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IMPLEMENTATION OF LEAN MANUFACTURING IN REDUCING WASTE IN ELECTRONIC ASSEMBLY LINE

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Abstract

This The concept of lean manufacturing was developed for maximizing the resource utilization through minimization of waste, afterward lean was formulated in response to the fluctuating and competitive business environment. Thorough literature survey, books and report analysis contribute to the most preliminary analysis of this study. The most common tools or techniques and their usefulness are investigated. In this research, a conceptual model for leanness measurement within the manufacturing industry has been developed and designed in two main levels, namely the size and thus the factors. There are seven main dimensions in measuring leanness in lean manufacturing practices like manufacturing process and equipment, manufacturing planning and scheduling, visual data system, Supplier relationship, customer relationship, workforce and product development & technology. In addition, the model also shows how lean dimensions within the manufacturing system relate to eight sorts of wastes. The majority of the study focuses on single aspect of lean element, only a few focuses on quite one aspect of lean elements, except for the successful implementation of lean the organization had to focuses on all the aspects like Value Stream Mapping (VSM), Cellular Manufacturing (CM), U-line System, Line Balancing, control, Single Minute Exchange of Dies (SMED), Pull System, Kanban etc.

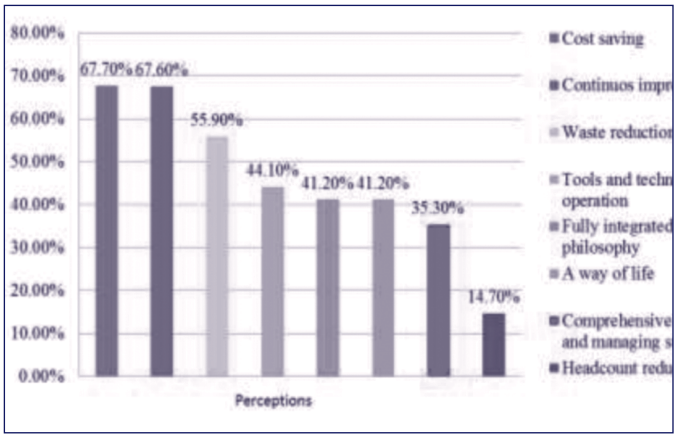
Keywords- Inventory control, Line balancing, Lean manufacturing, Cellular manufacturing.

INTRODUCTION

The core principle in implementing lean producing is to eliminate waste and regularly improve a method. By reducing waste to deliver method enhancements, lean producing sustainably delivers worth to the client. the kinds of waste embody processes, activities, merchandise, or services that need time, cash or skills however don't produce worth for the client. These will cowl underused talent, excess inventories or ineffective or wasteful processes and procedures. Removing these inefficiencies ought to contour services, cut back prices and ultimately give savings for a particular product or service through the availability chain to the client. Manufacturing has been recognized because the main engine for growth of the economy. Ever ever-changing globalized atmosphere has been motion challenges of fight and survival to any or all or any the constituents of the economy. makers inside the globe business have perpetually visaged heightened challenges like rising customer's demand for higher and improved merchandise, erratic demand, and competition in markets. there is no disbelief that the makers area unit perpetually clench changes and enhancements in their key activities or processes to handle the ever-growing challenges. Industries area unit paying ton of attention to Lean producing. many industries in Republic of India area unit troubled to be world category. Principal adoption of lean producing remains found to be advanced. Lean producing is also a group of techniques, that have developed bit by bit over AN extended amount and area unit supported numerous minor to major breakthroughs that facilitate in reducing value and thus increase productivity. The word "lean" refers to lean producing or lean production as a result of it uses less of everything. It solely uses 0.5 the human effort inside the industrial plant, 0.5 the producing area, 0.5 the investment in tools and 0.5 the engineering hours to develop a replacement product in 0.5 the time. Some typical edges that lean offers to the industries area unit money saving, less work on, reduced lead-time, inflated method understanding, less method waste and reduced inventory. supported analysis that had been exhausted two hundred SME firms, their perceptions toward lean edges area unit value saving, continuous improvement, waste reduction, tools and technique to enhance production operation, totally integrated management philosophy, the simplest way of life, comprehensive system of organizing and managing the availability chain and last is head count reduction, that area unit shown in figure one.1.Some typical benefits that lean offers to the industries are financial saving, less rework, reduced lead-time, increased process understanding, less process waste and reduced inventory. Based on research that had been done in 200 SME companies, their perceptions toward lean benefits are cost saving, continuous improvement, waste reduction, tools and technique to improve production operation, fully integrated management philosophy, a way of life, comprehensive system of organizing and managing the supply chain and lastly is headcount reduction, which are shown in figure 1.1.

