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IMPLEMENTATION OF LEAN PRINCIPLES IN A FURNITURE AND HOUSEHOLD APPLIANCES RENTING COMPANY WITH REFERENCE TO SOFA MANUFACTURING: A CASE STUDY

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Abstract

The concept of lean manufacturing was developed to maximize resource utilization through the minimization of waste, later lean was formulated in response to the fluctuating and competitive business environment. For the successful implementation of lean principles, the organization has to focus on all aspects. The objective of this study was to increase the space utilization of the warehouse, improve the output and productivity of the plant, and redesign the production line for the sofa manufacturing unit. The methodology used to achieve the desired objective was the implementation of VSM, 5S, Cellular layout, and Kanban system. After the successful implementation, it has been found that the reduction in inventory cost was 40%, the reduction in production cost was 44%, the rise in productivity was 95%, the rise in output was 98% and the utilization of the warehouse was 76%.

Key Words: VSM, Kanban System, Productivity, Pull System.

1. INTRODUCTION

As the world is heading towards an extremely competitive environment, the whole manufacturing sector is searching and bending towards the tools which can provide an edge over the conventional procedure of manufacturing/production, to encounter the competition and increase the value-added elements in the product to make its orientation towards value for money to the customer without any significant change in production cost, The overall goal can be achieved by the implementation of lean production that results in enhanced efficiency, decreased waste, and increase of productivity. There is an improvement in lead time because the processes are streamlined; manufacturers can better respond to variations in demand and other market challenges, resulting in fewer delays and better lead time.

Lean ideas have primarily evolved from Japanese industries, especially Toyota. Lean production is considered a waste reduction technique (Rother and Shook 1999, Stauryla 2021) However, in practice, lean manufacturing maximizes the value of goods through waste reduction. Lean principles outline the value of the product/service as perceived by the customer, then create flows tailored to customer interest and seek Value Added Activities (VA) and non-value-added activities (NVA) to eliminate various types of waste to strive for perfection through continuous improvement. The sources of NVA-related wastes are transportation, inventory, speed waiting, overproduction, over-processing, and defects. Elimination of those wastes is achieved through the implementation of lean principles and practices. Several surveys show that most researchers specialize in one or two elements to detect the existence of waste and recommend their ideas for implementing these elements (Hines and Rich 1997, Armenakis et. al, 2007).

For this research, a furniture and household appliance renting company located in the northern part of India experienced challenges and issues with the existing procedures used in their production system. There several resource persons (plant managers, middle-level managers, machine operators, and workers) were interviewed as well as discussions were carried out regarding the current concern in the production line.

The motivation behind the study was to reallocate the resources that could be used at a better place in the organization for value-creating operations and business expansion opportunities. A lean manufacturing company aimed to eliminate waste from the system and the operations and to extract the maximum outputs with the minimum inputs. Along with the desire for maximum output the motivation for conserving the planet Earth by conserving as much energy as possible and reducing pollution. The warehouse needed more exposure to sunlight so that illumination can be done naturally, the rainwater harvesting is set up for conserving water after the washing of appliances and upholstery (mattress, cushion, couch).

1.1 Originality of The Work

This work is performed as a live project at one of the plants in Bangalore (KA India) based manufacturing company. The challenges to be addressed for the smooth working and functioning of the plant were manpower utilization and optimization of waste.

2. LITERATURE REVIEW

Since the introduction of the Lean philosophy, Lean can be applied in all parts of the business and most companies prefer to start implementing Lean from the Shop floor (Zezulka et. al, 2016, Abdulmalek and Rajgopal, 2007). The main goal of Lean is to bring about continuous improvement and reduce cost by eliminating waste (non-value-added activities) and increasing the efficiency of processes. Lean comprises several tools

like 5S, just in time, Jidoka, Heijunka, Kaizen, etc. Lean is a competitive advantage and is considered one of the important methods to increase profits (Garre et. al,2007, McDonald 2007) and customer value. The lean concept includes doing the most with the least (Womack and Jones, 2003), to achieve high performance with fewer resources. Productivity and performance terms are often used within education as well as trade circles; they are not adequately defined or explained yet. They are often confused and regarded as inconsistent, with terms such as efficiency, productivity, and profitability (Tangen, 2004).

2.1 Review of lean implementation

The most important element thought about by the sooner researchers for the implementation of the lean-producing system is Value Stream Mapping (VSM)which defines value stream as "Each activity, as well as value-added activity (VA) and Non-Value-Added activity (NVA), needed to convert the material into finished product through the mapping of process and knowledge, flows essential to each product" (Deniz and Akbay, 2000), Push and Pull System that describes, the Pull system depends on client demand whereas push system relies on a planned schedule (Garre et. al,2007). One-piece flow ensures a just-in-time production system to adopt an easy schedule while not interrupting, backflow, or scrapping, restful the Takt time and decreasing the danger of machine failures and operator mistakes (Graves et. al,1995).

