CYCLE TIME REDUCTION THROUGH MINIMIZATION OF TRANSPORTATION AT DYNASTY PALLETS SYSTEMS INC.

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ABSTRACT

In the pursuit of profitability and competitiveness, more and more companies are turning to lean manufacturing to reduce or eliminate waste in their production processes. Cycle Time Reduction to increase productivity was the aim of the study. Top two (2) most existing lean manufacturing waste namely transportation and motion were identified and confirmed after observation. Other tools such as time study, interview, survey and measuring distances were used to obtain the necessary data.

The researcher presented a process activity chart and provided 4 different preferred lay-outs in order to minimize transportation, hence, reduced the cycle time in making the plywood-based pallet. Interchanging the nailing section after the cutting section (dice & cube), in line with the faceting section and the assembly line had been proposed.

In effect of the proposals, the company will be able to produce 69 units per hour which is equivalent to 552 plywood-based pallets per 8-hour of work.

Keywords: cycle time reduction, transportation minimization

INTRODUCTION

In today's competitive business arena, companies require small lead times, low costs and high customer service levels to survive which lead to customer-focused. The result is that companies are putting much effort to reduce cycle time in producing product. Companies that focused on cycle time as a productivity measure can reduce delivery time and improve quality, hence, creating more satisfaction to customers.

"Cycle Time Reduction through Minimization of Transportation at Dynasty Pallets System Inc". This work addressed the implementation of lean manufacturing in its production area, with a focus on activities which should have a proper rhythm of assembly line, eliminating consuming activities such as transportation. This results to waiting time of the workers, material handling time, etc. The prime objective is to develop different strategies to minimize the transportation, using lean manufacturing tools applied as method to lead the activities.

In manufacturing industries, lean manufacturing becomes popular as a beneficial way in the pursuit of better system efficiencies in meeting the customers' satisfaction. According to Ahmed (2011), lean strives to make organizations more competitive in the market by increasing efficiency, decreasing costs incurred due to the elimination of non-value added steps including transportation and efficiencies in the processes as well as reducing cycle times and increasing profits for the organization. Researchers agreed that lean manufacturing could be a cost reduction mechanism and if well implemented it will be a guideline to be a world class organization (Papadopoulu & Ozbayrak, 2005). Further concept according to Vallabhaneni (2008), that lean manufacturing can be applied to all kinds of manufacturing industries and all types of companies, including process industry, high-volume (mass production), and job shop industry. This lean concept was recently used by the local study about elimination of non-value added activities specifically transportation in order to reduce the cycle time (Diaz and Marcial, 2014).

Lean manufacturing is a short-hand for a commitment in eliminating waste, simplifying procedures, and speeding up production (Wang, 2010). Successful implementation of the said tool has brought about significant improvements, such as better quality, increased productivity, reduced lead times, major reductions in inventories, reduced setup times, lowering manufacturing costs and increased production rates (Hansen and Mowen, 2014). In the local study, recognizing the non-value added activities existing in the particular company named Pedd Manufacturing (Dadufalza, et. al, 2010), provides awareness of the efficiency of the performance and productivity of the workers in the company.

Many companies in various industries have implemented Lean manufacturing practices and successfully reduced operating costs, inventories, floor space, improved productivity and customer service. However, few companies have successfully implemented Lean principles across their operations.

The idea of lean thinking comprises complex cocktail of ideas including continuous improvements, flattened organization structures, team work, elimination of waste, efficient use of resources and cooperative supply chain management" (Green, 2008). This is a Japanese concept applied in manufacturing firms. The Japanese firms (firms in other countries as well) have been using this concept to reduce the cost of any process (be it service or manufacturing) by removing waste. The basic elements of the concept include waste elimination, continuous one piece workflow (EPA, 2007). As stated by Kilpatrick (2008), lean makes an organization more responsive to market trends, deliver products and services faster and produces products and services less expensive than non-lean organization. As viewed by Womack and Jones (2007), firms in several industries in North America, Europe and Japan followed this path and doubled their performance through reduction of inventories, throughout the times and errors. A planned implementation of lean production system leads to improved quality, better cash flow, increased sales, better productivity, improved morale and higher profits (Alukal and Manons, 2009). They further reported that company earned greater benefits by implementing lean techniques in the office functions in non-manufacturing organizations too, such as banks, hospitals, restaurants etc.