Lean manufacturing concepts can be organized into three levels consist of lean manufacturing objectives and fundamental principles, prime management and manufacturing approaches and also the implementation techniques that are the actions for applying and maintaining the stratagems. The orderly removal of waste will ease the cost of working the prolonged enterprises and satisfies the customer's need for supreme value at a lower cost.

Figure 1.1: Graph of perceptions towards lean practices.



LITERATURE REVIEW

Ahuett-Garza, H. and T. Kurfess [2021] [1], manufacturing industry like automotive industry, machine industry, semi-process industry, electronics manufacturing industry, pump industry and furnishing industry has been discussed. Lean manufacturing may be a multidimensional management practice including just in time-quality systems, work teams, cellular manufacturing, supplier management etc. the favoured definition of Lean Manufacturing.

Alhuraish, I., C. Robledo and A. Kobi [2021] [2], discussed the performance benefits of lean systems are of TPS, viewing it as a selected carpenter's kit technically implemented during a formulaic thanks to achieve pre-specified results. consistent with Shah, R et al, lean production may be a multi-dimensional approach that encompasses a good sort of management practices, including just in time, quality system, work teams, cellular manufacturing and supplier management in an integrated system.

Azadegan, A., P.C. Patel, A. Zangoueinezha,and K. Linderman [2021] [3], in his article made the analysis of the lean literature and concluded that among the authors dominates a view that lean is quite a group of tools, since it's a philosophical approach to lean. Therefore, lean production is additionally considered as a philosophy of continuous improvements and reference to people.

Azevedo, S.G., H. Carvalho, S. Duarte [2021] [4], illustrated the foremost common lean tools. The goal of lean production is about within the roof and consists of reaching for the simplest quality, lowest costs, shortest lead-time, highest safety and high morale. The left pillar encloses Just-in-Time principle that consists of production planning and levelling tools like takt time, continuous flow, pull system, quick changeover and integrated logistics. the proper pillar deals with Jidoka, which prevents a defective part from proceeding into subsequent workstation also as insists on separating people from machines.

Abdullah Ali H. Ahmadini et al, [2021] [5], study shows us to imagine a multilocation universal inventory of cover supplied by green investment in efforts to protect a huge portion of the countryside. The design is intended to be a four-objective universal fractional programming problem. To raise the profit ratio to the entire amount of demand, the very first solution is to cut the price of the storage system, and also the total waste created by inventory management. The effectiveness of the model is illustrated by a numerical control system. The resulting solutions can provide you with a good idea for in the decision-making process in the industry.

Christoph H. Glock et al, [2021] [6], The article provides a conceptual framework for controlled production rates, which includes the design of the horizon (short-term and long-term), the number of works per cycle (unit or several), and also the consequences on the controlled production of the volumes upon that achievement. For example, if a system, for example, has a low production cost, energy consumption, and product quality, and, like an outcome, the type of system, the batch value is fixed to (for example, had a low production cost and energy consumption). The paper summarizes the findings of a review of the research and analyses the current level of research on batch, model calibration with a regulated production rate.

Agus Darmawan et al, [2021] [7], The author of this article presents models and solutions for the creation of a retail network that considers not only site-travel and innovation issues, but also the implementation of structured asset management. The author examines and contrasts two distinct techniques based on whether asset management is employed in the procurement network.

Puppala Sridhar et al, [2021] [8], Suggested method will lower innovation by 40% & sales by 87 times compared to the present standard management system. Using Tournament s/w package, the prediction graph is built, controlled on a specific buy. The suggested programme is built using the Simulation software's opt Quest module.

G. Karakatsoulis et al, [2021] [9], The inventory policy (r, Q) is utilized to regulate the system in this article, which includes an auction, deterministic demand, and therefore the quantities, have the influence on the usual overall cost of an inventory system.

