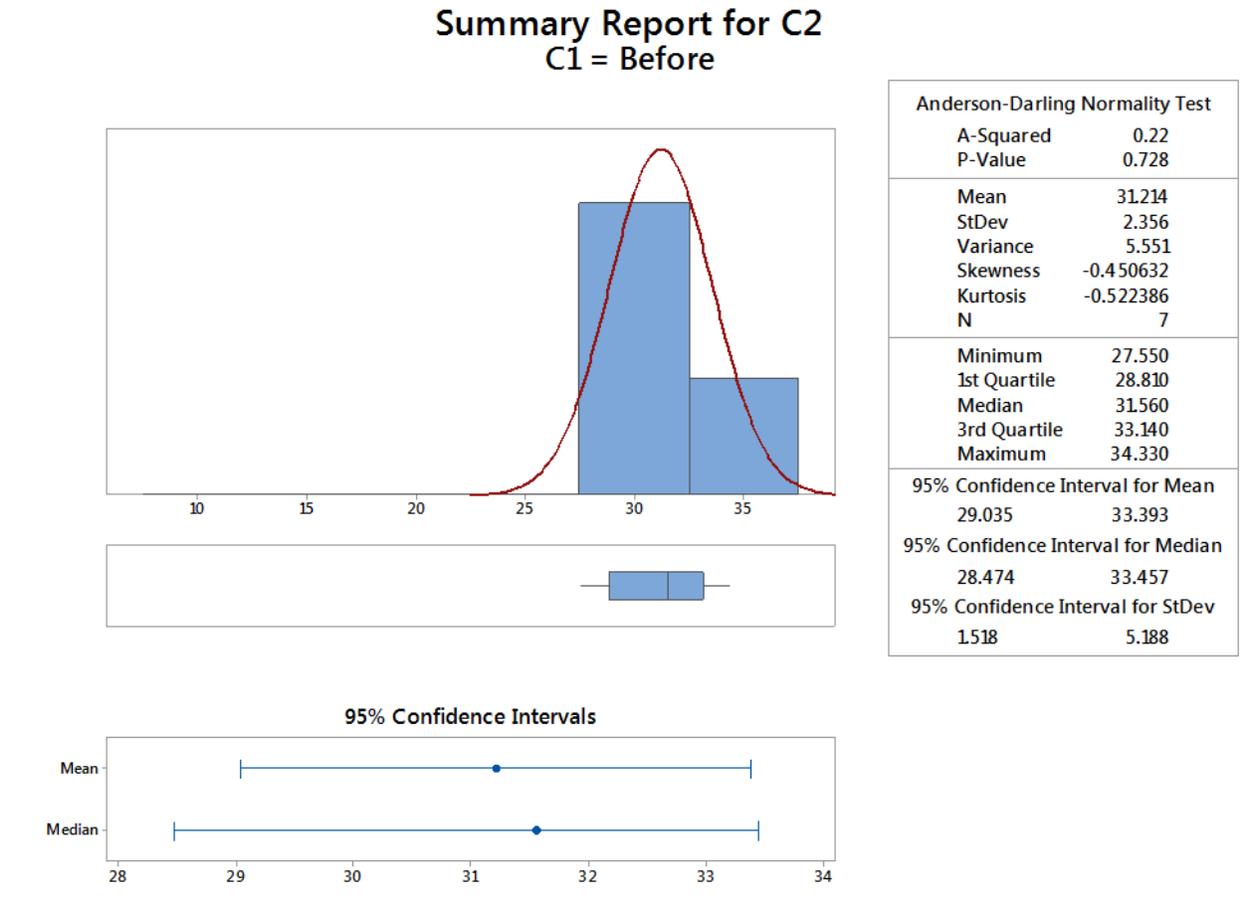


Figure 4: Summary Report: Before Implementing 4S

The Total Time Observed column shows the added sum of all the times observed for each tool. All the total time observed equated to 218 minutes, and 50 seconds. That is the highest time to search for tools in a day; this implies that most time is wasted just searching instead of working. The Anderson Darling Normality test is a statistical test of whether a given sample of data is drawn from a given probability distribution. In its basic form, the test assumes that there are no parameters to be estimated in the distribution being tested, in which case the test and its set of critical values is distribution-free (Stephens, 1974).

The Skewness of the graph moves from left to right on a downward slope (Fig. 4). The minimum of these times in total found is 27.50 and the maximum time is 34.33.

Figure 5 presents the analysis on after 4S implementation.

