

Effective implementation of toyota production system for tea making

¹Rakesh Basavegowda Krishnappa, ²Ashwini Krishna, ³Raksha V Hoysal, ⁴Deepika S

¹Assistant Professor, ^{2,3,4}Students
Department of Mechanical Engineering,
Jyothy Institute of Technology
Department of Mechanical Engineering, Bengaluru, Karnataka, India.
Corresponding author: **Rakesh Basavegowda Krishnappa**

Abstract-The industrial revolution had literally made a dynamic shift in the existing market scenario with ample contribution towards elevating economic growth of the nation's Gross Domestic Product (GDP). This paper reported a study, where identified a workplace and process to which the 5S methodology and Lean principle of Toyota Production System (TPS) is effectively applied. The stressful and time taking process involved in the kitchen (food preparation space) provided us a challenging opportunity to embrace on it. Among the various activities in the kitchen, one such activity considered was tea making process, Lean principle of Toyota Production System (TPS) was adopted and implemented to optimize the activity involved in tea making process. Results in successfully identifying unnecessary steps to easily eliminate without effecting the quality and taste of the product (Tea). Upon applying the principles, results shown a predominant reduction in time about 29.5% and 35% of reduction in steps needed for the tea preparation was effectively achieved. The result of the project determined that the industrial production principles can be also be applied to any nature of work domain, work place to optimize and to improve the efficiency of the process is being performed.

Keywords: Toyota Production System, Lean Principle, Tea Preparation, Gross domestic product (GDP)

I. INTRODUCTION

Reducing the workload is always a top priority for mankind. Eliminating repeated and non-value-added activities are always a focus for individuals and organizations alike. The assembly line crusade started by Ford triggered a revolution in continuous improvement of processes. The wind of continuous improvement hit Japan after World War II, as the industries in the country experienced severe cash crunch owing to an impoverished economy left behind by a disastrous war. The lack of resources and struggle for survival for industries resulted in a system developed at Toyota that later came to be known as Toyota Production System. Kiichiro Toyoda observed the 'wastes' in the form of walk time, rework and scrap while working as an engineer at Platt Brothers in erstwhile England and further inspired him to develop a better system of production at Toyota that would focus on eliminating wastes from the value chain, thus creating pure value for the customers.

Our present project focuses on a similar mind-set applied to kitchens at home which is nothing short of a shop floor in an industry, manufacturing products. We witness changeovers, breakdowns, quality loss, performance loss and many more such issues. Food preparation being a very time-consuming process and demanding attention often drains out the cook of his or her energy. To ease the work of the individual working in the kitchen the repeated, non-value-added activities have to be avoided or altogether obliterated.

II. LITERATURE REVIEW

The study has articulated the development of Lean principles to Taiichi Ohno's creation of TPS from the inception of Henry Ford's revolutionary assembly line process. This paper identifies and describes the seven wastes such as - Transportation, Inventory, Motion, Waiting, Overproduction, Over-processing and Defects [4]. The operational, administrative and strategic benefits such as utilization, improvement, reduction in errors and reduction in work-in-process inventory are discussed [14]. Reviews on Toyota production system (TPS) applied to food industry and concludes that some of the most used Lean tools in the food sector are cause and effect diagram, visual management, 5S and Pareto chart [6]. This paper mainly dwells on implementation of Lean principles with tools and techniques in TPS to small and medium scale food production industries in developing countries. It throws light on layout design for waste elimination [8].

Having TPS implementation consciousness in order to adopt is very important, while understanding knowledge areas of its strength and deficiencies and significant motives for

implementing TPS is discussed [15]. The ingrained concept of 5S within the Japanese culture and allied Lean principles like JIT and TPM having importance as a management method is emphasized. [10]

The study asserts that the deep implementation of TPS practices in turn leads to a well performing organization. The depth of effort made in implementation and sustenance of TPS explains the performance level of the organization and the holistic approach of that integrates aspects of HRM, quality, humanity [12]. The review assists in understanding the concept 'lean principles' helps the workplace to increase the rate of production or service with minimal usage of resource and thereby producing high quality products with nominal capital along with customer satisfaction [11].

This paper captured the four underlying rules of TPS which helps in inculcating it appropriately. The importance of specifying, standardizing each and every activity of the process and significance of having a simple and direct pathway to any product or service is exceptionally discussed [9]. Customer waiting time for the process to get complete can be reduced by analysing the whole process using TPS principles or tools is properly illustrated. The study showcases the importance of finding non-value-added activities involved and eliminate them [3]. This study states that implementation of Lean principles results in eliminating the unnecessary waste of any form which later positively effect on customer value through enhanced service or reduction in cost [11].

