

## Benchmarking Technique in Lean Manufacturing (5s) Practice

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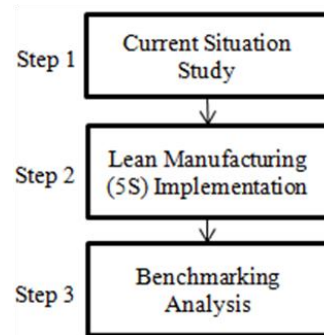
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### Graphical abstract



### Abstract

In today's competitive market, low cost production and high quality product could assist manufacturers to win new and maintain their existing customers thus gain bigger market share. Manufacturing cost is one of the key dominant factors towards achieving business success. As such, manufacturing firms are struggling to produce product with lowest manufacturing cost while at the same time maintaining their product quality. Lean manufacturing practice could be applied to lower the manufacturing cost and benchmarking technique to ensure on the implementation effectiveness. A case study was conducted in a small and medium manufacturing firm located in China. One of the lean manufacturing tools, i.e. 5S system was implemented in the production line of the case study company. For future reference, the present situation was studied prior to the 5S system implementation. Later, the result of the study was benchmarked against before, after and the best in class manufacturer. A framework was developed to guide the user during implementing the 5S system. The benchmarking result shows significant improvement in productivity and lower manufacturing cost after implementing the 5S system. The implementation of 5S system had created more comfortable workspace to production workers, standard procedures and method to produce the product. Therefore, it can be concluded, the 5S system was able to help the production workers to implement the lean manufacturing and benchmarking technique more effectively to bring additional advantages in producing lower cost and high quality product, which eventually helps the company to gain better market share.

**Keywords:** low cost, high quality, lean manufacturing, benchmarking, market share, competitiveness

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### 1.0 INTRODUCTION

In the rapidly changes global market, new product with better performance and competitive price has ceaselessly enter the market and it makes the market become so competitive nowadays. In order to sustain the market share, companies are forced to keep improving on the product in term of performance, cost, quality, service, etc. As such, lean manufacturing practice has become a must especially in manufacturing firm. Gudney and Elrod claims that lean principles have enabled corporations to achieve significant economic benefits while improving quality, costs and cycle time [1]. Antony debates that the concept of Lean Thinking developed from Toyota Production System (TPS) [2] involves determining the value of any process by distinguishing valued-added activities or steps from non-value added activities or steps and eliminating waste so that every step adds value to the process. Lean focuses on efficiency, aiming to produce products and services at the lowest cost and as fast as possible [2].

According to Badurdeen *et al.*, the steps in pursuit of lean manufacturing have been to learn the tools and techniques of Toyota such as 5S, visual control, kaizen, etc [3]. Bayo-Moriones *et al.* stated that 5S pillars are sort (seiri), set in order (seiton),

shine (seiso), standardize (seiketsu), and sustain (shitsuke). Bayo-Moriones *et al.* [4] further explain that in the daily work, routines that maintain organisation and orderliness are essential to a smooth and efficient flow of activities. Sort, the first S, focuses on eliminating unnecessary items from the workplace that are not needed for current production operations [4]. Set in order focuses on creating efficient and effective storage methods to arrange items, so that they are easy to use, and to label them, so they are easy to find and put away. Shine, the next step, is to thoroughly clean the work area. Daily follow-up cleaning is necessary to sustain this improvement. Once the first three 5S have been implemented, the next pillar is to standardise the best practices in the work area. Sustain, making a habit of properly maintaining correct procedures, is often the most difficult S to implement and achieve [4].

Gapp *et al.* has summarized the benefit of 5S implementation as following [5].

1. Orderliness (seiri and seiton) – to maximise efficiency and effectiveness by reducing people's workload and human errors through simplifying processes;

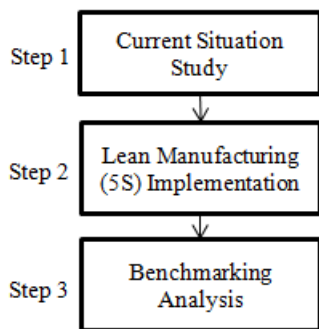
2. Cleanliness (seiso and seiketsu) – to maximise effectiveness by contributing to a healthier life, safety and wellbeing as well as enhancing transparency; and
3. Discipline (shitsuke) – through training and education to enhance the level of morale which leads to increased quality of work/life and work standards.