4.2 Summary Report: After Implementing 4S

Summary Report for C2 C1 = After

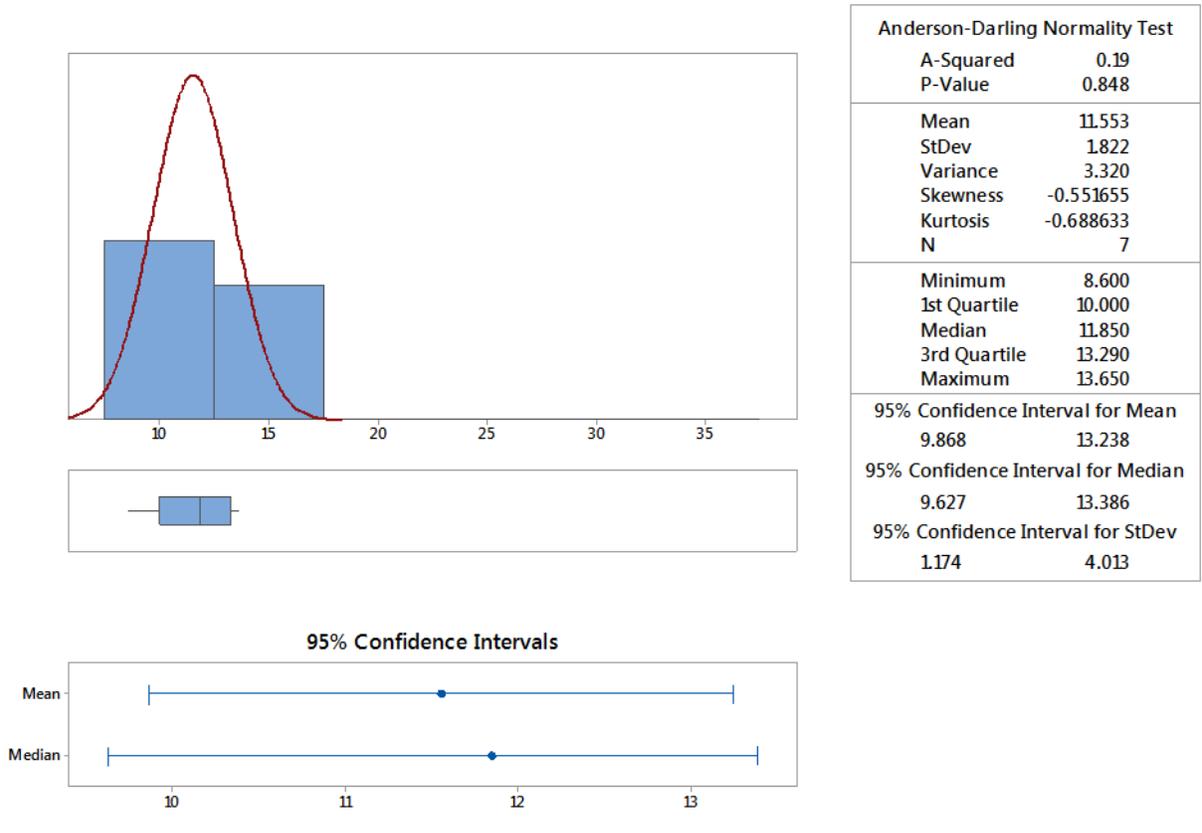


Figure 5: Summary Report: After Implementing 4S

The graph is now skewed differently from the graph of before implementation because of the change in times. The movement or shape of the graph has shifted to the left side and the two histograms have shortened than in before implementation.

The minimum time from TTO is 8.6 which serve as the shortest time in TTO for after implementation. The maximum time from the TTO is 13.65, lower than that of before implementation.

The two summary reports for before and after implementation show a normal distribution because their P-values are above 0.05. A normal distribution is positive when the P-value is greater than 0.05, and P-value less than that is not a normal distribution.

4.3 Individual Value Plot Data

Figure 6 shows individual value plot, where the Y-axis (C2) are the TTO ranging from both before and after implementation where the minimum time is found in after implementation as 8.6 and the maximum time is found in the before implementation times as 34.33.

The Plot is skewed upwards, where “C2” which represents the times observed is at the start of the Y-axis. The X-axis plots the C1 that is before and after implementation observed times. The slope goes up to where the C1 “before” and “after” starts or on its Median time and end on highest Median Time plot. It starts at the highest median from “before” and goes downward to “after” which has the lowest median. The other dotted plots represent upper and lower times.