Transportation can also occur within a facility. When materials are moved around a factory, they are not gaining value, but resources are expended to move the materials. This is an easy waste to identify. The majority of transportation costs are generated by moving raw materials to a factory and moving finished goods to a customer. (http://leangenie.com/7-wastes-transportation/, Date retrieved: February 23, 2015)

Transportation minimizes material and data movement. The waste of transportation to the movement of product between processes is normally using a forklift truck or a smaller "personal" piece of equipment to maneuver product around the factory. This transportation wastes both time and energy and has the potential to damage the products. Transportation is caused by large batches and over production as well as poor layout. It is quite normal for factories to be laid out in a traditional style with all specific process types being located in different areas. It leads to the need of transporting of product over potentially long distances. (www.the7wastes.com, August 27, 2012, Date retrieved: February 23, 2015)

Motion eliminates unnecessary motion and extra movement. The waste of motion is the movement within a process rather than the movement of materials between processes (transportation). When someone at work and see how often they end up having to stretch too far, have to orient their work piece or perform some sort of extra movement to achieve their work. All of these movements take time and also have the potential to cause damage to product and stress to the individual. (www.the7wastes.com, August 27, 2012, Date retrieved: February 23, 2015)

Within the production area, waste of transportation was found when product is not stored close to the point of use. If space allows (based on component sizes), keep a small store of inventory near the

production area. This will avoid having to bring the product back and forth to a warehouse. (http://www.lean-manufacturing-junction.com/waste-of-transportation.html)

When using the components, they should be at the station where they are being used. Any distance further than an arm's length away is considered a waste. Look for ways to store the components in use close to the worker whenever possible. When components get closer to the worker, continue looking for improvements by eliminating unnecessary motions (parts stored in the proper position on the correct side of the worker).

Waste of transportation will be more evident in the material delivery areas than the production areas. Moving product further than necessary, storing product in a temporary location only to move it shortly thereafter and moving with empty delivery carts are all considered a very big waste. Application of standardized material handling routes will help reduce this waste.

The process of transforming raw materials into finished goods is the objective of any manufacturing company. The processes that make the transformation possible are the result of two different activities those that add value and those do not (Dadufalza et. al, 2010). Value-added activities involved in the company considered are the actions and the process elements that accomplish transformations and add value to the product from the perspective of the customer. Non-value added activities are the process elements that do not add value to the product from the perspective of the customer such as transportation, inspection, storage of raw materials and avoidable and unavoidable delay.

Value in lean manufacturing is defined as something that the customer is willing to pay for. Value-adding activities transform materials and information into something a customer wants. Non-value adding activities consume resources and do not directly contribute to the end result desired by the customer's perspective (Bhatnagar, 2009). In the past, companies have been focused on the value-added steps. Today, lean manufacturing shows to improve as much as possible the value-added component of lead time, but focus first on reducing the non-value added component of lead time (Dadufalza et. al, 2010).

"Application of Lean Focus on Manufacturing Process: Case study of an American Furniture Company" by Bowen Zhou and Qian Zhao. The purpose of the research study is to investigate, analyze and find out solutions for waste-related problems in the manufacturing process of the company. They identified waste such as unnecessary movement like walking between different workstations which resulted to tiredness, low productivity and efficiency. The unnecessary movement happened at the manufacturing process as components will be delivered from one workstation to another. When the semi-finished parts have been completed, they are delivered by the work coordinators to the next workstation to the workers who have finished their former activities which take time for the worker to transfer the

material to other workstation. This implies that this waste is non-value added activity and can be eliminated after optimizing. It seems that these movements can be considered as non-value added activities but necessary. However, they identified the unnecessary movements as only non-value added activities. The reason why these unnecessary movements happened is because of the unreasonable arrangement of process layout. If the current process layout can be optimized, the wastes can be eliminated.

Project study entitled, "Determination of Non-value-adding Activities at Pre-assembly line of Pedd Manufacturing Company based on Lean Manufacturing Concept" authored by Dadufalza, et al (2010) talks about determining the existing waste specifically non-value added activities within the pre-assembly line of Pedd Manufacturing Company. The researchers focus on pre-assembly line of the company specifically in edging, planning and cutting section. The instruments used by the researchers for the study were non-value adding activity observation sheet, material handling chart and stopwatch time study. Non-value adding activity observation sheet consists of a description, classification of activities (movement, inspection and waiting), and elapsed time. While material handling chart consists of a description, movement of method, pieces per load, number of the load number of people, total input and output. Lastly, the stopwatch time study is used by the researcher in getting the standard time of production and elapsed time of the activities that need to be measured. The researchers conducted 10-days of observation of the investigation. The research is about determining only the non-value adding activities and as the results of their study, most of these activities are arranging the processed wood batch on the container; transportation of woods; worker's idleness because of waiting for the lacking of materials and personal needs; set-up time of machine adjustment and other related activities. The researcher did not focus on cycle time, but rather in the improvement of worker's productivity efficiency. The Bottom line of the study which is the proposed system made by the researchers resulted the following: In edging section of the company, the efficiency of the production was changed from 65.13% to 89.71%; in planning section, the efficiency increased by 2.34% from 110.94% to 113.28%; lastly, in cutting section, the efficiency was increased by about 58.41% to 103.11%. This topic is interrelated to our study since our focus is to eliminate the non-value adding activities to reduce cycle time within the production area in Dynasty Pallet System Inc.