2.2 Significant Insights from the Literature

A model based on ten essential criteria and supporting elements of "best practice" for lean implementation was provided by Kaye and Anderson and advocated a planned and integrated approach for achieving continuous improvement in an organization (Kaye and Anderson, 1999). This study will help the author to make the goods flow continuously and create pull within the system also the cost analysis for the successful implementation of continuous flow, without the vision and knowledge of uniform flow, lean waste like inventory cannot be reduced and productivity improvement will be affected.

The Kanban system is one of the pieces of equipment underneath lean manufacturing which could gain minimal inventory at Anyone time.

The discussion about the lean implementation process and its quantified benefits for the production industry with the help of value stream mapping (VSM) was done by Singh (Singh et. al, 2010). This study will help the author to create current and future state maps of the shop floor with VSM techniques to highlight improvement areas and fill the gap between the current and future state of manufacturing of sofas in warehouses.

The Kanban system provides many blessings in coping with operations and commercial enterprise inside the Enterprise. Rahmana states that the use of the Kanban system is a strategic operational choice for use within the manufacturing strains (Rahmana et. al, 2013). It Helps to enhance the organization's productivity and at the same time limit waste in production. The Kanban system requires production only when the demand for products is available.

Table 1. Insights from the literature

Author and Year	Name of Journal	Significant Findings.	Remarks / Gaps Identified
Mike Kaye, Rosalyn Anderson (1999).	"Continuous improvement: the ten essential criteria"- MCBUP.	Continuous Improvement Push-Pull system Make the goods flow endlessly through the remaining added step Introduce pull between all steps wherever continuous flow is feasible.	The successful continuous improvement heavily relies on the decision of top management and supervisors are not committed in any of the literature reviewed hence the supervisors generally do not take ownership of kaizen activities on the ground level.
Bhim Singh (2010).	"Lean implementation and its benefits to the production industry"- Emerald insight.	The existing status of the selected manufacturing industry is prepared with the help of VSM symbols and improvement areas are identified.	It was found that the overall cost analysis was not done which will give a clearer view regarding the reduction in cost resulting in greater acceptance of lean tools.

Nor Azian Abdul Rahmana , Sariwati Mohd Sharifb , Mashitah Mohamed Esac(2013).	"Lean Manufacturing Case Study with Kanban System Implementation"- Elsevier.	The Kanban system is one of the tools under a lean manufacturing system that can achieve minimum inventory at any one time. The Kanban system provides many advantages in managing operations and business in the organization	The study of the literature shows that the Kanban system is more suitable for industries with repetitive and mass production, but in job shop scenario like Sofa manufacturing, the implementation and application of the Kanban system was not reported widely.
Angın and Taşdemi, (2022) [7].	"Identification of internal dynamics of Turkey's furniture industry in the context of lean manufacturing integration maturity".	Currently, all industries are operating in a dynamic internal and external environment, trying to survive in tougher competition amid the COVID-19 pandemic, Under the circumstances, organizations have reassessed their production systems to adapt to new industry dynamics and global megatrends	The study will help the author to understand the pre and post-pandemic manufacturing complications.

2.3 Gaps and Discussion

a) The successful continuous improvement heavily relies on the decision of top management, It was found that the supervisors are not committed. The literature reviewed suggests that supervisors generally do not take ownership of kaizen activities on the ground level or shop floor.

b) It was found that the overall cost analysis was not reported which could give a clearer view regarding cost reduction, resulting in greater acceptance of lean tools.

c) It was found that the Kanban system does not resolve the conflict of Minimum Order Quantity (MOQ), vendor pricing, and multiple vendor options for purchasing raw materials.

d) The study of the activities shows that the Kanban system is more suitable for industries with repetitive and mass production. However, in job shop scenarios like Sofa manufacturing, the implementation and application of Kanban systems are not reported.

3. PROBLEM STATEMENT AND RESEARCH OBJECTIVES

The aim was to implement lean philosophy in the furniture and household appliance renting company which was suffering from various problems. The higher management was convinced about the reachability of projected demand, monetary benefits, customer satisfaction, and reduction in the delivery time; once the study about the functionality of the plant was completed and the implementation of lean tools is successful.

It was observed on the shop floor that there exists a multi-dimensional opportunity concerning the improvement of productivity, an increase in output, better warehouse space utilization, and redesign of the sofa manufacturing facility. The higher management was convinced about the reachability of projected demand, monetary benefits, customer satisfaction, and reduction in the delivery time.

