Productivity Improvement in Furniture Manufacturing Industry by Using Kaizen

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Abstract: **The objective of this study is to understand and improve the productivity by applying kaizen methodology in the industry. Kaizen is a continuous improvement cycle which includes various techniques. Kaizen is an ongoing improvement involving everyone, including both managers and workers. Kaizen implementation and other continuous improvement practices can be used by companies to lower manufacturing costs and increase productivity. Kaizen activities are one way that companies can increase their effectiveness. In a manufacturing industry, the plant layout and material flow in the shop floor also plays a key role in influencing productivity through distance and time. Research work has been carried out to evaluate the designed plant layout. Initially, production process was analyzed through time study. Preliminary survey showed that in the existing layout travelling distance was time-consuming. Efforts were made in new plant layout to reduce the time and distance between subsequent processes. The study initiated by evaluating and identifying the problems occurred in the industry, continued by data collection. Study, process analysis and plant layout design, simulation were used as technique to improve the process. The plant layout is modified by using kaizen methodology. The new layout result was compared with existing layout result and shows an improvement of productivity. The distance and time of the production flow can be reduced**

Keywords **- Cycle Time, Kaizen, Layout design, Productivity, Simulation.**

I. INTRODUCTION

In the world of competitive business every manufacturer wants to earn maximum profit with minimum inputs. Continuous improvement in the product is required for the survival of the industry in the global competition. Setting the time standard for different product is vital success of any manufacturer. Time study gives the cycle time of the products on various machines which help in the plant layout calculations [1]. The Toyota Production System is known for kaizen, where all line personnel are expected to stop their moving production line in case of any abnormality and, along with their supervisor, suggest an improvement to resolve the abnormality which may initiate a kaizen [2]. The cycle of kaizen activity can be defined as:

• Standardize an operation and activities.
• Measure the standardized operation (find cycle time and amount of in-process inventory)
• Gauge measurements against requirements
• Innovate to meet requirements and increase productivity
• Standardize the new, improved operations
• Continue cycle

One of the main goals of a manufacturing system is the maximization of its productivity. This depends upon several factors, such as the complexity of the product made, the quality of the raw materials, the complexity of the manufacturing process and the arrangement of the workstations constituting the production process. The challenge of determining the best arrangement of the workstations is one of the elements that have a great impact on system performance. It is known as the "facility layout problem" From the manufacturing perspective; cycle time is one of the most important variables in manufacturing organizations. The reason of creating the existing production floor is to analyze and evaluate the existing production floor performance which in turn, decreases in traveling distance and time reduction, increment of production productivity. Lot of definitions of various layout problems the literature gives a one of the first date back to 1957, when it was defined as an ordinary industrial problem with the aim of minimizing the cost of transporting materials between the different workstations. Transportation, as a matter of fact, is the key factor in the facility layout problem. A well-known study of the 1970s, in fact, has highlighted that from 20% to 50% of total operating manufacturing costs are related to the material handling activities and that these costs could be reduced by 10% to 30% annually with efficient facility planning [3].

Selection of the best layout was also done formally using multi-criteria decision, using software (simulation-Arena software). The best layout was compared with the existing layout to demonstrate improvements gained by formal approaches to layout design [4].

The successful application of kaizen had a profound impact in a variety of industries, such as aerospace, computer and electronics manufacturing, forging company, process industry (steel), and automotive manufacturing. Their methodology is similar, using kaizen and they are adapted to the study variables, but the improvement point and the results achieved are different. Considering the available literature, the present work is the first attempt that explores the degree of use of kaizen methodology in furniture manufacturing industry and provides direction for future continuous improvement [5].

A. Some Related Terms

1. Kaizen: Kaizen is a Japanese term for "improvement", or "change for the better" refers to philosophy that focuses upon continuous improvement of processes in manufacturing, engineering [2].

2. Productivity: The ratio between output and input is known as productivity. It may also be defined as the arithmetic ratio of amount produced to the amount of resource used in any production. The resource may be land, plant, labor, material, machines, tools or it could be a combination of all [2].

3. Cycle Time: It is defined as the actual time taken to complete a set of activities (one cycle) [2].

4. Takt Time: It is the theoretical time allowed to produce one product ordered by customer. It can be determined by ratio of net available time by customer demand [2].