A study entitled, "Reduction of Cycle Time by Eliminating Transportation at FBC Upholstery and Fabric Supplies", was conducted by Diaz and Marcial (2014) with a main goal of eliminating or reducing the production waste particularly transportation to be able to improve productivity to lessen the cycle time producing the product. Work sampling was used to determine the efficiency of the worker's in terms of their productivity. Also, this was a tool used by the researcher to determine the delay in the production. The aid of distance measurement of transportation, lessen the travel time from 25.2 meters

down to 9.6 meters by changing the layout of the production. It resulted to improve the capacity output of producing chair from 30 chairs per month to 38 chairs. Aside from the changing the production area, the researchers implemented 5s to increase the productivity and organize the worker's workplace.

A project study of Atienza, et al (2008) entitled, "Plant Layout: A Case of Productivity Improvement at Lhasa Rubber Industrial Corporation" with the goal of minimizing transportation time, determining the cycle time before and after redesigning the plant layout, removing unneeded equipment and materials from the work area and eliminating bottleneck. The study was focused on the importance of plant layout efficiency and establishes a standard time on their process of production area. As the results of the investigation, with the combination of eliminating the unnecessary machines and changing the layout to eliminate transportation, the researchers' recommendation results a total time of 46.596 minutes (0.777 hours) to produce a piece of time and the total tire per day is 10 units per day as to compare with the previous cycle time, the researchers' were able to lessen it after the recommendation was applied.

The above study will aid in order to find ways to improve the productivity through eliminating production wastes. By eliminating the existing waste, which does not add value to the product output, the production would be efficient enough.

Dynasty Pallets Systems Inc. is located in Cabuyao City Laguna, Philippines and categorized as a manufacturer of high quality wooden pallets in Southern Tagalog having 21 workers operating in the production area. The company manufactures different types of wood products: 1) lumber based pallet; 2) tech wood pallet; and 3) plywood based pallet. The scope of the study focused only on the production of plywood based pallet. The plywood based pallet has 3 parts: 1) Wood slab; 2) Plywood (based and dice).