On the other hand, benchmarking is defined as key themes that include measurement, comparison and identification of best practices, implementation and improvement [6]. Selecting the right benchmarking methodology and systematic approach are very critical in ensuring the success of the benchmarking process [7, 8]. The main benefit of benchmarking is information about where a company stands when compared against standards set by their customers, themselves, national certification or award requirement [9]. As such, benchmarking is a powerful to analyze the result from 2 comparison factors.

This paper is aimed to optimize the lean activities result by using benchmarking technique as an analyzing tool. The structure of this paper embraces the review of lean practice, 5S, benchmarking technique and the relationship. A conceptual benchmarking framework is proposed for the implementation. The result revealed the important factor in 5S and the activities carried out throughout the implementation. Besides, the effectiveness of implemented technique and the improvement made also been evaluated.

**2.0 METHODOLOGY**

This section discussed about the methodology adopted in the study. Ultimately, the study is carried out in a contracture manufacturing company in China. There are many contracture manufacturing companies especially located in China, however, to well manage the improvement and lead to achieve higher quality output would be a difficulty topic. The reason being, quality awareness is still lacking in employees’ mind set. It could be possibly caused by inadequate of knowledge among the employees and management toward the quality tools. As such, the methodology of this study consists of 3 steps. Figure 1 shows the methodology structure for this study. It begins with the study at current situation of the company. The study will focus on the defective parts as a benchmark, thus the part per million (PPM) study will be carried out at first.



**Figure 1** Methodology

Lean manufacturing practice is then implemented after the primary study on the PPM. Toward the implementation, a framework is proposed to enhance the overall process to be more systematic and improve on the efficiency. The lean manufacturing practice will be focusing on the 5S technique. The data was collected based on the final inspection data because it could reflect the overall quality performance of the production line.

Besides, it is the last quality gate before the product reach to customer so it could be consider as the determinant point of the quality level. The collected reject numbers are clustering into 5S pillars categories. The improvement plans are initiated from the 5S pillars group. First 3S (Seiri, Seiton and Seiso) are taken as the clustering category whereas the other 2S (Seiketsu and Shitsuke) are taken as control plan. After the implementation of 5S, the reject data is collected again and benchmarking technique is adopted for analysis. Internal benchmarking with before-after analysis is an essential step to analyze the effectiveness of the improvement plan activities. Also, the benchmarking result is published after the analysis.

**3.0 RESULT & DISCUSSION**

The research company is a contracture manufacturer located in Guang Zhou, China and start operation since year June 2001. It is a small and medium sized enterprise with about 200 employees. It produces electrical product, just like other surface mount technology (SMT) company, the process basically embraces components pick and place and assembly the SMT part into housing. There are a lot of manual works needed in the production line like assemble into housing, labelling, etc. Since there are so many manual works, operator skill and awareness are important factors to lead the success of the manufacturing line. Generally, contracture manufacturing company in China is very common nowadays as the labour cost is cheap. However, to create quality awareness among the operators is not an easy task. That is the reason why 5S is selected as the tools in this study.

Table 1 shows the reject data during primary study. The data were collected at final inspection stage and it was calculated in PPM. The reject criteria were clustered into 3S elements which are Seiri, Seiton and Seiso. Also, the reject criteria were analyzed based on 3S elements and improvement plan will be generated from the 3S elements. Those reject criteria basically are human dependent error. As such, 5S implementation is considered as a suitable solution.

**Table 1** Reject data before 5S implementation & suggested activities

Reject Criteria	Before		3S	Activities
	Reject Qty	PPM		
Label Wrong Orientation	31	3100	Seiri (Sort)	1. Arrange the product in only one orientation. 2. Set procedure/operating instruction.
Label Wrong Position	3	300		
Missing Cardboard	23	2300	Seiton (Set)	1. Set the step-by-step process, 2. Check before move to next process 3. Put only correct label on the work station
Missing Screw	6	600		
Wrong Label	3	300		
Contamination	21	2100	Seiso (Shine)	1. Clean up the work station frequently. 2. Do not leave the dirty on table.
Foreign material	8	800		

After primary study, a framework is proposed to guide from the implementation. Figure 2 shows the 5S implementation framework. 5S pillars are separated into 2 areas. The first area consists of the first 3S which it focuses on the improvement plan. From the groups that determined in primary study, a procedure was evaluated and set to make the process simpler more systematic to operate. After the procedure set, a crucial factor that could not be neglected is training. A proper training need to be given to the operator so that they are fully understands on the operation. Basically the activities were to set a proper method and procedure for the workers to follow, for example to arrange the raw material in proper manner or orientation during working. If possible, the method is targeted to be fool prove. In addition, cleanliness of work station was also emphasis during the implementation. All these activities were eventually lead to build up the discipline of the workers.