Problem Statement

The warehouse situated in Gurugram has a churn of around 305 SKUs comprised of 6 categories (upholstery, metal, preLam, solid wood, Appliances, and home décor). Productivity is 4.43 units/Man days and the productivity of the sofa manufacturing unit was at 1.05 seats/Man days.

a) Improper Plant Structure : The plant structure was not qualified for high productivity. Goods and equipment were not in the right place.

b) Essential Flow and Movement : There was a random arrangement of objects and a temporary flow of the wrong material in the plant area. The backward movement was present in the movement of material objects.

c) Storage Problem Storage of pillows, plywood, appliances, finished goods, etc. was not in the right place and warehouse utilization was low.

d) Management Problem : Consumables, finished, and finished goods were required to be transported from one place to another over and over again thus central inventory was required.

e) Use of Manual Process Many procedures were performed in person. No semi or full automation was involved.

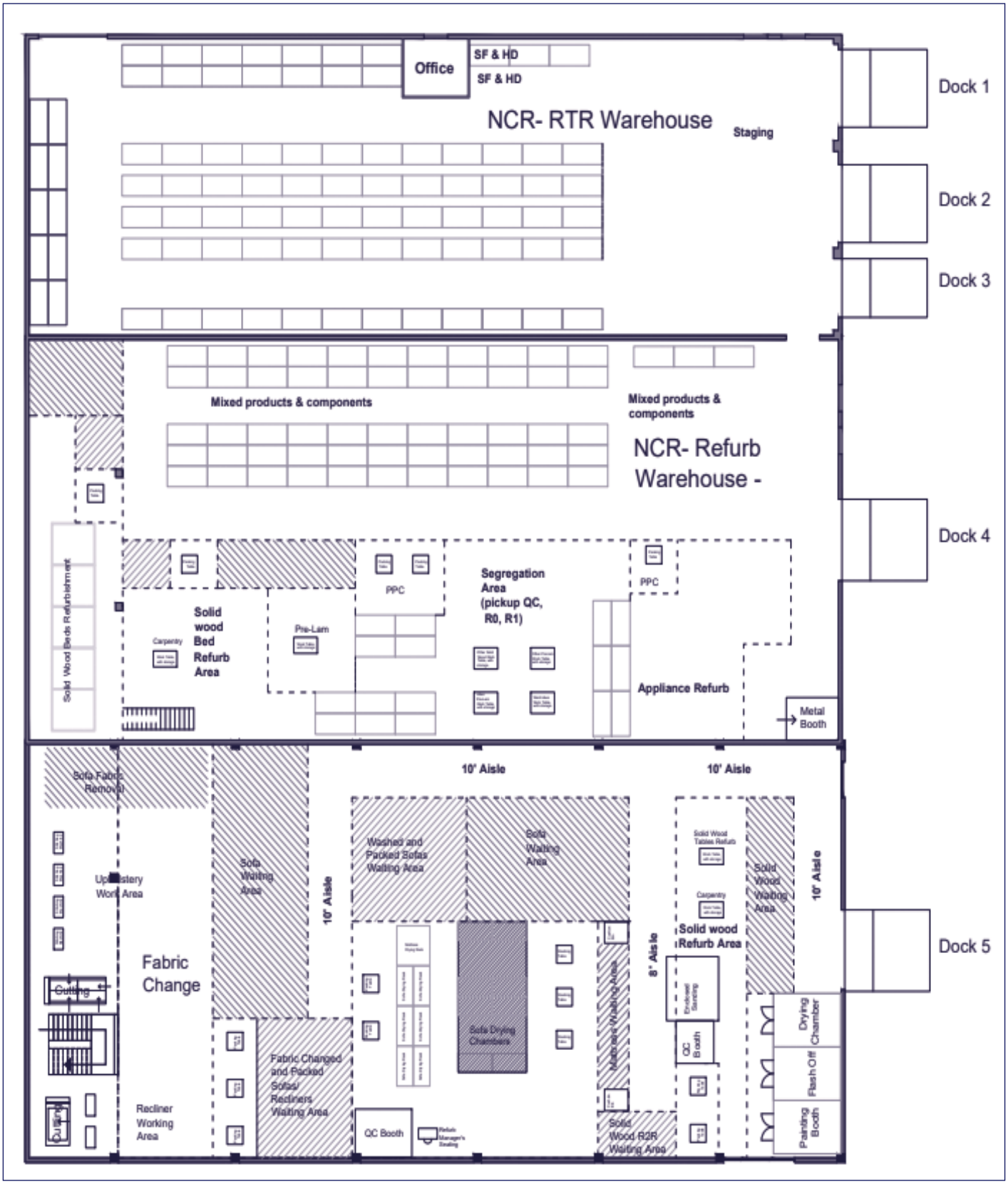
Objective of the Study

The future demand projection of the company is 3 times the current state within the next year and the manufacturing unit was very inefficient in terms of productivity and quality assurance.

To improve the space utilization of the Plant by using various industrial engineering techniques.

To increase the output and productivity of the plant by streamlining the production plan and continuous floor improvement with the involvement of department-wise supervisors.