FIGURE 1: Current Layout

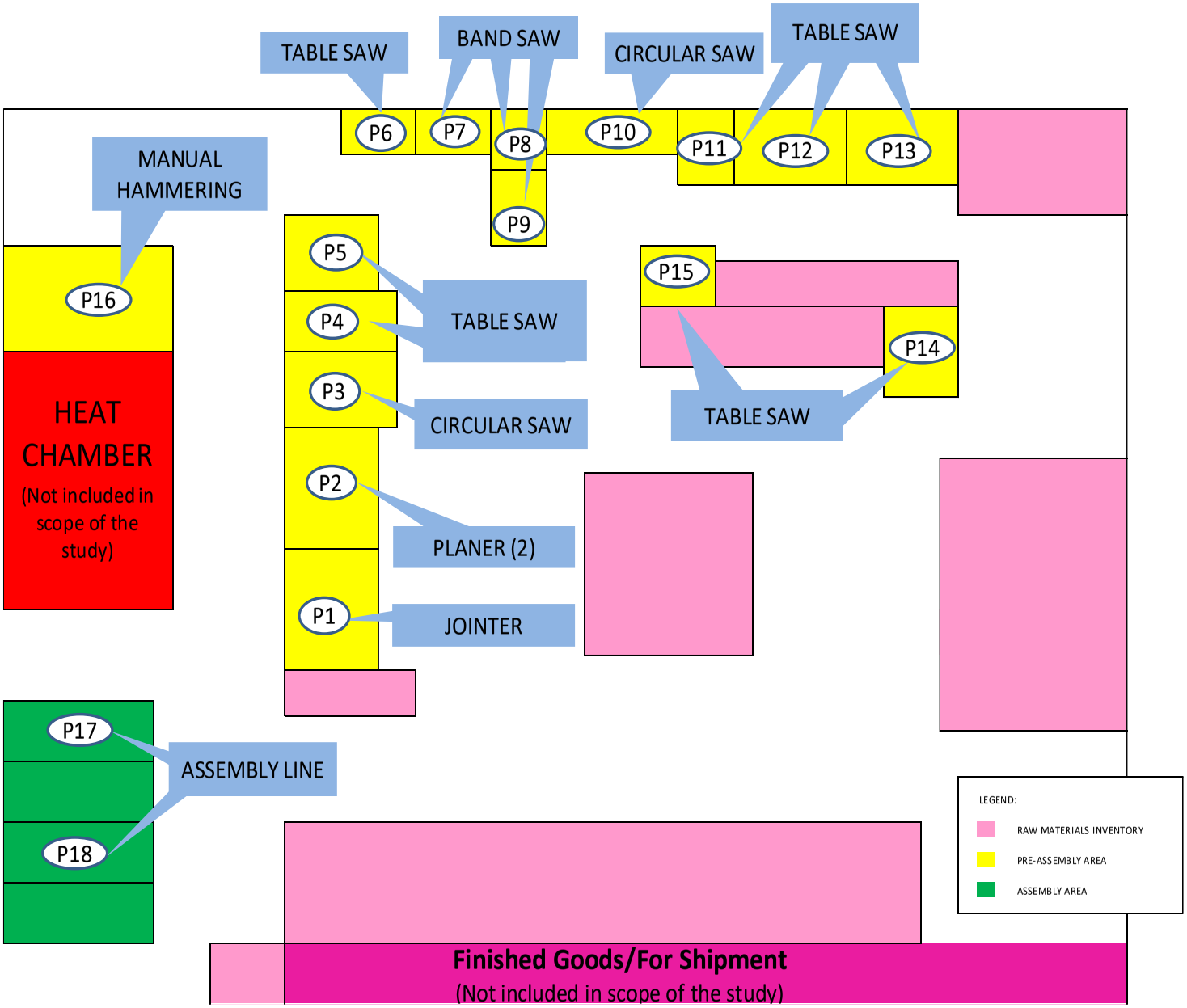


TABLE SAW
BAND SAW
CIRCULAR SAW
TABLE SAW
P6
P7
P8
P9
P10
P11
P12
P13
MANUAL HAMMERING
P16
HEAT CHAMBER
(Not included in scope of the study)
P5
P4
P3
P2
P1
TABLE SAW
CIRCULAR SAW
PLANER (2)
JOINTER
P15
P14
TABLE SAW
P17
P18
ASSEMBLY LINE
LEGEND:
RAW MATERIALS INVENTORY
PRE-ASSEMBLY AREA
ASSEMBLY AREA
Finished Goods/For Shipment
(Not included in scope of the study)