Abdullah Ali H. Ahmadini et al, [2021] [10], study shows us to imagine a multilocation universal inventory of cover supplied by green investment in efforts to protect a huge portion of the countryside. The design is intended to be a four-objective universal fractional programming problem. To raise the profit ratio to the entire amount of demand, the very first solution is to cut the price of the storage system, and the total waste created by inventory management.

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on batch, model calibration with a regulated production rate.

Josef Svoboda et al, [2021] [12], Research on inventory models using a multi-source tool. It will be possible to determine the major trade-offs in relation to various financing sources, and future research paths. For this section of the front, the "annex" - a policy that is more heuristic than the optimum policy. Three areas of future study are recommended to make it more functional.

Heibatolah Sadeghi et al, [2021] [13], The author proposes an optimum integrated production and warehousing model in this work. The model's more objective job is to generate an ideal quantity & to return to it for the cheapest price possible. They introduce a fully distinct way smoothing out the technique & heuristic method to address this problem, the non-linearity of a system. The resulting findings are of practical utility when compared to the conventional version of economic order quantity.

R. Janani et al, [2021] [14], The study reflects Planning, commercial, business, and management are all aspects of management. Planning, Sourcing, Procurement, and Delivery make up the management team. Management team is made up of resolute management and a keen understanding of material storage and administration.

Abolfazl Gharaei et al, [2021] [15], The Economic order quantity concept is suited for usage in systems that support ever-growing demand with the aid of the examples. The model's results revealed that considering factors of sustainable development for product manufacture improves the number of orders, but it also lowers the time of product's life cycle. As per the findings, as matched to I s and GWO algorithms, the I s-GWO system provides significantly better and more efficient answers to the given model, reduces CPU time. In addition, the resistance of a duration of the quantity and quantity of orders is better, as it weakens, and the expense of the task, the environmental standards, plenty of the sources of emissions.

A.N.M Karim, 2021 [16] has applied MOST to improve workflow and productivity in the automotive industry, incorporation of MOST to estimate the standard times for various activities involved results in substantial improvement in productivity of sector from the present situation to future ready.

PROBLEM STATEMENT

The present status of lean implementation in Indian machine industries also as tinted some allied issues. The survey has attempted to formulate simple questionnaire-based tool to spot the prevailing level of lean practices, reasons for inadequate priority to lean concepts, sort of lean tools employed, perceived level of various wastes, and therefore the common difficulties encountered by the Indian machine Manufacturers. Majority of the survey on lean elements focuses on just one or two element or combination of two or three elements. For successful implementation of lean, practically need incorporation of all lean elements and sequencing of implementation task.

OBJECTIVES

- Researching Lean Manufacturing Methodologies.
- To Implement Lean Manufacturing Techniques.
- To Investigate the Various Kinds of Inventories Methods of Control.
- To Research the Ordering Level of Lean Implementation.

METHODOLOGY

Primary data was collected from the stock registers maintained within the stores by making use of the format. the first aim of this study is to seek out the requirements and examine the degree to which the concepts of lean management are put into practice within various manufacturing Industry.

Step 1: This is often a summary for locating the present situation of lean management practices in manufacturing industries.

Step2: It's a measure to spot the constrains that retains lean manufacturing within the infant stage in manufacturing firms and helps to spot the Muda (waste) that evolves in a processing unit and provides out supporting measures to get rid of an equivalent.

Step 3: The obvious problems are taken care of first. There is no reason to spend time describing and timing work elements that are obviously unnecessary.

Step 4: The time study analyst should familiarize with the assembly operations before documenting the elemental times. Also, there should be plenty of communication between assembly operator and the time study analyst. The operator participation must be encouraged and their ideas must be captured.

Step 5: The constraint that predicts the implementation and sustainability of lean manufacturing tools and techniques also are discussed.

Types of Waste Targeted by Lean Method during a process are categorized in following categories. it's interesting to notice that the "wastes" typically targeted by environmental management agencies, like non-product geo output and staple wastes, aren't explicitly included within the list of producing wastes that lean Practitioners routinely target.