Figure 1. The current layout of the Warehouse



- The present study aims to develop the adoption of lean manufacturing in the Furniture manufacturing industry. The first task was to collect and observe all the relevant facts about the current methods of production. Tools that are incorporated for the implementation of lean philosophy are as follows:
- **VSM** Value stream mapping is a pen-paper tool, drafted using a predefined set of icons.
- **5S** is a methodology for creating a clean, uncluttered, safe, and well-organized workplace to reduce waste and increase productivity.
- **One-piece flow** also called continuous flow, refers to the efficient flow of products from one phase of the process to the next by planning workflow around the product and its needs, rather than just the entire organization or equipment.

Kanban System Kanban is a workflow management method designed to help you visualize your work, maximize efficiency and be agile.

The flowchart of the current state map of sofa manufacturing was made to study the process and material flow which lead to finding out the bottleneck department and work balancing was done.

Effective numbers of working days are 30 per month, The number of shifts per day is one and the working hours per shift are eight.

Available working time per day in minutes = 430 min.

TAKT time=Available work time per day per minute/Customer demand per day.

= 430X60/171

Here takt time = 158 sec for Upholstery.

In the current state of sofa manufacturing, it was found that the cycle time for the stitching department is 1800 seconds thus work balancing was done and the number of the station was increased.

The future state of sofa manufacturing was driven by the FIFO mechanism and lead time decreased from 24 hours to 3 hours.

Figure 2. The current state of sofa manufacturing

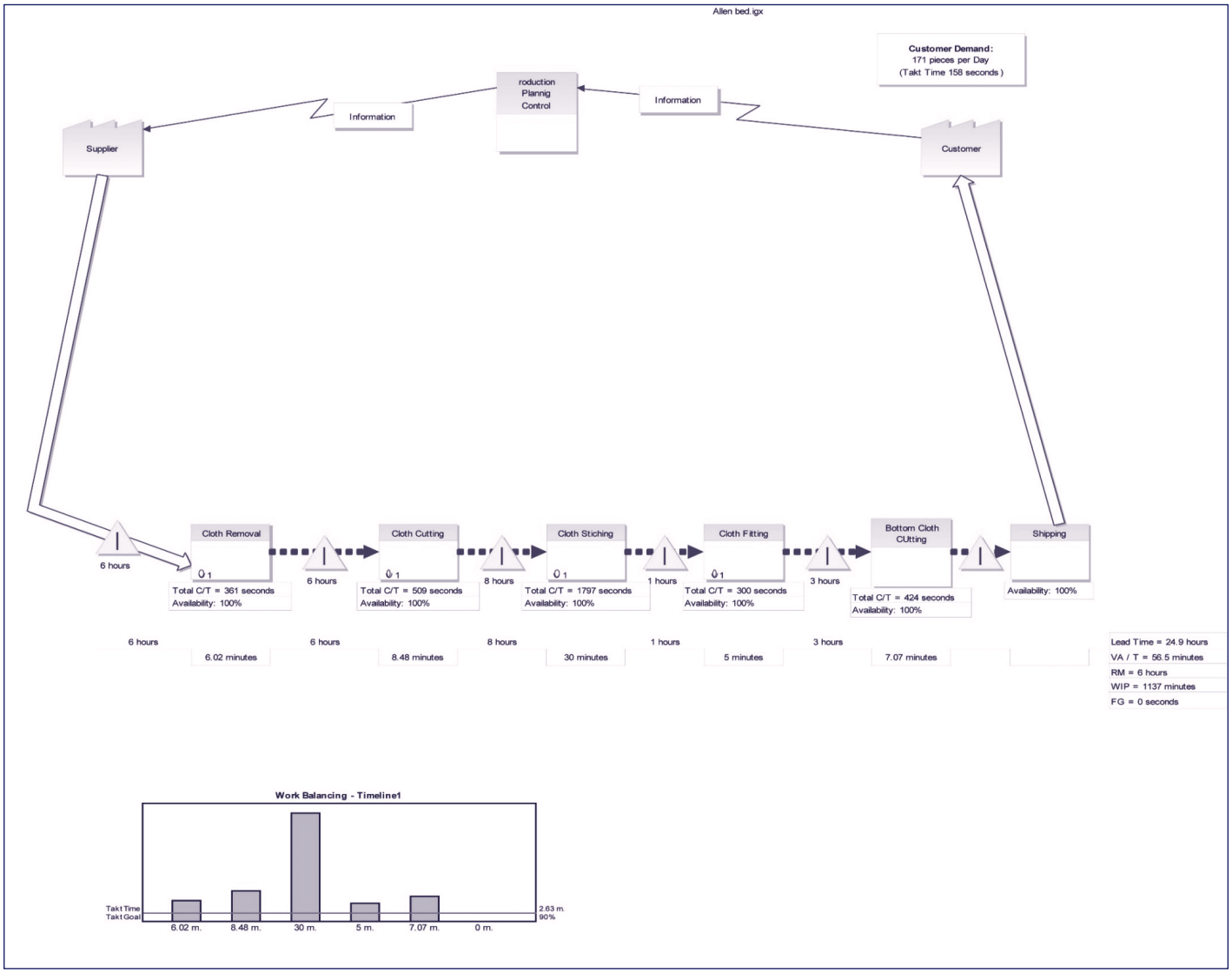


Figure 3. The future state map of sofa manufacturing.