II. METHODOLOGY

To redesign the facility layout of a manufacturing process, it is possible to apply many different methods. Each one is based on a specific idea and goal to be achieved. Since a method usually gives an optimal layout configuration different from the others, it is important to have a performance measurement tool in order to gain hints about the best method to adopt. This comparison could be made through a score, such as a simulation analysis highlighting the results of the main production process parameters, such as times and distance [6].

Before investigating the best facility layout design method, we present in this section some of their major features, especially those of the systematic layout planning (SLP) technique and the layout suggested by the wider activity of “kaizen” redesign, through the value stream mapping tool.

SLP, developed in 1973 by Richard Murther, the redesign of a facilities layout, SLP includes three specific phases, namely:
a] Data collection and analysis; b] Searching among the possible layout solutions; c] Evaluating alternatives and the choice of the best layout

The next step is the construction of the relationship diagram. This represents the activities of the operation given in the figure [7]. The number of lines linking two activities derives from the level of desired nearness.
The relationship diagram, which derives from the relationship chart, allows the consideration of alternative layout configurations. Among them we will find the best solution, chosen considering more than just factors of economy, such as the improvement of material flow and waste reduction, etc.

A. Kaizen facility layout system

Kaizen manufacturing is a production system born in Japan, based on the Toyota Production System. This was founded on certain central ideas. The most significant are total quality management, total productive maintenance and the ‘just in time’. The first is related to the process itself and each element related to the production process. The second refers to the strategic role of maintenance activities, while the last refers to the optimization of the logistic flow so as to decrease stock levels. The central idea of kaizen manufacturing is waste elimination, which is essential to increase profitability and productivity [8].

In particular, three different kinds of operations have been identified
1] Non value adding.
2] Necessary but non value adding.
3] Value adding.

The facility layout obtained according to this process has properties and goals similar to the kaizen manufacturing ideas: it will be oriented towards a reduction of each kind of waste, such as transporting time, space and unnecessary workstation.

1] Identification of the process’s value stream and the definition of the current state mapping
2] Waste elimination and the identification of alternative solutions
3] Representation of the future state map.
4] The design of the new facility layout, based on the changes and improvements identified in the previous phases.

III.CASE STUDY

Spacewood Furniture Pvt. Ltd. Hingna Road, Nagpur which manufactures different types of product on machines at different prices The company’s present production process have job order production of various products which having product wise routing in which various operation are done with respect to product specification which is shown in figure of office table operation. The product wise routing is time consuming because one product gets lot of time due to various components and it is very difficult to take the timings. The system of the company has standard norms for standard products. If the products gets changes, then ultimately the norms also changes and thus the cycle time of the product also changes. Therefore there is loss in efficiency and productivity, utilization of man and machine.

In this study all the information related to raw material, demand, operation time, travelling distance, etc. were collected. We have choose the one product given them name as office table on machine namely CNC rover-321, rover30, Beam Saw, KDT as shown in figure 1.

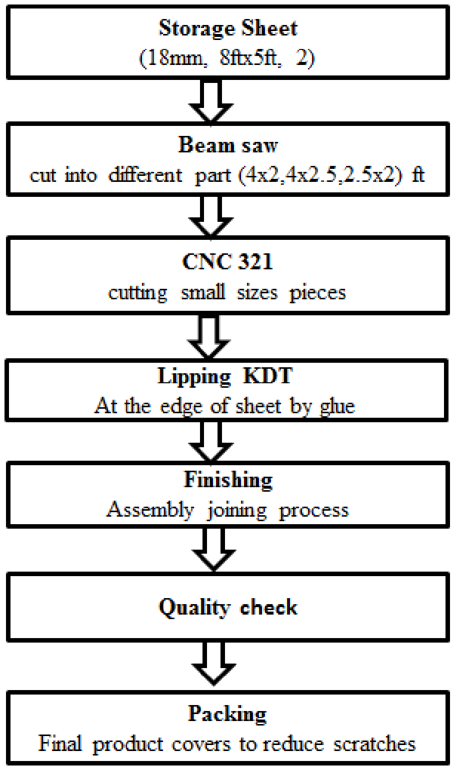


Figure 1: Production process chart of office table

A. *Design Process*

In this industry plywood sheet are used as raw material and this raw material is converted into the finish good. The process for one of the section is follows.

1] The plywood boards come into the factory; it is stored in the storage area by using fork lift followed by inspection.