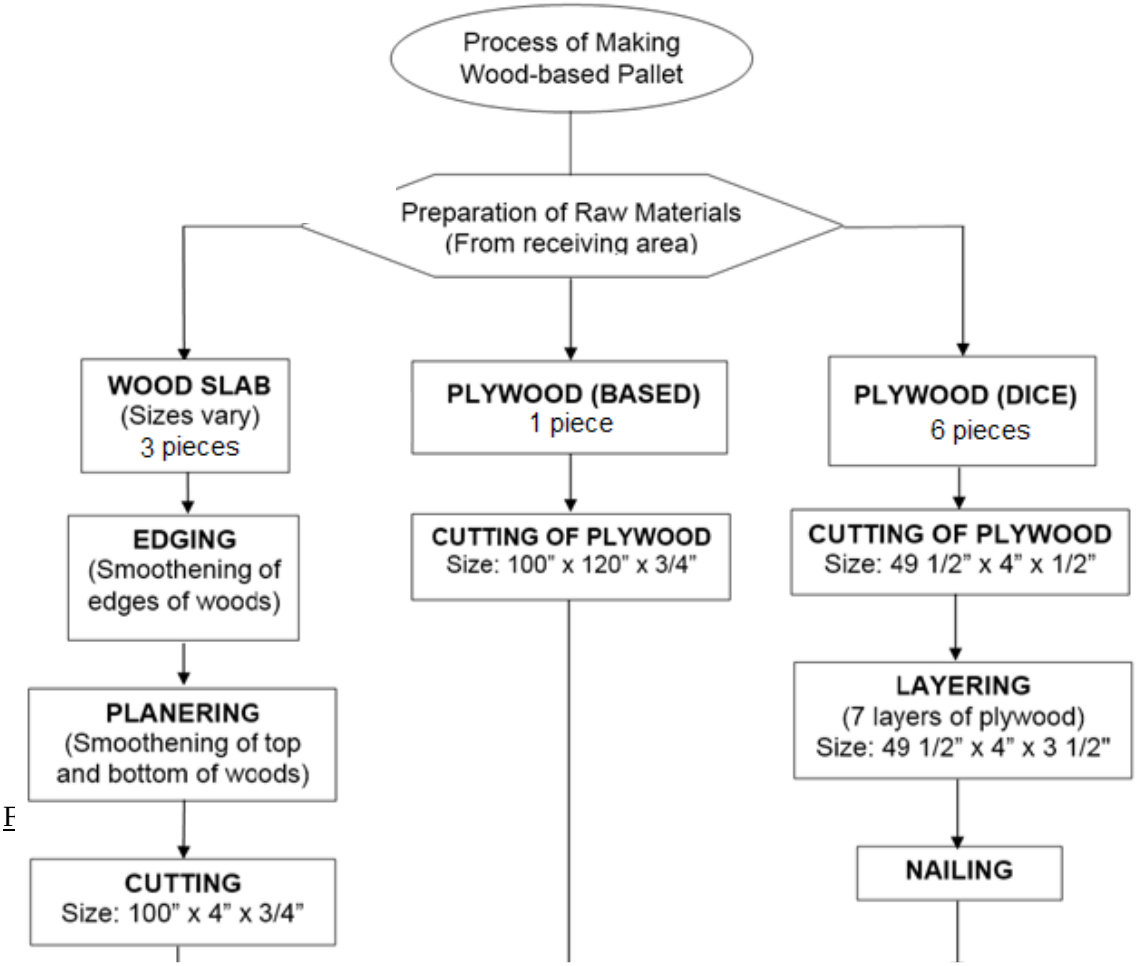


FIGURE 1: Current Company Layout of Dynasty Pallets System

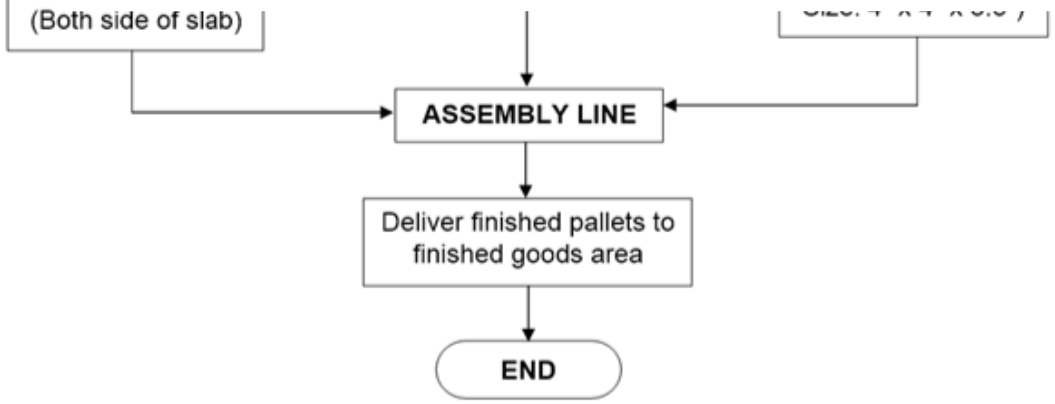


FIGURE 2: Machine Name of Each Process

FIGURE 3: Parts of Plywood-based Pallet (1 unit)

Plywood-based Pallet
Quantity: 1 unit

Wood Slab
Quantity: 3 pieces
Size: 100” x 4” x 3/4"

Plywood (Base)
Quantity: 1 piece
Size: 100” x 120” x 3/4"

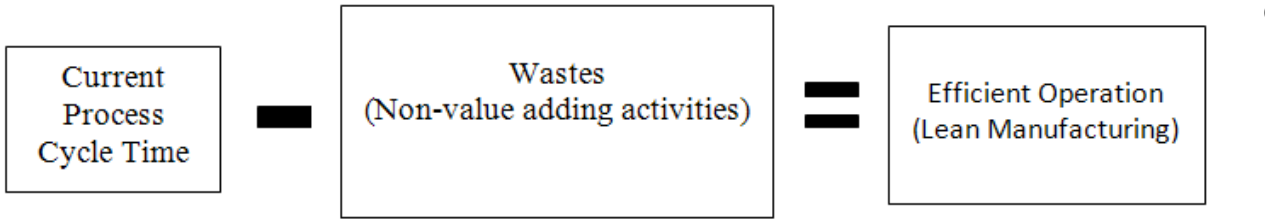
Plywood (Dice)
Quantity: 9 pieces
Size: 4” x 4” x 3 1/2"

In the relentless pursuit of profitability and competitiveness, more and more companies are turning to lean manufacturing to reduce or eliminate waste in their production processes.