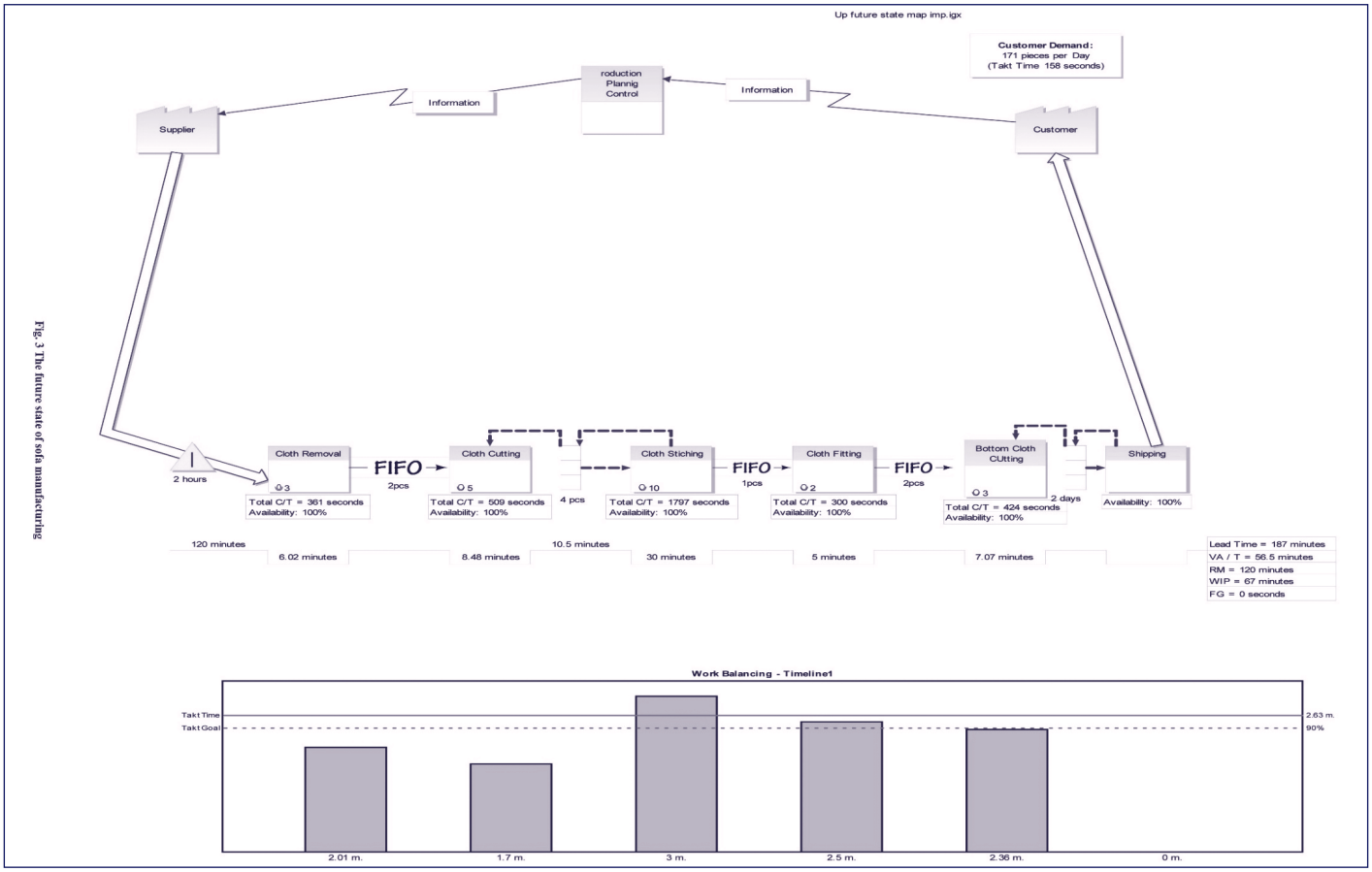


Fig. 3 The future state of sofa manufacturing

5. DATA COLLECTION

The scope of the project was to design the warehouse, increase the output, and productivity, and redesign the sofa manufacturing of the enterprise which leads to comprehensive data collection regarding all the aspects of the production such as process flow, work-study, time study, demand, and future projection.

a) Process Flow : provides a visual overview or workflow diagram of all the tasks and relationships involved in a process.

b) Cycle Time Study : The cycle time of the top-selling models was collected and similar products were identified to map the remaining cycle time

c) Demand : For the effective implementation of the Kanban system, the bill of material of each model and their respective demand for the last six months were taken to build the inventory management system.