2] The raw material (sheets) comes to beam saw department where cutting operation is performed as per requirement. Operators take the sheets on beam saw. The plywood is then clamped with machine. The sheet is cut as per size.
3] Precise cutting is come on CNC rover machine with proper or exact dimensions. A computer numerically controlled (CNC) rover cuts several aprons according to computer specifications. This rover is especially suited to cutting sheet goods such as plywood. The shapes to be cut are defined by the drawing programs such as AutoCAD. The information is transferred to a CAD/CAM program that allows the user to define the path of the rover tool. When the tool path has been defined, the computer software allows a tap file to be made, which actually runs the tool over the plywood, cutting it into the desired shape. The rover is able to create high quality routing and carving effects with uniform consistency and with very little wasted wood. If the office table is to receive a drawer, then the front,

sides, and bottom of the drawer are cut on the CNC router.

4] As the operation of cutting on CNC finished, the material travel to lipping section to cover the edges by lipping process with the glue

5] After lipping process quality of finished good is checked.

6] The quality checking finished goods are dispatched to the packing department.

7] Finally, finished, QC ok, products sent in storage area for final dispatch to distributor or retailer.

B. *Data Collection*

During study element wise time and distance reading were taken for various operations as shown in table 1, as a part study standard time was calculated considering company allowances policy and standard rating.

STD time = Normal time + (Normal time x allowance)

S.N	OPERATIONS	TIME (min)	∑TIME (min)	DISTANCE (m)	∑DISTANCE (m)
1)	Board Loading 0n trolley	3.0048	3.0048	---	---
2)	Travel to beam saw	2.1307	5.1355	43.75	43.75
3)	Loading to beam saw	2.6952	7.8307	---	43.75
4)	Cutting sheet	6.4728	14.3035	---	43.75
5)	Travel to CNC(30)	0.7197	15.0232	13.5	57.25
6)	Cutting time	1.74	16.7632	---	57.25
7)	Travel to KDT	0.304	17.0672	6.2	63.45
8)	Lipping	0.3729	17.4401	---	63.45
9)	Finishing	11.728	29.1681	10.75	74.2
10)	Travel to Quality checking section	0.2104	29.3785	2	76.2
11)	Quality checking	2.9328	32.3113	---	76.2
12)	Travel to packing section	0.2848	32.5961	3	79.2
13)	Packing	13.992	46.5881	---	79.2
14)	Travel to storage	1.4026	47.9907	24	103.2
	Total		48		103.2

Table 1: Time and Distance study of company product in existing layout Before Kaizen

IV. DATA ANALYSIS AND RESULT INTERPRETATION

S.N	OPERATIONS	TIME (min)	∑TIME (min)	DISTANCE (m)	∑DISTANCE (m)
1)	Board Loading 0n trolley	3.0048	3.0048		
2)	Travel to beam saw	0.4626	3.4674	9.5	9.5
3)	Loading to beam saw	0.2952	3.7626		9.5
4)	Cutting sheet	6.4728	10.2354		9.5
5)	Travel to CNC(30)	0.4531	10.6885	8.5	18
6)	Cutting time	1.74	12.4285		18
7)	Travel to KDT	0.9741	13.4026	20	38
8)	Lipping	0.3729	13.7755		38
9)	Finishing	9.3184	23.0939	3.5	41.5
10)	Travel to Quality checking section	0.1104	23.2043	2	43.5
11)	Quality checking	2.9328	26.1371		43.5
12)	Travel to packing section	0.11	26.2471	1	44.5
13)	Packing	13.992	40.2391		44.5
14)	Travel to storage	1.4026	41.6417	24	68.5
	Total		41.6417		68.5

Table 2: Time and Distance study of company product of proposed layout After Kaizen

A. *Analysis and Calculation of Process Time*

Overcoming the drawbacks in existing layout new layout was proposed. It results in reduction of distance of travelling raw material and corresponding time. From equating we got proposed time like shown in table 2. We can see second number process travelling to beam saw, we got time 0.4626 min corresponding to distance 9.5 meter.

The all distance and time of process is shown in table 2. There are 14 process including operation. Company run daily for 2 shifts (each of 12 hour shift) and 6 working days in a week i.e. (12*6*60 =4320min) . Therefore calculated new time (2.1307/43.75= X/9.5), it result is 0.4626 min. like that we calculated all time shown in table 2

B. *TAKT Time Calculation*

Talk time is the average time allowed to produced unit production to meet customer demand and the process time should be less than or equal to talk time. The calculation of takt time as shown below

Available time: 720 min (12 hrs.)

Lunch break: 30 min

Tea breaks: 15 minutes

Net available time: (720-30-15) =675 min/shift

Total machining time=39.993 min

Machine working efficiency=75%

Requirement: 15 (Office Tables) per shift (12 hrs.)