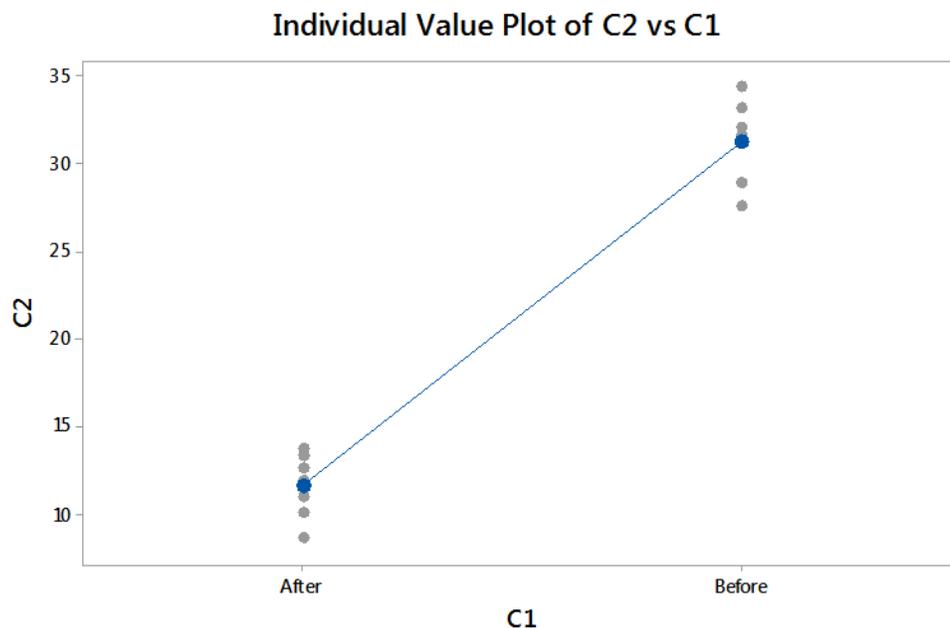


Figure 6: Individual Value Plot of C2 (TTO) vs C1 (Before and After Implementation)

5. Conclusions

After 4S implementation, it is observed that the workshop area is clean, free from any hazards, improved working environment and conditions, well organized offices, efficiency has improved, and well secured locations for tools, materials and equipment. Moreover, increased space utilization has been achieved through proper placements. Efficiency to save time when searching for any tool or other item has shown significant improvement after implementing Seiri, Seiton, Seiso and Seiketsu (4S). Before implementation, it took approximately more than 4 minutes to search and find a tool and just higher to 7 minutes 40 seconds until a tool is found. It was quite challenging to gather data before implementing 5S, because everything was unorganized. Before 5S was implemented it usually took 218.5 minutes (Total Time) which equals the efficiency of 76.48% in a random week, these results are detrimental to the efficiency of saving time. After 5S implementation, a gradual decrease to 80.78 minutes on Total Time Observed, which equals the efficiency of 28.30% as, this is an achievement and objective attained. That is the difference of 137.72 minutes saved in a week. After Total Time Observed is achieved, Time Saving Efficiency has been achieved as anticipated from a disappointing 76.48% before to a 28.30% after implementation. That is a satisfying decrease of 48.18%.

It proves the effectiveness of 4S of 5S implementation in a machine shop of mechanical workshop.

References

- Bamber, C., Sharp, J., Hides, M., Developing Management Systems towards integrated manufacturing: A case study perspective. *Integrated Manufacturing Systems*, Volume 11, Issue 7, pp. 454-461. 2000.
- Chavan, Y., Jambhale, S., Kamble, R., Gharal, S., Mulla, M., Study and Implementation of first “S” OF “5S” in a college workshop: A case study. *International Journal of Scientific and Engineering.*, Volume 8., Issue 4. 2017
- Deshpande, P., Damle, V., Patel, M., Kholamkar, A., Implementation of “5S” Technique in a Manufacturing Organization: A Case Study., *International Journal of Research in Engineering and Technology.* Volume 4. Issue 01, pp. 136-148. 2015
- Gapp, R; Fisher, R; and Kobayashi, K., Implementing 5S within a Japanese Context: An Integrated Management System., *Management Decision.* Volume 46. Issue 4, pp 565-579, <https://doi.org/10.1108>. 2008.

Khamis, N., Rahman, M., Jamaludin, K., Ismail, A.R., Ghani, J., Zulkifli., R., Development of 5S practice checklist for manufacturing industry., *Proceedings of the World Congress on Engineering*, 1–3 July Volume 1, pp.545–549, ISBN: 978–988–17012–5–1, London, UK. 2009.

Maidhili, S; Meenambika, G and Dr. Nithyanandam, K., Application and Usefulness of 5S and KAIZEN for Library Space Management. Conference Paper. 2010.

Michalska, J., and Szewieczek, D., The 5S Methodology as a Tool for Improving the Organization., *Journal of Achievements and Manufacturing Engineering*, volume. 24, issue no. 2. 2007.

Stephens, M.A., EDF Statistics for Goodness of Fit and Some Comparisons., *Journal of the American Statistical Association.*, issue 63., volume. 1, pp. 730-737. 1974

Sukdeo, N. The Application of 6S Methodology as a Lean Improvement Tool in an Ink Manufacturing Company., *International Conference on Industrial Engineering and Engineering Management (IEEM)*. 2017

Vaidya, R.D; Trivedi, R; Rathi, T; Niwal, S; Panbude, S. Implementation of 5S in Workshop at DMIETR – A Case Study., *International Journal of Advance Research and Innovative Ideas in Education.*, Volume 3., Issue 2., pp. 1127-1131. 2017.

Biographies

Valentine Khumalo is a Masters' student at the University of Johannesburg, majoring in Quality and Operations Management. She is busy conducting research in industrial, manufacturing, and quality engineering.

Kapil Gupta is working as Associate Professor in the Dept. of Mechanical and Industrial Engineering Technology at the University of Johannesburg. He obtained Ph.D. in mechanical engineering with specialization in Advanced Manufacturing from Indian Institute of Technology Indore, India in 2014. Advanced machining processes, sustainable manufacturing, green machining, precision engineering and gear technology are the areas of his interest. Several SCI Journal and International Conference articles have been credited into his account. He has also published some books on hybrid machining, advanced gear manufacturing, micro and precision manufacturing etc. with renowned international publishers.