Defects: Production of Products not as per Specification, Components or Services which Consequence in scrap, Rework, Replacement Production, going over, and/or Defective Materials.

Waiting: Delays associated out of stock, delay in processing, equipment downtime, competence bottlenecks.

Unnecessary Processing: Process steps that are not required to produce the product.

Overproduction: Manufacturing of extra items for which no orders are there.

Movement: Human motions that are unnecessary or straining, and work-in-process (WIP) transporting long distances.

Inventory: raw material in excess, or finished goods.

Unused Employee Creativity: Failure to tap employees for process improvement suggestions.

Complexity: More parts, complicated process steps, or requirement of time more than necessary to meet customer needs.

Lean core methods Described below are eight core lean methods:

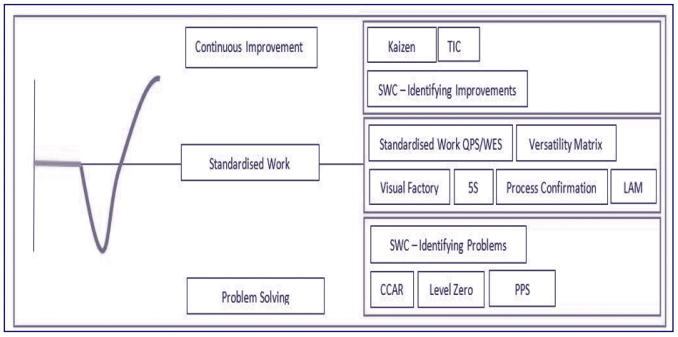
• Cellular Manufacturing / One-piece Flow Production Systems, • 5S, • Just-in-time Production, • Total Productive Maintenance (TPM), • Kaizen, • Kanban, • Six Sigma, • Pre-Production Planning (3P)

Approaches adopted for implementation of lean manufacturing: A successful implementation of any particular management practice frequently depends upon organizational characteristics, and not all organization can or should implement an equivalent set of practice. Unionization: it's generally supposed that because implementation of producing practices requires negotiating changes in work organization, unionized facilities will resist adopting lean practices and lag behind non-unionized facilities.

Age of Plant: Plant age may imply either a bent toward resistance to vary or a liability of newness. The "resistance to change" view is supported by the organizational sociology literature which suggests that the age of an institution should inversely influence the speed of adoption of innovations, because organizational forms tend to be "Frozen" at birth.

Size of Plant: Large manufacturers are more likely to implement lean practices than small manufacturers.

Figure1.2: Integrated Production Systems / Lean Practices and how they fit around production



EXPERIMENTAL PROCEDURE

Applying Lean Method: Once observation and identification are done, data that have been collected will be used to identify which method of lean is suitable to be implemented in the production area. This will be justified according to the seven elements of waste which occur in lean manufacturing.

Simulation by Using Software: The Witness simulation makes it possible to creating a variety of discrete and continuous elements. Subject on the type of component, each can be in any quantity of 'states' which means either idle, busy, blocked, in-setup, broken down, and waiting labor. The end of the simulation done by using Witness software, the result from the data will be analyzed whether it brings any improvement towards the company.

The performance for current production is run in software and the result of performance is shown in Table 5. According to the results of performance of each labor, it shows that Gauging Process has workers with a high percent of idleness. By referring to this result, an improved process can be made.

Table 4.1: Data collections in existing production

Type of data	Time
Demand per day	4000
Working Hours per day	hours 10
Break per day	hours 0.75
Available Working Hours per day	hours 9.25
Takt Time	seconds 8.3
Target per Hour	433
(Conveyor Speed (m/s	0.03