Takt Time= Net available time/customer requirement = (675/15) = 45 min

Rate of production = $\{\frac{12*0.75*60}{39.993}\}*100 = 13.50$

i.e. 14 office Tables per day

C. *Simulation calculation by using arena software*

This study works on applying simulation method to compare the results with time study for improving the operations in the company. Therefore, the project objectives can be briefly explained as to design and improve the floor layout of company, analyze the designed layout and select the best solution.

Simulation software designers generally define simulation as reproducing the operations of various kinds of real-world facilities or processes, the process of designing a mathematical-logical model of a real system and experimenting with this model on a computer.

By running an experiment on the suggested alternatives to improve the output of office table, these alternatives are modeled in the ARENA Simulation software and run for the experimental time of 12 hours. These results are analyzed; they are as shown in 2.

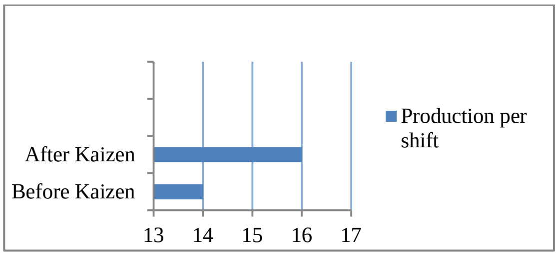


Fig. 2: Final production per shift by using Arena software

Production per shift of company before applying kaizen = 14

Production per shift of company after applying kaizen = 16

Therefore Increased in productivity = $\{\frac{16-14}{14}\}*100 = 14.285$ **%**

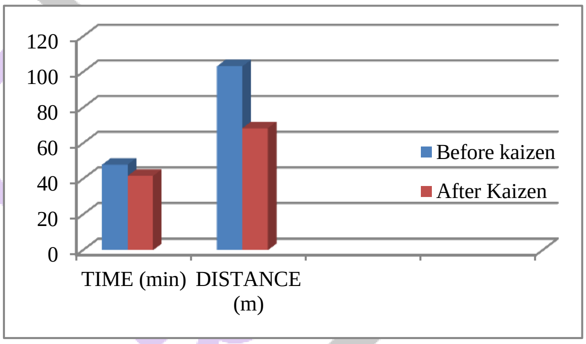
D. *Calculation of productivity by using time study*

Man power = 63 (50 W+3 E+10 O) Where, W- Worker

Cycle time before kaizen= 48 min. E- Engineers

Cycle time after kaizen = 41 min. O- Office staff

Increased in productivity = $\{(\frac{48}{41.6417}) - 1\}*100 = 15.269$ **%**



E. *Comparison between Before Kaizen and After Kaizen*

Fig. 3: Comparison between Time and Distance

PROCESS	BEFORE KAIZEN	AFTER KAIZEN	% Saving
TOTAL TIME TAKEN FOR PROCESS	48 min	41.6417 min.	[(48-41.6417) *100]/48 = 13.24%
TOTAL DISTANCE TRAVEL IN PROCESS	103.2m	68.5m	[(103.2-68.5) *100]/103.2 = 33.62%

Table 3: The percentage saving of travelling distance of the raw material and corresponding time of company

MOVES	BEFORE KAIZEN	%	AFTER KAIZEN	%
BYPASS MOVES	8	(8/13) *100 =61.53%	2	(2/8) *100 =25%
BACK TRACK MOVES	3	(3/13) *100 =23.07%	0	(0/8) *100 =0%
IN-SEQUENCE MOVES	2	(2/13) *100 =15.38%	6	(6/8) *100 =75%
TOTAL	13	∑100%	08	∑100%

Table 4: The percentage of saving move while of travelling distance of raw material of company