Table 2. Output/ Day of sofa manufacturing

Month	(Output (seats	Output / Day
November	1980	79
December	1520	58
Average	1750	70
Future projection	2625	105

d) Current Manpower : The current manpower data needs to be collected to examine the current productivity and the manpower which will be required for meeting the future projection.

Table 3. Current output of sofa manufacturing

Department	Skilled	Semi-skilled	Helper	Total Manpower
Carpentry	6	3	7	20
Foaming	5	1	2	8
Upholstery	4	2	4	10
Final Assembly & Packing	1	4	6	11
Stitching	6	9	6	21
Recron	1	0	2	3
Fabric Cutting	2	0	2	4
Recliner Assembly	1	0	1	2
Logistics	2	0	2	4
NPD	2	0	2	4
Total	30	19	34	87

e) Dimension of the SKU : For the effective utilization of the racks, the dimension of each SKU is required so that the most efficient rack size can be deployed.

6. DATA ANALYSIS

The data analysis was done basis the data collected i.e process flow, cycle time, projected demand, current manpower, and the dimension of the SKUs for warehouse design, implementation of the Kanban system, and development of production model.

a) Warehouse Design

The warehouse design requires the dimension of the SKU to be placed along with the quantity and preference based on fast-moving and slow-moving articles, here is the sample calculation for the rack requirement of a particular SKU (Stock Keeping Unit):

Number of racks required to store "Pico Dining Table"

The volume of one rack@5feet height= 8'X6'X5'

=240 CFT

The volume of 1016.5 units of "Pico Dining Table= 1016.5*11.54 CFT

= 11276.371

Number of Racks = Total volume of "Pico Dining Table"/ Volume of one rack

= 11276.371/240

=49 Rack @ 100% utilization

= 69 Rack @ 72% utilization.

b) Identification of Bottle-neck Department

The identification of the bottleneck department was done based on output in seats per hour in that department.

Table 4. Department-wise output of sofa manufacturing

Department	Seats/Hr	Seat /Person @ 11 Hrs	Avg. Hours/Day	Hours Worked in April	Seats/ Hour
Carpentry	0.83	7.4	18.4	461.2	6.4
Cutting	2.45	26.68	21.4	534.8	5.6
Upholstery	1.42	14.22	20.5	512	5.9
Foaming	1.55	15.27	19.2	480.8	5.9
Stitching	0.74	7.36	20.8	519.9	5.2

c) Current Output Basis Cycle Time & Manhours

The current output of the plant has been defined based on the cycle time obtained on the floor and the manhours deployed. To overcome the variation in the cycle time of the various model, X-factor (Miranda 3-Seater) is introduced and the current output of the plant is defined in terms of X-factor seats.

Manpower in bottleneck department (Stitching)

= 21 Total manhours (@8 hours shift) = 21X8 Hrs.

=168 Hrs. Cycle time in the stitching department =12600 seconds = 3.5 Hrs.

Capacity per day (@75% efficiency) = (168/3.5) X (75/100)

= 36 X-factors/ day

= **108** X-factor seats/day(@75%efficiency).

d) Development of Production Model

• Various steps were taken to create a pull system and introduction of the term **"Full-kit"** which suggest that after receiving the order from the customer the product will begin to manufacture only when its complete raw material is available in the plant's inventory department, the above concept help in reducing the WIP and increase the surface area for better movement of the material.

- Implementation of the production plan based on dispatch dates.

  Deployment of Production Planning Based on Capacity and Manpower alignment accordingly.
- Daily release of production plan in both in-house verticals.
- Removal of scrap to increase the space for better movement and connectivity with solid wood carpentry.

Rearrangement of the floor area to maximize the storage space for raw materials and stagnant old white finish stock.