Table 4.2: Cycle time for each worker

Workers	Process	Cycle time 1 (s)	Cycle time 2 (s)	Cycle time 3 (s)	Avg. Cycle Time (s)
1	Wire Soldering	59	58	46	54.3
2	Wire Soldering	60	58	48	55.3
3	Toroid Winding	99	99	86	95
4	Toroid Winding	56	55	58	56.3
5	Toroid Winding	67	64	68	66
6	Toroid Winding	92	91	89	91
7	Toroid Winding	62	65	64	63.7
8	Toroid Winding	34	29	31	31.3
9	Toroid Winding	40	38	39	39
10	Wire Forming & Cutting	12	10	11	11
11	Wire Forming & Cutting	13	12	13	12.7
12	Header Assembly	13	15	14	14
13	Header Assembly	7	8	7	7.3
14	Epoxy	40	37	37	38
15	Epoxy	40	30	30	33.3
16	Epoxy	24	22	22	22.7
17	Chopping	3	3	3	3
18	Gauging	4	5	4	4.7
19	Gauging	2	2	2	2
20	VMI	5	15	7	9
21	VMI	13	15	14	14
22	VMI	31	27	28	28.7
23	Test & Packaging	6	5	5	5.3

Table 4.3: Improvements After Implementation

Project	Quantitative Benefits	Qualitative Benefits	Monetary
Reducing In-house rejections	57% reduction is PPM in all the 9 units	-Importance of data collection and data-based decision Making -Awareness of Pareto analysis, Cause and effect diagram, Why-why analysis to find the root cause of the problem	Rs.32.0 lakh
Imroving OEE	OEE has been improved above 70 % in 3 units	-Major downtime is addressed -Machine utilization improved	
Improving 5S	5S levels of 9 units has been increased by 156% (from 32 to 82)	-Unwanted items removed & space utilized- Searching of items reduced by proper arrangement - Visual controls for better shop floor maintaining	Rs. 6.32 lakh
Implementation of Kaizens	90 Kaizens have been implemented in 9 units	Employee morale has been improved -Active participation of employees in day-to-day shop-floor Problems and coming up with suggestion to solve it	Rs. 3.26 lakh
Reducing changeover time	64 % reduction in changeover time in two units	-Awareness on SMED, VA and NVA- Importance of tool kits in changeover to reduce the time taken	Rs. 2.25 lakh
Inventory Optimization	28.57 % reduction in inventory	Importance of Raw material planning -Better Delivery performance	Rs. 4.00 lakh
Improving Productivity	30% improvement in productivity in two units	- Awareness on identifying and optimizing operating parameters	Rs. 10.0 lakh

DATA ANALYSIS FOR FIRST IMPROVEMENT

Based on existing data, an improved process is developed to be one of the future setups for this company. The method used to create an improved process is by referring to the percentage of the idleness of the labors in existing production where it is found that two labors that are in the gauging process have a high percent of idleness compared to others. According to that, one workstation is reduced, and the performance of it is being analysed by using Witness. The two labor of Gauging Process in current production has been reduced to one labor, which means the workstation is reduced from 23 to 22. Lady18 is chosen to be removed because she has the highest percent of idleness that is 93.84%. After the workstation has been removed, based on the performance in Table 6, the labour's performance did not have any different except for Lady17, which is 85.53% of idleness reduce to 71.05 since she handles the process that had been removed from Lady18. The performance calculation of this improvement is shown by Eq. (1).

Performance (1041piece/288min) x100 51.64%

7piece per min .....(1)

Table 5.1: Result of performance by using Witness.

Job Element	Name	Busy %	Idle %	No. Jobs Started	No. Jobs Ended	Avg Job (Time (s
Wire Soldering	Lady01	99.87	0.13	334	333	54.3
	Lady02	99.78	0.22	327	326	55.3

Toroid Winding	Guy01	99.57	0.43	238	237	75.53
	Guy02	99.57	0.43	380	379	47.53
	Guy03	99.57	0.43	406	405	44.39
	Lady03	99.48	0.52	351	350	51.5
	Guy04	99.48	0.52	374	373	48.22
	Guy05	99.48	0.52	704	703	25.61
	Lady12	99.48	0.52	820	819	21.97
Wire Forming & Cutting	Lady04	78.03	21.97	684	683	20.7
	Lady13	99.24	0.76	621	620	29
Header Assembly	Lady05	99.05	0.95	2565	2564	7
	Lady14	51.61	48.39	1282	1281	7.3
Epoxy	Lady06	89.45	10.55	427	426	38
	Lady16	78.33	21.67	427	426	33.3
	Lady07	53.49	46.51	427	427	22.7
Chopping	Lady09	18.48	81.52	1116	1116	3
Gauging	Lady17	14.47	85.53	558	558	4.7
	Lady18	6.16	93.84	558	558	2
VMI	Lady19	55.43	44.57	1116	1116	9
	Lady10	85.7	14.3	501	500	31
	Lady20	85.75	14.25	542	541	28.7
Test & Packaging	Lady11	13.21	86.79	1041	1041	2.3