Article says, 5S and its association with manufacturing performance is extremely important. Adoption of 5S methodology reflects on measures of operational performance especially about quality and productivity [1]. This journal paper says due to introduction of 5S methodology, a considerable improvement can be established in work culture of the organization and through holistic adoption of that principle the tangible and intangible benefits are accrued [5].

A thought of how Lean implementation strategies indicates an opportunity to increase efficiency of production and effectiveness in operations of manufacturing is deeply discussed [2]. One of the methods of identify the problem in workspace is discussed i.e., by video recording the process and split that into step by step actions which in turn will be easy to identify non-value-added activities and eliminate it properly [15].

The summary of literature review asserts that 5S and Lean principles could be applied to a kitchen considering it as a food production unit. The benefit in the implementation of this technique is reduction in time and transportation. In addition, waste management can be anticipated.

Research problem

As we understand on a good amount from literature review that challenges associated with sustainability and growth for a small and medium value-added food chains business are elevating day by day such as: hotels, restaurants and eatery outlets etc. These entities struggle to stabilize and sustain due to volatile external factors that exist in the current market. Apart from the above factors, entities really have to emphasis on the internal processes involved to prepare a food on time, never compromising on the quality, hygiene and deliver quickly at the pace to meet customer demand. This has provided a greater opportunity to define a systematic process to constantly engaging stakeholders (customer) by eliminating non-value-added steps involved in the process. This paper has made sincere efforts with a proven result to tackle the above issue in a well-defined manner.

Terminologies

5S Methodology [16]

Sort, Set in order, Shine, Standardize and Sustain.

- **Sort (Seiri):** It is sorting all items in the workplace and removing unnecessary things
- **Setin order (Seiton):** Placing the sorted items in the assigned location to accomplish their function in the workplace.
- **Shine (Seiso):** On a regular basis the whole workplace including tools and machinery is inspected and cleansed.
- **Standardize (Seiketsu):** It is to standardize the methodology used in sorting, organizing and cleaning the workplace.
- **Sustain (shitsuke):** Workplace organization progress of success is well established by implementing and standardizing with the ethics of habits and behaviours

Toyota Production System (TPS)

The **Toyota Production System (TPS)** is a kind of **socio-technical** system composed of management philosophy and their practices originated by Toyota. For the automobile manufacturer, TPS being a management system helps in organizing logistics and production systems, including association with customers and suppliers. Between 1948 and 1975, the system was developed by two Japanese industrial engineers **Taiichi Ohno** and **Eiji Toyoda** clear out **overburden** (muri) and **inconsistency** (mura), and to be free from **waste**(muda) and the important objectives of TPS [17] containing the greater quality of product with lowest cost in optimal lead time is the goal of TPS [18]

Gemba and gemba walk

Gemba: The Japanese word Gemba refers to the real workplace where actual tasks are conducted.

Gemba Walk: Gemba walk is an occasion to stand out and observe the operations in order to identify the non-required activities [19].

Waste management

One among the chief engineers of Toyota, Taiichi Ohno developed a concept of waste management known as Muda (Seven waste) which includes as a part in TPS [17].

The term Muda is often referred by the acronym 'TIMWOOD'

T	Transportation
I	Inventory
M	Motion
W	Waiting
O	Overproduction
O	Over processing
D	Defects

III. OBJECTIVES AND METHODOLOGY

Objectives

- Implementing 5S methodology to kitchen
- Implementing Lean principles in tea making process
- Elimination of steps in the process of tea making, to minimize the time taken and effective utilization of man power within the available work place (Gemba)

Methodology

- Perform the line walk (Gemba Walk) to understand the existing state of the kitchen
- Implementation of '5S'
- Experimentation - Trial 1: Make tea after implementing 5S
- Tabulate all the steps in tea making along with the total time taken and note the lesson learnt. And the lesson learnt is to implement Lean principles to the process

Implementation of Lean Principles

Experimentation - Trial 2: Alter the layout and the placement of ingredients used in tea making so as to eliminate the repeated and non-essential activities were identified in the first trial

IV. RESULTS AND DISCUSSION

Experiment results

Performing gemba walk

Figure 1 shows Gemba the workplace, where Gemba Walk is performed to identify the problems in order to get productive outcomes. After the initial diagnosis of the kitchen, the difficulties faced in recognition of placements of utensils and basic ingredients were found which led to the implementation of 5S.