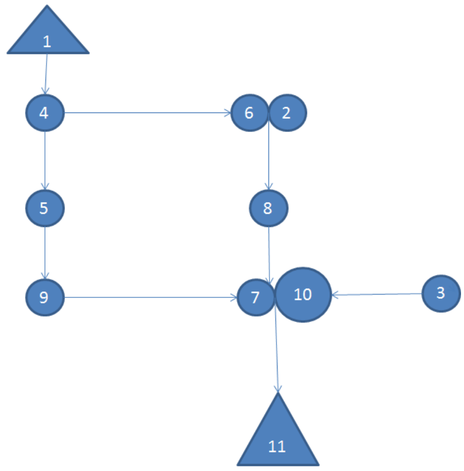


Fig. 5: Travelling distance of each successive operation of proposed layout

F. *Various Diagrams of Time & Distance before Kaizen and After Kaizen*

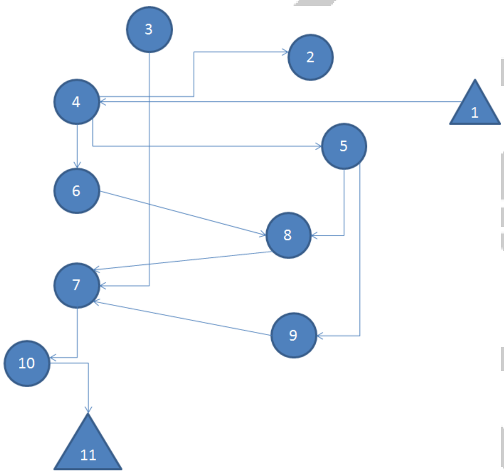


Fig.4: Travelling distance of each successive operation of existing layout

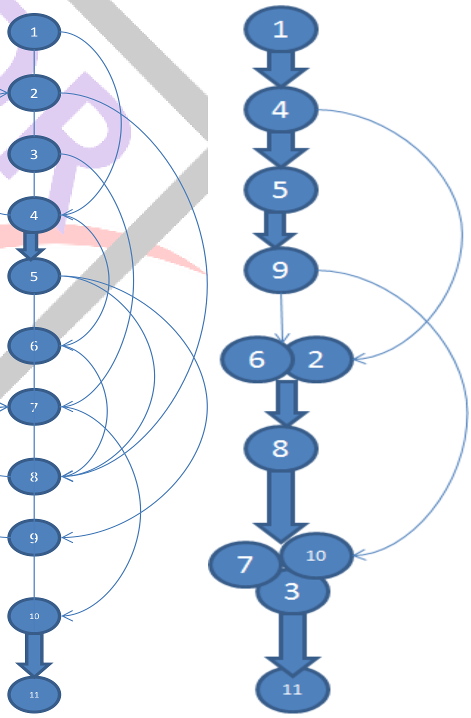


Fig. 6: Representation of flow path of existing layout and proposed layout

Where,
1] Storage, 2] Cutter, 3] Hardware, 4] Beam Saw, 5] CNC Rover (30), 6] CNC Rover (321), 7] Finishing, 8] Lipping (KDT), 9] Lipping (KDT) (Manually), 10] Packing, 11] Final Product Storage

V. RESULTS

- The production time can be reduced from about 48 min to 41.67 min. that is Cycle time reduced by 6-7minutes.
- The distance of the production flow can be shortened from 103.2 m to about 68.5 m. that is distance reduced by 34-35m.
- Reduced Total Distance Travel In Process By 33.62%
- Reduced searching time for material.
- Weekly and monthly performance of maintenance activity can be easily analyzed by section engineer.
- The result showed that productivity is increased by more than 15% by removing unnecessary moves.
- By using simulation ARENA software, productivity is increased by 14.285%.
- By using simulation ARENA software, production increased by 1248 tables per annum.
- As by simulation and calculation the increased in productivity is nearly same and it is near about 15%.

VI. CONCLUSION

The examination of the productive performance of layout in spacewood furniture Pvt. Ltd. was done & compared with kaizen technology & existing one, a separate event simulation was performed. The simulation model allowed us to analyze the productivity of each layout through its quantitative results. For each layout configuration, a corresponding simulation model was realized, generating many important productive parameters or output product shown in figure

The production time (the sum of all the times necessary to make final product office table, from the first operation on the raw material to the last packaging phase) is barely conditioned by the chosen layout. The transfer operation times, which are a direct importance of the layout arrangement, are in fact very low when compared to the production time. The kaizen layout ensures the best time reduction, because it better respects the operation sequence. The proposed kaizen layout is increases the 1,248 final output of production per year and near about more than 15% productivity with respect the old layout. Hence, the simulations results prove that the layout derived from the kaizen approach is the best for the production of table in this case study. The percentage of saving of travelling distance of raw material and corresponding time of company is shown in table

VII. FUTURE SCOPE

I. Any industry by referring this paper can improve their plant layout.
II. The results can be validate using simulation method or simulation software.
III. Optimization can be done using various optimization tools like Toyota production system (TPS)
IV. This study evaluates daily output of production and average processing time generated from the simulation experimentation.

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