Data

ANALYSIS OF SECOND IMPROVEMENT

A reallocating method is used in this second improvement by reallocating the free labor to a workstation that has a bottleneck which has a low capacity of buffer. The final improvement that gives increment in productivity when the labor is put into that process is by reallocating the labor to VMI process, since this process can be considered as final process before test and packaging stage. The analysis for this second improvement gives increment in productivity of the production, which is from 1041 total output it becomes 1109. The productivity for this improvement is calculated below.

Performance (_____1109pieces/288 min) x100 55.01%
7piece per min .....(2)

Below is the labors performance for second improvement where it shows that the output gained in this improvement is increased a bit. This output can be seen in number of jobs ended in the final process in Table 5.2, which in test and packaging stage.

Table 5.2: Data on labors performance for second improved process

Job Element	Name	% Busy	% Idle	No. Of Jobs Started	No. Of Jobs Ended	Avg. Job Time
Wire Soldering	Lady01	99.87	0.13	334	333	54.3
	Lady02	99.78	0.22	327	326	55.3
Toroidal Winding	Guy01	99.57	0.43	238	237	75.53
	Guy02	99.57	0.43	380	379	47.53
	Guy03	99.57	0.43	406	405	44.39
	Lady03	99.48	0.52	351	350	51.5
	Guy04	99.48	0.52	374	373	48.22
	Guy05	99.48	0.52	704	703	25.61
	Lady12	99.48	0.52	820	819	21.97

Wire Forming and Cutting	Lady04	78.03	21.97	684	683	20.7
	Lady13	99.24	0.76	621	620	29
Header Assembly	Lady05	99.05	0.95	2565	2564	7
	Lady14	51.61	48.39	1282	1281	7.3
Epoxy	Lady06	89.45	10.55	427	426	38
	Lady16	78.33	21.67	427	426	33.3
	Lady07	53.49	46.51	427	427	22.7
Chopping	Lady09	18.48	81.52	1116	1116	3
Gauging	Lady17	28.95	71.05	1116	1116	4.7
VMI	Lady18	55.43	44.57	1116	1116	9
	Lady19	68.66	31.34	434	433	28.7
	Lady10	75.35	24.65	370	369	37
	Lady20	70.61	29.39	310	309	41.4
Test & Packaging	Lady11	14.08	85.92	1110	1109	2.3
Stn 5			12.39	1.6		

CONCLUSION

From the table 1 it is found that there is a direct savings of INR 6 million for these 9 units through lean implementation over a period of 18 months. More than the direct savings, the improvement in the productivity and competitiveness of the units have given the units an edge over their competitors. It has brought them more jobs as they are in a better position to offer competitive prices and higher quality. Also, they are able to take up more challenging jobs as they are equipped with employees who can solve any challenge through brainstorming and Kaizens. Their machines are always available for production as they had implemented TPM and improved their OEE considerably. The employees are highly motivated and many systems are in place. The achievement in 5S practices keeps the working environment pleasant and accident free. On-time development of the Tools required in Press shop which was very rare earlier helps in achieving the production target and keeps the customer delighted. The inventory turnover ratio has increased from 8 to 14 which means the inventory undergoes six more cycles in a year. The reduction in change over time from 135 min to 45 min has increased the production time by 90 min for every change over. More than 300 Kaizen were implemented at an average of 30 per unit and resulted in saving of material, process time, effort, etc. which leads to overall benefits. The reward scheme for Kaizen has highly motivated the employees and has made them involve more in their jobs. Reduction in PPM is the result of using the data more effectively and applying more lean tools to eliminate the root causes of rejections. It was aimed to reduce the waste exist in line production that related by the performance of workers in line. The virtual simulation was simulated based on data collections gained during observation process. The significant of each improvement was verified according to simulation result in the software used which the performance of production was calculated to support the result. The performance was reduced from 56.04% to 55.01% with total production from 1041 to 1109 pieces. According to the results obtained, the waste that had been addressed by this simulation is processing waste; a situation of a particular process step that does not contribute any benefit to the product where the two labors in one process are having a small percent of busy. In addition, with this improvement, the productivity of it is increased, since one of the bottlenecks of the production is solved. Production was calculated to support the result. The performance was reduced from 56.04% to 55.01% with total production from 1041 to 1109 pieces. According to the results obtained, the waste that had been addressed by this simulation is processing waste; a situation of a particular process step that does not contribute any benefit to the product where the two labors in one process are having a small percent of busy. In addition, with this improvement, the productivity of it is increased, since one of the bottlenecks of the production is solved.