Figure 1: Gemba (Workplace)

Implementation of 5S ***Sort and Set in Order***

The house essentials were sorted out and the needy things were kept respective to the kitchen and the others were moved to preferable location of usage as shown in Figure 2. Later the ingredients of the kitchen were set in order according to the frequency of their usage refer Figure 3.



Figure 2: Sort



Figure 3: Set in order

Shine and Standardize

As stated, the workplace (kitchen) was cleaned and maintained after each and every step in the process. To set standards in the kitchen, ingredients were filled in alike containers and labelled as shown in the Figure 4 and Figure 5.



Figure 4: Standardized Inventory rack

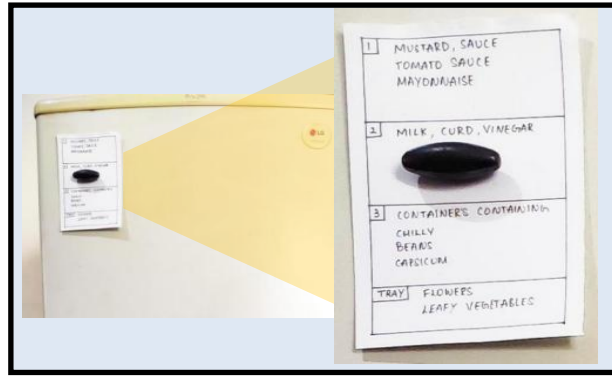


Figure 5: Standardized Refrigerator

Sustain

It says about maintaining previous four steps of 5S methodology for long-term and here the modified kitchen is to be well maintained in future.

Outcome implementation of 5S

Before the implementation of 5S methodology in kitchen, an experiment was conducted to check the time consumed by a stranger to pick essentials required to prepare tea in a standardized process and the result was noted. After the implementation of 5S principle the same action was performed. There was a reduction in time (20 sec) from 1min 15sec to 45sec showing the significant effect of 5S implementation. The result regarding time was bar graphed shown in Figure 6.

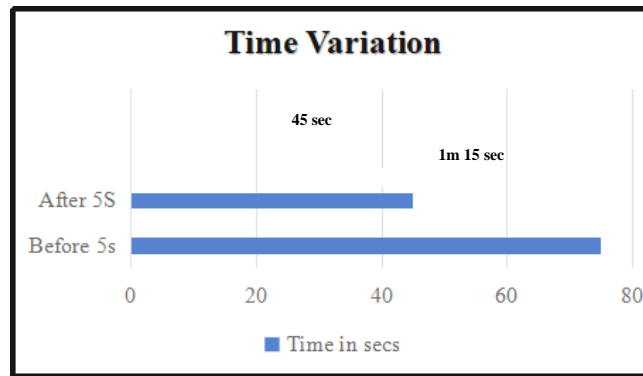


Figure 6: Bar graph of 5S

Experimental trial 1

After the implementation of the 5S methodology, a person entered the workplace (kitchen) to prepare the tea (in the modified kitchen). Figure 7 shows a part of modified inventory rack.

Each and every action performed was noted in table 1.

The Requirements to the experiment are:

- LPG & Stove
- Refrigerator
- Inventory Rack
- Scissors
- Utensils
- Tumblers
- Lighter
- Water container
- Water & Milk
- Tea Powder & Sugar

TIME TAKEN: 6min 12s			
Sl No.	Activity	Category	Remarks
1	Walk to fridge	Transport	

	with a tumbler		
2	Open the door	Motion	
3	Take the milk packet	Motion	
4	Close the door	Motion	
5	Walk towards the stove	Transport	
6	Place the milk packet near the stove	Motion	
7	Walk to the inventory rack	Transport	Shift the ingredients near the stove
8	Take tea powder, sugar and strainer	Transport	
9	Walk back to the stove	Transport	
10	Walk to the inventory rack	Transport	
11	Take scissor	Motion	
12	Walk to the cupboard	Transport	
13	Open the door	Motion	
14	Take one utensil	Motion	
15	Close the cupboard door	Motion	
16	Walk back to stove	Transport	
17	Place the utensil on the burner	Motion	
18	Walk to get water	Transport	Shift the water container near stove
19	Took the tumbler on the lid	Motion	
20	Opened the lid of water container	Motion	
21	Take tumbler full of water	Motion	
22	Close the lid of water container	Motion	
23	Walk back to stove	Transport	Shift the water container near stove
24	Took milk in left hand	Motion	