e) Kanban System

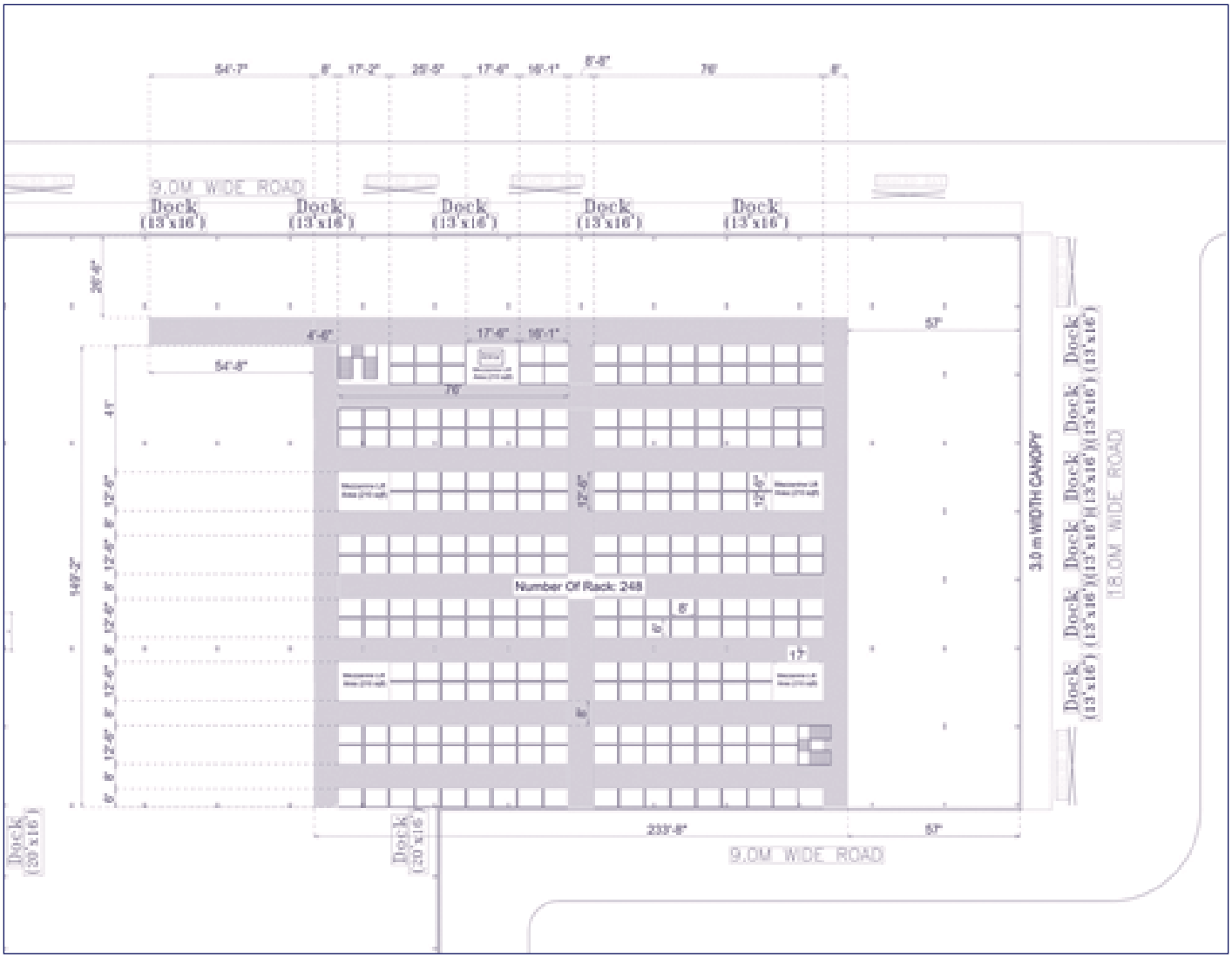
The Kanban system is to be implemented for raw materials as well as fabric to reduce the inventory level in the plant, for the development of the Kanban system, the current inventory stock, bill of material,

The Kanban system also consists of various vendor options with different Minimum Order quantities (MOQ) and pricing. This will serve as a better bidding system and frugal deal for raw material purchases hence more monetary benefits.

7. RESULT AND DISCUSSION

The result and discussion of this study comprise the results obtained from the implementation of the lean tools by which warehouse design, output, and productivity of the sofa manufacturing, inventory management through the Kanban system, and overall cost analysis were done.

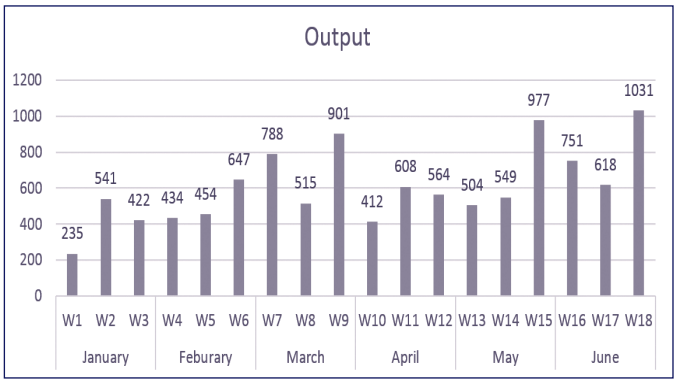
Figure 5 The ground layout of the warehouse



a) Warehouse Design : The implementation of the new design of the warehouse has been successful, as it increases the efficiency of the plant, the dock calculation was carried out for loading and unloading of the vehicle of classes A & B. The warehouse utilization was at 76%.