REFERENCES

1. *Ahuett - Garza , H . , and T . Kurfess . 2018 . "A Brief Discussion on the Trends of Habilitating Technologies for Industry 4.0 and Smart Manufacturing." Manufacturing Letters 60 :١٥–63.*
2. *Alhuraish , I . , C .* Robledo *, and A . Kobi . 2017 . "A Comparative Exploration of Lean Manufacturing and Six Sigma in Terms of Their Critical Success Factors." Journal of Cleaner Production 164: 325–337.*
3. *Azadegan , A . , P . C .* Patel *, A . Zangoueinezhad, and K. Linderman. 2013. "The Effect of Environmental Complexity and Environmental Dynamism on Lean Practices." Journal of Operations Management 31 (4): 193–212.*

4. *Azevedo, S. G., H. Carvalho, S.* Duarte, *and V.* Cruz-Machado. *2012. "Influence of Green and Lean Upstream Supply Chain Management Practices on Business Sustainability." IEEE Transactions on Engineering Management 59 (4): 753–765.*
5. *Abdullah Ali H. Ahmadini, Umar Muhammad Modibbo, Ali Akbar Shaikh and Irfan Ali, Multi-objective optimization modelling of sustainable green supply chain in inventory and production management, Alexandria Engineering Journal, vol. 60, issue 6, ed. December, pages 5129-5146, 2021.*
6. *Christoph H. Glock et al, Optimal reorder level and lot size decisions for an inventory system with defective items, Applied Mathematical Modelling, vol. 92, ed. April, Pages 651-668, 2021.*
7. *Agus Darmawan et al, Optimal reorder level and lot size decisions for an inventory system with defective items, Applied Mathematical Modelling, vol. 92, ed. April, Pages 651-668, 2021.*
8. *Puppala Sridhar et al, Optimal reorder level and lot size decisions for an inventory system with defective items, Applied Mathematical Modelling, vol. 92, ed. April, Pages 651-668, 2021.*
9. *G. Karakatsoulis et al, Optimal reorder level and lot size decisions for an inventory system with defective items, Applied Mathematical Modelling, vol. 92, ed. April, Pages 651-668, 2021.*
10. *Abdullah Ali H. Ahmadini et al, Optimal reorder level and lot size decisions for an inventory system with defective items, Applied Mathematical Modelling, vol. 92, ed. April, Pages 651-668, 2021.*
11. *Christoph H. Glock et al, Optimal reorder level and lot size decisions for an inventory system with defective items, Applied Mathematical Modelling, vol. 92, ed. April, Pages 651-668, 2021.*
12. *Josef Svoboda et al, Optimal reorder level and lot size decisions for an inventory system with defective items, Applied Mathematical Modelling, vol. 92, ed. April, Pages 651-668, 2021.*
13. *Heibatolah Sadeghi et al, Optimal reorder level and lot size decisions for an inventory system with defective items, Applied Mathematical Modelling, vol. 92, ed. April, Pages 651-668, 2021.*
14. *R. Janani et al, Optimal reorder level and lot size decisions for an inventory system with defective items, Applied Mathematical Modelling, vol. 92, ed. April, Pages 651-668, 2021.*
15. *Abolfazl Gharaei et. al, multi-objective optimization modelling of sustainable green supply chain in inventory and production management, Alexandria Engineering Journal, vol. 60, issue 6, ed. December, pages 5129-5146, 2021.*
16. *A.N.M Karim: A case study of printer remanufacturing," Computers and Industrial Engineering, vol. 151, ed. January, article no. 106525, 2021.*

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