25	Took scissor right hand	Motion	
26	Cut the milk packet	Motion	
27	Place the scissor near the stove	Motion	
28	Pour the milk into the tumbler (almost close to the brim)	Motion	
29	Throw the cut milk packet piece into the sink	Motion	
30	Pour the milk to the utensil	Motion	
31	Poured half a tumbler of water into the utensil	Motion	
32	Take the lighter near the stove	Motion	
33	Turn on the gas supply in the stove	Motion	
34	Light the burner with the lighter	Motion	
35	Keep the lighter back	Motion	
36	Wait till one boil- (went to get a container to keep the milk packet)	Waiting	
37	Simmer the flame	Motion	
38	Take the tea powder container	Motion	
39	Open the lid	Motion	
40	Put 5 teaspoons of tea powder into the utensil	Motion	
41	Close the lid	Motion	
42	Keep the tea powder container back near the stove	Motion	
43	Took sugar container	Motion	
44	Opened the lid	Motion	

45	Added 5 tea spoons full of sugar	Motion	
46	Close the lid	Motion	
47	Keep the sugar container near the stove	Motion	
48	Walk back to the inventory rack	Transport	Shift the Spoon stand near stove
49	Take a table spoon	Motion	
50	Walk back to the stove	Transport	
51	Stir the tea with the spoon	Motion	
52	Increased the flame	Motion	
53	Wait till second boil (Walk to inventory keep back the tea powder and sugar containers, walk back to stove)	Waiting	
54	Turn off the gas supply	Motion	

Table 1: Steps involved in the preparation of tea in the current kitchen state

The time taken for the tea preparation in Trial 1 is 6 minutes and 12 seconds.

Shortfall of Trial 1

The extra activities which are repeated and non-value added or unnecessary were listed.

Table 2: Table shows the extra activities which are repeated and non-value added or unnecessary in Trial 1

TIME TAKEN: 6min 12s			
<i>Sl No.</i>	<i>Activity</i>	<i>Category</i>	<i>Remarks</i>
7	Walk to the inventory rack	Transport	Shift the ingredients near the stove
8	Take tea powder, sugar and strainer	Transport	
9	Walk back to the stove	Transport	Shift the ingredients near the stove
10	Walk to the inventory rack	Transport	
18	Walk to get water	Transport	Shift the water container near stove
23	Walk back to stove	Transport	
48	Walk back to the inventory rack	Transport	Shift the Spoon stand near stove
49	Take a table spoon	Motion	
50	Walk back to the stove	Transport	

This intend lead to the application of waste in Lean management to the kitchen.

Implementation of lean management to kitchen

Frequent issues faced in the kitchen are non-standardized processes and untidy work environment which intends to produce waste. Various Lean tools can be used to achieve this improvement in the tea making process so that repeated and unnecessary activities can be eliminated and alternatives can be implemented in trial 2.

Therefore, the Lean concept is implemented in the tea making process, where the ingredients required are systematically organized and placed at ease of reachability (location) to reduce the efforts made by the people and time taken to complete process at the workplace.

The wastes recognized with the help of Lean management are **transportation, motion** and **waiting**. One of our main aim is to reduce unnecessary transportation carried out to fetch the necessary items required to complete the process. This was achieved by strategically placing the inventory rack which contain tea powder, sugar, etc. near the stove. The ingredients required which were previously placed in a faraway cupboard were moved in order for them to be placed near the actual workspace (stove). After the ingredients were moved near the stove, the items were rearranged in order of their preferences as shown in Figure 8.



Figure 7: Updated inventory rack

Experimental trial

After implementing the Lean concept, a person entered the workplace (kitchen) to prepare tea. Each and every step performed by the person was noted while preparing the tea as shown in Figure 8.



Figure 8: Performing experiment

Table 3: Activities performed in preparation of tea after elimination of waste.

