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Analysis of the application of the lean six sigma method to minimize waste in the plywood production process

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ABSTRACT

PT. XYZ is a manufacturing company that produces plywood. The problem that this plywood company has faced is that in the plywood production process, there are still many activities classified as waste, thus disrupting productive activities. Therefore, identification of waste and the factors that cause it must be done to provide improvements so that waste in the production process can be reduced or even eliminated. Efforts that can be made to overcome the problems that occur were by using the lean six sigma method. The most influential waste in the plywood production process is overproduction with a sigma level of 0.00, waiting with a sigma level of 1.52, and defects with a sigma level of 3.85. The factors that cause waste are WIP waste overproduction, waste waiting between the process, and waste defect delamination. The recommendation for improvement for waste to minimize waste is for waste overproduction, namely making digitization forms, waste waiting, adding mini dryers and waste defects, and implementing the Kanban system.

ABSTRAK

PT. XYZ merupakan perusahaan manufaktur yang memproduksi kayu lapis (*plywood*). Permasalahan yang ditemui pada perusahaan adalah dalam proses produksi *plywood* masih terdapat aktivitas yang tergolong kedalam *waste*, sehingga mengganggu kegiatan produktif. Oleh karena itu, identifikasi *waste* dan faktor penyebabnya perlu dilakukan, sehingga dapat memberikan perbaikan agar pemborosan pada proses produksi dapat dikurangi atau bahkan dihilangkan. Upaya yang dapat dilakukan untuk mengatasi permasalahan tersebut adalah dengan menerapkan metode *lean six sigma*. *Waste* yang paling berpengaruh pada proses produksi *plywood* adalah *overproduction* dengan *level sigma* sebesar 0.00, *waiting* dengan level sigma sebesar 1.52, dan *defect* dengan *level sigma* sebesar 3.85. Faktor-faktor penyebab *waste* adalah untuk *waste overproduction* WIP, *waste waiting between process*, dan *waste defect* delaminasi. Rekomendasi perbaikan untuk *waste* untuk meminimasi masing-masing *waste* adalah untuk *waste overproduction* yaitu membuat *form* digitalisasi, untuk *waste waiting* yaitu menambah *dryer mini*, dan untuk *waste defect* yaitu untuk menerapkan sistem Kanban.

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1. Introduction

Indonesia is a country that excels in natural wealth, namely wood. Some types of wood often used include meranti, keruing, kapur, jelutung, mersawa, mixed jungle, matoa, and others. Wood has many advantages, one of which can be processed as a basic material for making furniture, plywood products, and others [1]. Plywood can be used as a wall layer, floor base to building construction [2].

The development of plywood is quite fast, indicated by the high demand for exports [3]. According to BPS [4], the main destination countries for Indonesia's plywood exports are Japan, with 478.2 million kg worth 570.2 million US dollars and the United States 266.8 million kg worth 346.9 million US dollars. When the plywood commodity competes in the world market, the ongoing plywood production process requires good equipment and machines to create high productivity [5]. In the competition between countries, companies must produce quality products [6]. Quality plywood goods meet the tolerance standards of each country's grading regulation, including dimensions, thickness, visual grade, moisture content, edge straightness, and curvature.

However, in implementing plywood production activities, there are still activities that are not of value to consumers. This activity is a waste that will cause losses [7]. In general, waste is a waste of the use of materials and other resources that have no benefits [8]. In production process activities, waste is often encountered, namely waiting, overproduction (overproduction), defective products (defect), transportation (excessive transportation), inventory (inventory), process (inappropriate processing), and movement (motion). [9].

PT. XYZ is a manufacturing company that produces plywood. The product produced is plywood with three-ply and five plies up. America and Korea are the main export destinations for this company. Each country has its quality standards that must be met. Eight main types of machines are used to meet consumer demand, namely chainsaw, rotary, dryer, composer, glue spreader, press, double saw, and sander. The problem encountered in this plywood company is that in the plywood production process, there are still activities classified as waste to interfere with productive activities.