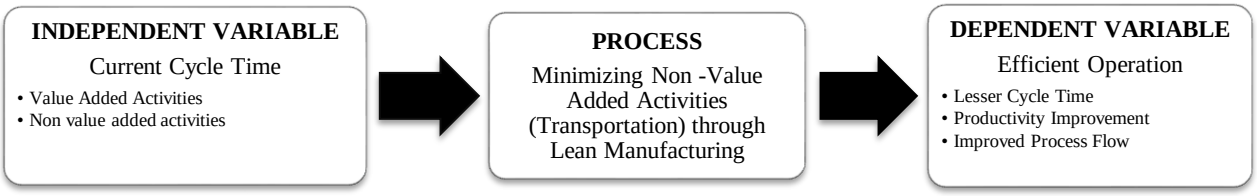
A lean strategy also focuses on eliminating existing wastes; wastes that does not add value to the product being paid by the customer. According to Langley et al (2009) in his book entitled The Improvement Guide, that lean manufacturing approach focuses on continuously reducing waste in operations and in product and services and continuously enhancing the value proposition to customers.

Reduction/elimination of non-value adding activities specifically transportation in the production will make things work more efficiently; therefore an increase in productivity can be achieved.

Paradigm of Lean Manufacturing Concept



Operational Framework



The variable that will be processed in this study is the cycle time. The current cycle time is consists of both value added and non-value added activities. Minimization if not totally elimination of existing non-value added activities specifically transportation through lean manufacturing is the process. The dependent variable is the result after minimizing if not totally eliminating the non- value added activities are lesser cycle time, productivity improvement and improved process flow.

In order to eliminate waste and ensure consistency of process, the phases or steps in it must be examined to make the process be visible so that waste or inequality is highlighted and can be rectified.

The main problem of this study is to reduce cycle time by eliminating non-value added activities in the production area of Dynasty Pallets System Inc. This study aims to answer the following questions: 1.What non-value added activities are currently present in the production?

2. What are the possible ways of reducing the cycle time?

3. What is the total cycle time, if the transportation activity is reduced/ minimized?

4. What is the impact of reducing the cycle time to the output of plywood-based?

In discussing this study, the researcher has come with the hypothesis. Reducing the cycle time of making the plywood-based pallet has no impact to the output produced by Dynasty Pallets System Inc.

The study focused on establishing the lean manufacturing and minimizing the transportation activities as identified in the production area to reduce cycle time. The aspect looked into where the productivity of the workers; the problems associated with it and proposed solutions to the problem. This investigation was conducted to determine the non-value added activities in making pallet specifically the plywood-based pallet and to provide recommendation with the best possible way of reducing it if not totally eliminating it to lessen the cycle time of output produce by Dynasty Pallets Systems Inc.. The results will be based on the data collected from the production activities performed along the production area.

METHODS

The procedures for this study have been chosen to meet each of the project objectives. To have first-hand knowledge of the production flow and to be familiar with the activities being performed at the production line in the manufacturing of pallet in Dynasty Pallet System Inc. the researchers went through the line and identified each process involved from source of raw materials to output of the selected line.

The research utilized the descriptive method of research with the preliminary observation as the main source of data. The descriptive method is viable for the study since the purpose of the study is to generate prevailing conditions prevalent in the setting of the study.

The following research instrument used in obtaining and gathering data for this study are: 1.*Observation.* Actual observation in the production area in Dynasty Pallet System Inc. was conducted. The researchers observed the actual scenario and the different process that is being performed inside the company. 2. *Interview.* The researchers performed interviews with the foreman of the company for the purpose of attaining necessary information for the study. Likewise, the researchers' asked for the workers' responses for any questions necessary for understanding the process and any related information that could help in making the research more reliable. 3. *Survey.* The researchers conducted a survey to the

workers involved in the production area in order to acquire information. 4. *Time study.* It is a tool used to measure the elapsed time of how long the process being done. It also an effective tool to determine the actual cycle time of each activity (operation, transportation, inspect, storage and delay) involved in the study. 5. *Measuring Distances.* It is used by the researchers as a guide to determine the distance travelled of the worker and product. 6. *Flow Process Chart.* It is a simple half-text, half-picture method of showing steps in a process, using symbols to indicate the type of action being taken and text to give details of the action. Flow process chart is a tool used by the researchers to determine the physical process and cycle time in the production line. This tool includes the sequential list of activities from the raw materials to the storage of finished pallets. 7. *Cause and Effect (Fish Bone) Diagram.* It is used to determine and illustrate the flow of factors between the causes, main problem and the effects of the study. It is a tool used by the researchers to determine the cause and effect of the existing manufacturing wastes present in making the product.