On the other hand, the second area which included Seiketsu and Shitsuke is concentrate on the control plan. After the procedure determined, the procedure need to place into document. The procedure has to publish to the operator so that they can refer anytime during work. Discipline of the operator is an important factor as well, thus control is needed. Complimentary was given to the operator with good discipline. However, punishment will be made to those always repeat the same error in the production line. This is to ensure the smoothness and flawless production line.

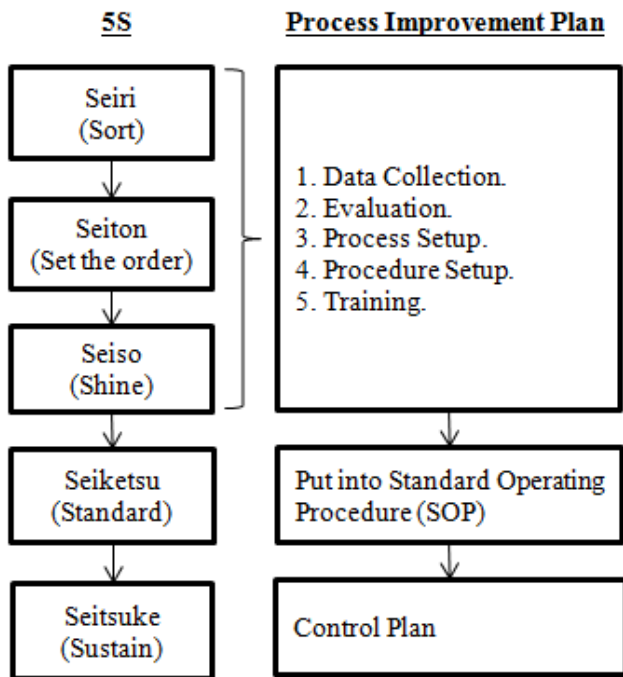


Figure 2 5S Implementation framework

Based on the result as shown in table 2, the data indicates huge improvement using 5S technique in resolving the issue found in production. It has successfully reduced the reject quantity. The before data are benchmarked against after data. From the benchmarking process, it has come to a result where the next steps could take place. As part of benchmarking technique methodology, Ahmed and Hassan [7] argued that Deming’s plan-do-check-act (PDCA) is an excellent technique in monitoring and problem solving for continuous quality improvement where individual’s brilliant ideas can be accommodated. As such, PDCA law can be applied in this case. For those reject criteria that need

further improvement, perhaps it need to study again in PDCA chain. The root cause need to be identified and corrective action need to implement to overcome the issue.

Table 2 Reject data after 5S implementation & benchmarking result

Reject	Before		After		Benchmarking Result
	Reject Qty	PPM	Reject Qty	PPM	
	Label Wrong Orientation	31	3100	2	
Label Wrong Position	3	300	0	0	Reject eliminated.
Missing Cardboard	23	2300	7	70	Procedure need to improve
Missing Screw	6	600	0	0	Reject eliminated.
Wrong Label	3	300	0	0	Reject eliminated.
Contamination	21	2100	4	40	Further improvement needed.
Foreign material	8	800	1	10	Further monitoring needed.

4.0 CONCLUSION

As the result, the reduction of the reject quantity not only helps to eliminate the waste material, it has directly increased the productivity as the worker focus on their work using the standard procedure and rework has been minimized. Throughout the implementation, worker satisfaction has been enhancing as well due to the process setup to make it easier for operation and they get all necessary material when they need it. At least they have no need to re-arrange the product orientation, look for the necessary part when they are working on the station. The frustration of the workers was eliminated. Eventually, the overall product quality has improved drastically from the 5S implementation.

The proposed guideline is not aimed as a compulsory tool for 5S or benchmarking implementation. However, it is a recommended tool will allow the users to have statistical analysis from the data to understand the current performance and use them to benchmark and generate improvement plan. As such, this will ensure that continuous improvement activities are in place all the time. Furthermore, the proposed guideline can help to achieve lean manufacturing objective and it could help the company to save money on waste material and improve productivity as well. Last but not least, the authors hope that using the guideline could helps toward the lean manufacturing practice. However, from

design standpoint, the human dependent error has to have fool prove or pokayoke method for the operator instead of controlling them from not making mistake.

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