Based on the observations, the waste encountered in the company, namely waiting, is related to waiting time between processes and loss time machines. In addition, there is another waste, namely overproduction, where the emergence of work in process (WIP) that accumulates, which will later become an inventory indicator. Another problem, namely waste defect due to worker error as the main cause. The defects found in plywood products are delamination, roughness, split, overlap, non-standard size, bubbles, and others. Therefore, identification of waste and its causal factors needs to be done to provide improvements so that waste in the production process can be reduced or even eliminated.

To overcome the problems above, the effort that can be done is to apply the lean six sigma method. Lean six sigma is a methodology that combines two methods, namely lean and six sigma [10]. There are five stages used in lean six sigma known as DMAIC (define, measure, analyze, improve, and control) [11]. This methodology can reduce or even eliminate the waste found in the industry [12]. In addition, it can improve the quality of the resulting product and minimize product variance. Lean six sigma is oriented towards continuous improvement efforts to create an efficient and error-free production process [7]. The purpose of this study was to determine the types of waste identified in the plywood production process, find out the factors causing waste in the plywood production process, and find out the proposed improvements to minimize waste in the plywood production process at PT. XYZ.

Several previous studies are used as comparison materials and studies in research related to efforts to minimize waste using the lean six sigma method. [13] identifies waste in production activities, analyzes the causes of waste, and provides suggestions for improvements to the production system. [14] finds out what waste affects the frying pan production process with a lean six sigma approach and suggestions for improvements that can be made to reduce waste in the production process. [15] minimizes defects and reduces non-value added activity in the moslem fashion production process. [15] explains the use of VSM to reduce dominant waste in the production process to increase productivity. The research was carried out in different locations. The research was carried out using a different research object, namely plywood, while the research object was the previous research used objects of research, such as frozen fish, frying pans, and moslem clothing.

2. Research Methodology

Quantitative research is the type of research used in this study. To find out the problems that exist in PT. XYZ, then the stage of research carried out is a field study. The data collected consists of primary data and secondary data. Primary data were obtained by conducting observations, interviews, and distributing questionnaires. The data must be collected, namely the time of the production process, the identified waste, the factors causing the waste, and recommendations for improvement of waste. Secondary data was obtained from company documents, books, and other literature. The data must be collected, namely the number of production data, product defect data, and inventory data. Furthermore, data processing is carried out based on the DMAI (Define, Measure, Analysis, and Improvement) methodology from six sigma.

At the define stage, waste identification is carried out on the object of observation—the identification of production process flow at PT. XYZ is done by creating a value stream mapping. Based on the identification results, it can be seen the actual condition of the object of observation in several indicators that are classified as value-added, non-value-added time, and necessary non-value-added time. After that, the waste contained in the plywood production process is identified. In the measuring stage, measurements are made on the waste that occurs to see the actual condition of the company's production process by measuring the CTQ to determine the most critical waste. After that, the measurement of the DPMO and the sigma value of the waste indicator is carried out. In the analysis stage, an analysis of the causes of the occurrence of each waste is carried out. The tools used in this research are cause and effect diagrams. At the improvement stage, the priority RPN value is determined to obtain suggestions for improvement. The suggested innovation uses FMEA to reduce waste in the plywood manufacturing process.

3. Results and Discussion

3.1. Define

3.1.1 Identify Production Process Flow with VSM

At this stage, identification of the plywood production process flow at PT. XYZ by analyzing the value stream mapping. Value stream mapping analysis includes a description of the flow of information and materials from the company's existing production processes. Value stream mapping is used to identify waste in the plywood production process at PT. XYZ. The following value stream mapping is shown in Figure 1. Figure 1 shows a picture of the flow of information and materials from the production process within the company. Value stream mapping is used as the initial stage of the waste identification process that occurs in the plywood production process at PT. XYZ.

3.1.2 Identification of Production Processes Classified as VA, NVA, and NNVA

The production process is identified through value stream analysis which groups activities into value-added (VA), non-value-added (NVA), and necessary but non-value added (NBVA). Based on the results of grouping activities, it can be seen that the identification of activities along the value chain is activities that are not value-added (NVA) with a percentage of 51.10% and value-added activities (VA) with a percentage of 48.90%. Therefore, waste must be identified to minimize waste in the plywood production process.