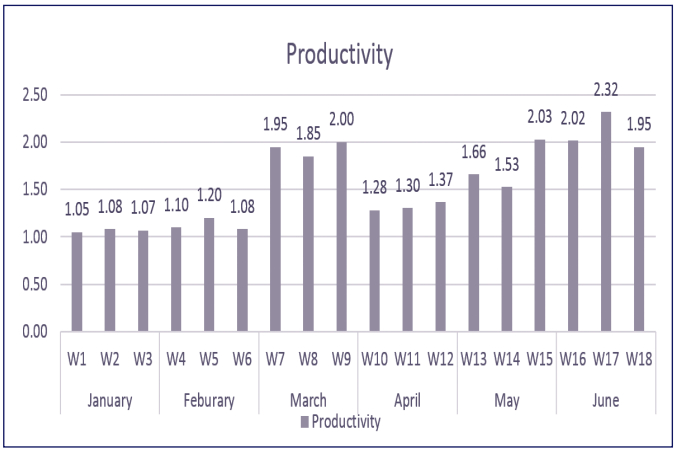
b) Output of Sofa Manufacturing Unit : The output with current manpower was at 70 seats/day which has been increased to 100 seats/day.

Figure 6. Output of the sofa manufacturing



c) Productivity of Sofa Manufacturing Unit : As the full kit assurance was given by the store department the product doesn't hold in any department

Figure 7. Productivity of sofa manufacturing



d) Implementation of Kanban System: Various problems like overproduction, waste, non-continuous flow of material, etc. are eliminated by developing the Kanban system.

Table 5. Kanban summary of raw material regarding inventory cost

Row Labels	Count of SKU Name	Sum of Avg. Consumption Value	Sum of Current Stock Value	Sum of Future Physical Stock Value Estimated	Inventory In days	Projected inventory in days
A	167	₹ 1,27,57,188	₹ 75,57,891	₹ 55,17,173	15.4	11.2
B	100	₹ 11,08,164	₹ 9,29,466	₹ 4,11,296	21.8	9.6
C	366	₹ 6,29,187	₹ 12,07,805	₹ 2,02,805	49.9	8.4
NM /Dead	1850		₹ 9,82,720			
Grand Total	2483	**₹ 1,44,94,540**	**₹ 1,06,77,883**	**₹ 64,85,515**	19.2	11.6

Table 6. Kanban summary of fabric regarding inventory cost.

ss	Count of SKU	Sum of Avg. Consumption Value/Month	Sum of Current Stock Value	Sum of Future Physical Stock Value Estimated	Inventory In days	Projected inventory in days
A	234	₹ 72,60,699	₹ 65,37,007	₹ 18,00,563	23.41	6.45
B	183	₹ 8,53,628	₹ 12,60,372	₹ 12,60,145	38.39	38.38
C	317	₹ 4,02,487	₹ 17,83,977	₹ 12,24,036	115.24	79.07
DEAD	76		₹ 1,43,638			
NM	1614		₹ 6,56,930			
Grand Total	**2424**	**₹ 85,16,814**	**₹ 1,03,81,923**	**₹ 42,84,744**	31.69	13.08

e) Reduction in Production Cost : The implementation of lean tools provides monitorial benefits to the enterprise which directly affects the mindset to adopt lean manufacturing more openly.

Table 7. Month-wise cost analysis

(Salary of production worker (On roll & Temporary				
Row Labels	Sum of Total Salary	Actual Seats	Cost per Seat	Percentage improvement wrt Feb
February	₹ 19,62,173	1535	₹ 1,278	-
March	₹ 17,12,430	2204	₹ 777	WIP and FG stock .clearance
April	₹ 15,88,995	1601	₹ 993	22.36%
May	₹ 15,98,786	**2030**	₹ 788	38.39%
June	₹ 16,92,000	**2400**	₹ 705	44.00%

8. CONCLUSION

This study presents a real industrial case study of the implementation of a Kanban system in a manufacturing plant. The research results show that a Kanban system is essential to ensure smooth part flow throughout the production system. Systematic and full commitment during the implementation the of Kanban system is essential to ensure its effectiveness and; ultimately customer satisfaction. It can be said that the Lean tools like 5S, VSM, one piece flow, and Kanban system implemented in this manufacturing company were found to be adequate with many benefits such as operating costs, waste, scrap, and losses have been minimized.

The output of the plant increased from 70 seats/day to 100 seats/day which is a 42 percent increment. The productivity of sofa manufacturing jumps from 1.10 seats/man-day to 2.05 seats/man-day which implies an

86 percent increment. The Kanban system results in a reduction in the inventory cost of 40 lakhs in raw materials and 60 Lakhs in a fabric store.

9. LIMITATION OF THE STUDY

The results of the study and objectives were set to examine the furniture manufacturing unit with specific problems and factors; thus, generalization is difficult.

10. FUTURE SCOPE OF THE STUDY

The future scope of the project that can further enhance output, productivity, and on-time delivery is Total productive maintenance (TPM). The use of simulation software like Witness for the movement of man and material in the production line and warehouse layout.

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