TIME TAKEN: 4min 22s		
<i>Sl no.</i>	<i>Activity</i>	<i>Category</i>
1	Walk to fridge	Transport
2	Open the door	Motion
3	Take the milk packet	Motion
4	Close the door	Motion
5	Walk towards the stove	Transport
6	Place the milk packet near the stove	Motion
7	Open the door	Motion
8	Take one utensil	Motion
9	Close the cupboard door	Motion
10	Took milk in left hand	Motion
11	Took scissor right hand	Motion
12	Cut the milk packet	Motion
13	Pour the milk into the tumbler (almost close to the brim)	Motion
14	Throw the cut milk packet piece into the sink	Motion
15	Place the scissor back	Motion
16	Pour the milk to the utensil	Motion
17	Place the utensil on the burner	Motion
18	Take the lighter near the stove	Motion
19	Turn on the gas supply in the stove	Motion
20	Light the burner with the lighter	Motion

21	Keep the lighter back	Motion
22	Took the tumbler on the lid	Motion
23	Opened the lid of water container	Motion
24	Take tumbler half of water	Motion
25	Close the lid of water container	Motion
26	Poured half a tumbler of water into the utensil	Motion
27	Wait till one boil - (went to get a container to keep the milk packet and oped the lids of tea and sugar containers)	Waiting
28	Simmer the flame	Motion
29	Add 5 teaspoons of tea powder into the utensil	Motion
30	Added 5 teaspoons full of sugar into the utensil	Motion
31	Take a table spoon	Motion
32	Stir the tea with the spoon	Motion
33	Increased the flame	Motion
34	Wait till second boil (Close the lids of tea powder and sugar containers)	Waiting
35	Turn off the gas supply	Motion

Experiment Outcome

Implementation of 5S and Lean principles leads to maximize efficiency and effectiveness by reducing people's workload through simplifying processes as well as enhancing transparency of kitchen and elimination of waste. The steps are compared with both the experiments with drastic decrease of 19 steps is noticed i.e., from 54 steps (before implementation) from table 1 to 35 steps (after implementation) from the table 3. Results are bar graphed as shown from the Figure 9

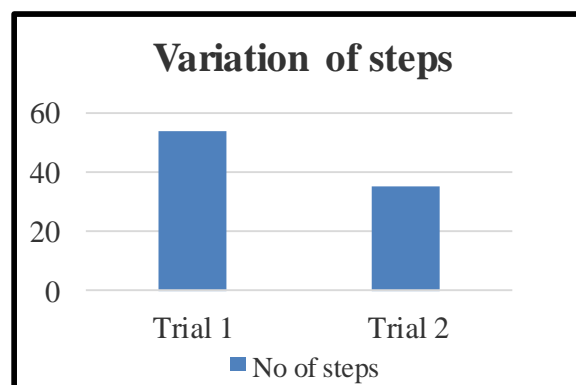


Figure 9: Bar Graph of Variation of steps

The experiment was conducted again with 2 more trials to prove the consistency of time required for preparing tea with the implementation procedure. which as met the requirements and results were consistent with each trial as shown in Figure 10.

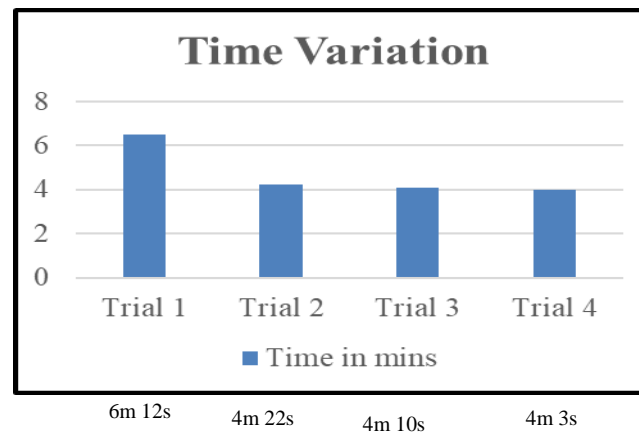


Figure 10: Bar Graph of Time variation

V. CONCLUSION

This project shows that the 5S methodology and Lean principles can be effectively implemented in food industry and showed the best implementation in the kitchen arena. Performing the Gemba Walk, the workplace (kitchen) was studied and an experiment was conducted as mentioned above. 5S methodology was implemented and the same experiment was conducted while the results were computed. Before 5S implementation there was no particularity and transparency in the kitchen, after the its implementation any person would take a walk into the workplace and find the required ingredients on their own.

- There was 40% of reduction in time after the implementation of 5S principles to the kitchen. The fig 10 highlights the improvements achieved in the kitchen.
- 5S principle implementation to the workplace, helped us in sorting, setting the things upright, shine and standardize the work place with proper refilling ingredients on time and sustain all the operation for next set of cycle.
- Lean principle implementation leads us to identify and recognize the waste such as ingredient transportation and unnecessary motion.
- There was 35% of reduction in steps after the implementation of Lean principles to the work place i.e., (kitchen).