Statistical treatment was applied to the result of surveys and interviews. The results lied on the frequency level of its questions and come up with its percentage. The interview helped the researchers collect data from their findings. Descriptive statistics were utilized in the study. In the descriptive statistics, the researchers used frequency and percentage to determine the number of occurrence on the survey questionnaire.

The researchers used simple linear regression to determine the effect or impact of an independent variable on a dependent variable. The independent variable (x) of the study is the computed reduced cycle time while dependent variable (y) is the output produced in assembly area.

RESULTS AND DISCUSSION

Result of the survey shows that majority of the workers said that the procedures currently implemented by the company were okay. However, the target outputs were not accomplished at the right time. Based on the follow up question no.3 on what is the common cause of delays encountered, the main reason why their target outputs were not accomplishes at the right time is because of transportation. In question no. 4 which affects the performance of the workers, majority of the workers said that their performance was most affected by environmental factor which is noise. But upon verification of the sound level in the production using sound level meter, the result was within the required limits which is 90 decibels. Meaning, the noise level was still acceptable and tolerable. In question no. 5 on how adequate is the location of each area, majority of the workers says that the distance between the locations was adequate. 33% of the respondents said that the safety equipment in the production area not enough. Same percentage of the workers also said that their workplace doesn't have good ventilation. In terms of temperature, 9 out 21 workers said that the temperature in the workplace affect their productivity. The

researchers observed in nailing section and assembly area doesn't have ventilation. (The survey results are tabulated at appendix __)

The researcher observed that the most visible lean manufacturing wastes that are present in the production area are transportation and motion waste. These are evidenced by the current layout with spaghetti diagram shown in Appendix ___ and Table 3 – Summary of Total Distance Travelled from one process to the next (page ___).

Through the use of Cause and Effect diagram, the researcher identified that the main contributor of the long distance between work stations are: inappropriate route of transporting materials and backtracking of materials and processes. As to the causes of motion waste, bending and reaching for material was observed due to poor work station, poor method design due to improvised small chair used and incorrect posture while working (bended knees). Frequent cleaning of workplace by sweeping wood residues were also observed.

In order to find ways of reducing cycle time, the researcher provided four (4) proposed layout. From these layout, cycle time was computed (Appendix ___) in order to determine the layout with the highest output. To determine the impact of reducing cycle time to the output, the researcher conducted time study to determine the Value Added activity and the Non Value Added activity with their corresponding output using the company's current layout. From the trials made through time study, the researcher use linear regression to determine the slope of the regression line (b) and the y-axis intercept (a). Applying the values to the proposed layout, the researcher were able to predict/impact of reduced cycle time to the output as shown in Appendix ___.

Conclusion:

Based on the finding the most visible non-value added activities that are present in the production line are transportation and motion. These two are also considered as lean manufacturing waste present in making the plywood-based pallet. In transportation, the factors that contribute are the large distances between the stations needed in such process, inappropriate route of transporting materials, and backtracking of delivering materials. In motion, the factors that contribute are the poor work station layout, poor method design, unnecessary movements, and repetitive non-value added activities done by the workers.

The possible ways of reducing the major contributor of non-value added activity of the total cycle time is revision of the layout.