We found significant reduction in time and work needed for the tea to be prepared effectively. The processes performed is evident to the aim of our project. All of the process and principle as used in the industrial workplace can also be implemented in many ways even at domestic kitchen, hotels and restaurant.

Future scope of this project work can be considerably adopted and implemented in food industries (Restaurant/hotels), results in cost reduction, better usage of workplace, improved process growth and efficiency, time management, customer satisfaction and improved profit margin and working conditions.

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REFERENCES:

1. Alberto Bayo-Moriones et al., 5S use in manufacturing plants: contextual factors and impact on operating performance. *International Journal of Quality & Reliability Management*, Vol. 27, pp. 217-230, 2010.
2. Boppana V. Chowdary and Damian George, Improvement of manufacturing operations at a pharmaceutical company: A lean manufacturing approach, *Journal of Manufacturing Technology Management*, Vol. 23 No. 1, pp. 56-75, 2012.
3. David Ng et al., Applying the Lean principles of the Toyota Production System to reduce wait times in the emergency department. *Canadian Journal of Emergency Medicine*, Vol 12 No. 1, pp. 50 – 57, 2015.

4. Joel Sutherland and Bob Bennet, the seven deadly wastes of logistics: Applying Toyota production System principles to create logistics value. Research Gate-Business Management-Logistics, CVCR White Paper #0701, 2007.
5. Jugraj Singh Randhawa and Inderpreet Singh Ahuja. An investigation into manufacturing performance achievements accrued by Indian manufacturing organization through strategic 5S practices, International Journal of Productivity and Performance Management, Vol. 67 No. 4, pp.754-787, 2018.
6. Luana Bonome Message Costa et al., Lean, six sigma and lean six sigma in the food industry: A systematic literature review. Trends in Food Science & Technology, 2018.
7. Lei, Jinna et al. Fine-grained kitchen activity recognition using RGB-D. ACM Press the 2012 ACM Conference - Pittsburgh, Pennsylvania (2012.09.05-2012.09.08), Proceedings of the 2012 ACM Conference on Ubiquitous Computing - UbiComp '12 208, 2012.
8. Nilda Tri Putri and Lora Seprima Dona. Application of Lean manufacturing concept for redesigning facilities layout in Indonesian home-food industry - Case study. The TQM Journal, Emerald Publishing Limited. Vol. 31 No. 5, pp. 815-830. 10.1108/TQM-02-2019-0033. 2019.
9. Robert Lioyd et al. A Review of the Development of Lean Manufacturing and Related Lean Practices: The Case of Toyota Production System and Managerial Thinking. International Management Review (IMR), Vol. 15 No. 2, 2019.
10. Rod Gapp et al. Implementing 5S within a Japanese context: an integrated management system. Management Decision, Vol. 46 No. 4, pp.565-579, 2008.
11. Steven Spear and H. Kent Bowen. Decoding the DNA of the Toyota Production System. Harvard Business Review, September-October 1999
12. Tsu-Ming Yeh et al. The implementation of technical practices and human factors of the toyota production system in different industries. Human Factors and Ergonomics in Manufacturing & Service Industries, Vol 22, No. 6, 2012.
13. Ulla Lehtinen and Margit Torkko. The Lean Concept in the Food Industry: A Case Study of Contract a Manufacturer. Journal of Food Distribution Research, Vol 36 No. 3, 2005.
14. Vivekanand S Gogi et al. A brief overview on Toyota Production System. International Journal for Research in Applied Science & Engineering Technology (IJRASET), Vol 8 No. V, 2020.
15. Waseem Akhtar and Afsar Ansari. The Implementation of Toyota Production System (TPS) in Indian MSMEs: A study on the Motive, Barriers, Challenges, Success Factor and Applications. International Journal of Engineering Applied Sciences and Technology(IJEAST), Vol. 4, No. 12, pp.102-111, 2020.
16. [https://en.m.wikipedia.org/wiki/5S_\(methodology\)](https://en.m.wikipedia.org/wiki/5S_(methodology))
17. <https://en.m.wikipedia.org/wiki/ToyotaProductionSystem>
18. <https://kanbanize.com/continuousflow/heiijuna>
19. <https://kanbanize.com/Leanmanagement/improvement/gemba-walk>