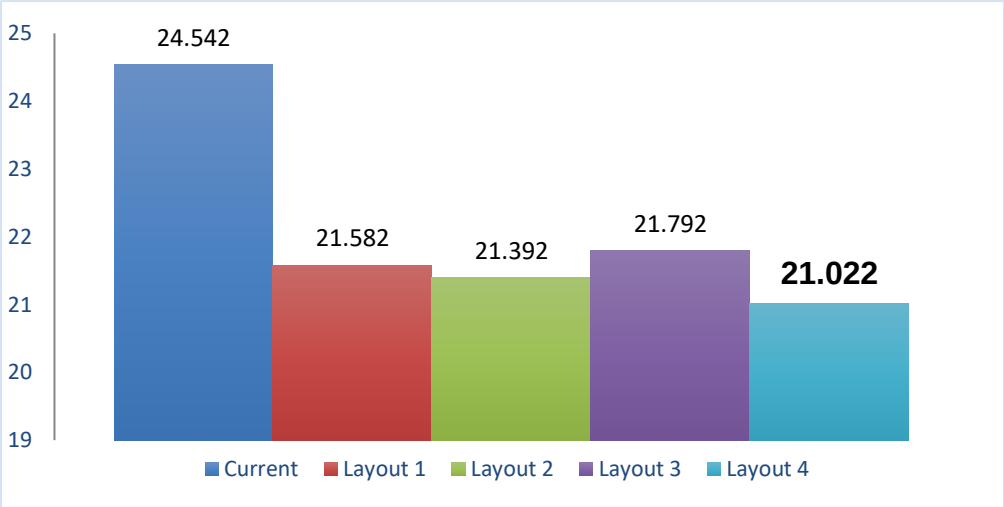


FIGURE 1: Comparison of Reduced Cycle Time

Figure 1 shows the impact of each proposed layout in terms of total cycle time. It shows that layout 4, if implemented, ranks to be the least cycle time in making the plywood-based pallet numbering to 21.022 minutes. Layout 2 ranks to be the second least cycle time with 21.392 minutes total cycle time. Layout 1 and 3 ranks to be the 3rd and 4th least cycle time respectively.

At the current production system, the total cycle time of making the plywood-based pallets is 24.53 minutes. Value added activity which is operation, consumed 53% if the total time numbering to 12.95 minutes. Meaning, the remaining 47% is the non-value added activity. On the time study conducted by the researchers, transportation is the major contributor of the non-value added activity which contributes almost 35% of the total cycle time equivalent to 8.67 minutes out of 24.54 minutes of the total time. Among the 4 layout that the researchers provided, layout number 4 is the preferred layout since it would lessen the cycle time of making the plywood-based pallets from 24.54 minutes to 21.02 minutes.

Table below shows that impact of revising the layout with respect to the output per work hour of producing the plywood-based pallet.

LAYOUT	TOTAL CYCLE TIME	OUTPUT PER DAY (7 HOUR)
Current	24.542 minutes	357 Pallets
Layout 1	21.582 minutes	462 Pallets
Layout 2	21.392 minutes	469 Pallets
Layout 3	21.792 minutes	455 Pallets
Layout 4	21.022 minutes	483 Pallets

Upon verification and testing the hypothesis through computation using simple linear regression, researchers have found out that every time the cycle is reduce, their corresponding output increases. There is a big impact of the reducing the cycle time with respect to the output. Hence, it is advisable to the company to continuously improve their production system to increase productivity.

Direction For Future Use

The researchers recommend that there must be a change in the layout of company to improve its production process in order to reduce transportation, if not totally eliminated. The preferred layout to be implemented is layout number 4 which have the least cycle time but with the highest output in making the plywood-based pallet.

One of the factors need to be considered in the performance of the workers at the production is the ergonomic factors. Existence of motion waste resulted in poor method design. The researchers recommend that the workers must be aware, educate, and train to utilize good body mechanics at work. Increase workers awareness of MSD signs and symptoms and encourage early reporting of any problems. Based on the observations of the researchers, the workers usually sit in the improvised small chair. As a recommendation, the workers should provide a fully adjustable chair to optimize comfort and support (height, depth, width, and angle) subjected to the height level of the table at the nailing section. To eliminate shoveling of sawdust/ woods' residue, use a vacuum system to collect it directly or use bins or containers to catch the pieces from the machine.

As observed by the researchers, the current signages present at the production have been covered by the sawdust and unrecognized because of its small size which is unreadable and cannot identified more. The researchers' recommendation is to have a clear and readable concise form of signages located at the wall side of each station. Proper ventilation should be considered by the management for better productivity of the workers. Some of the exhaust fans located at the ceiling of the production area are not working properly; they should provide a new one for proper temperature of their surroundings. The noise is also one of the problems being observed by the researchers and being identified by the workers based on the survey results because of the large cutting equipment. The certain method of preventing occupational deafness is to reduce noise. The researchers recommend having every workers should have an ear plug which is inserted to block the ear canal. They may be remolded (preformed) or moldable (foam ear plugs). One of the safety precautions need to be observed at the Dynasty Pallet Systems Inc.

Another proposal of the researchers is the implementation of 5s in the production. These are sorting – going through all the tools, materials etc.., in the plant and work area and keeping only essential items. Everything else is stored or discarded. Straighten or set in order – the tools, equipment and parts should be properly arranged in a manner to promote smooth workflow. Shining – systematic cleaning or

the need to keep the cleanliness of workplace. At the end of the shift, the work area should be cleaned up and every tools and materials must be placed in a proper storage for easy access. Standardizing - standard work practices or operating in a consistent and standard fashion. Everyone should know exactly what his/her duties and responsibilities are in the workplace. Sustaining the discipline – refers to maintaining and reviewing standards. The implementations of 5s can be helpful in sustaining the workflow smooth and to lessen the workers to be idle because if they done their job or quota in a day they are required to clean their work area to maintain the cleanliness in the workplace.

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