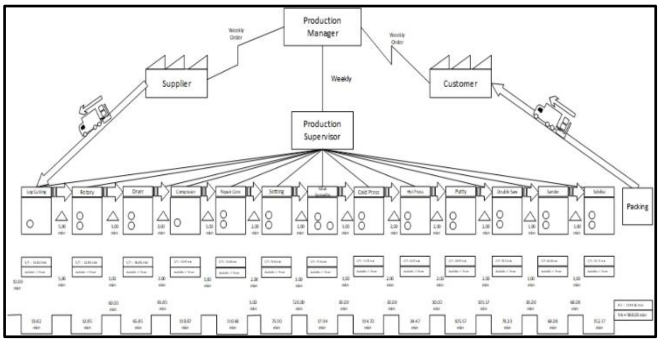


Figure 1. Value stream mapping.

3.1.3 Waste Identification

Identification of waste throughout the production process is as follows:

a. *Excessive transportation*

Excessive transportation can be identified based on transportation activities in the existing production process. Based on the identification of production activities, the percentage of transportation time is 2 % of the total time of the production process. It is known that excessive waste transportation has a total transportation time value of 34.00 minutes. Waste excessive transportation is not too significant because the existing production lines have been designed sequentially according to the production process, with the distance between each process being relatively close.

b. *Waiting*

There are two types of waiting activities in the company's production process activities, namely waiting between the production process and waiting for the repair of production machines. The process can lead to an increase in the production lead time. Waiting is waiting between processes. Namely, plywood that has gone through the putty process has a waiting time to go to the double saw process because after the puttying is done, it needs to be allowed to stand for a while before entering the next process. Waiting for a loss time machine on the dryer machine is the most critical machine with the most frequent breakdown frequency. Especially on the roll dryer 2, which has a record of machine operation with the highest loss time, one of which is due to the lower deck motor output being burned out.

c. *Inappropriate processing*

Waste inappropriate processing occurs when there is an error production or procedure. If the MC (Moisture Content) of the output veneer is not following the provisions (wet veneer), a re-drying process will be carried out in the dryer process. This process is because the steam does not reach the standard. After all, the boiler temperature is below 140 degrees Celsius. In addition, several other processes are frequently reprocessed, namely re-putty, re-jointing, re-sandering, and re-grading.

d. *Unnecessary motion*

Based on the observations, it can be seen that the activities related to reaching, placing tools and materials are appropriate. In addition, operators and workers in the production department carry out their work movements according to the work instructions of each process. Waste unnecessary motion occurs when workers carry out the identified movements that do not have added value to the product. Therefore, this waste is not discussed further because no unnecessary movements can indicate waste in the production line.

e. *Overproduction*

Waste overproduction occurs if the production output is greater than the existing demand. In the production of 2.7 x 1,220 x 2,440 products for USA destinations, there is waste overproduction on work in process (WIP) goods. During the last three months, there has been an excess of 410,081 pcs of core and face/back veneers that have not been processed and are at risk of being damaged, so the waste overproduction will be discussed further.

f. *Unnecessary inventory*

Based on the finished goods stock warehouse data, it can be seen that the number of product outputs produced does not have non-order stock. All product output 2.7 1220 x 2440 produced is a stock order buyer. Where the buyer owns the stock, this stock accumulation is only temporary. This process is because the company implements a make-to-order production system, so the unnecessary inventory is not significant for further discussion.

g. *Defect*

The waste defect was identified in plywood production activities of size 2.7 1220 x 2440 for American destinations at PT. XYZ. Based on cumulative defect data for the last three months, namely August 2020 to October 2020, there were 16,058 defective products. These defects include delamination, press marks, core voids/broken, broken faces, patches, overlapped, repair fractures, bubbles, less wide faces, cracked cracks, transport damage, dirt on cores, rough cores, and others.

3.2. Measure

3.2.1 Measurement of Seven Waste

a. *Excessive transportation*

It is known that transportation waste in the production process has a total time of 34.00 minutes. The following is a calculation of lost products caused by transportation waste shown in Table 1. Table 1 shows the calculation of excessive transportation. It was found that the company lost 69 products per day. In three months, the company experienced a loss of 4,968 products.

Table 1. Lost product excessive transportation.

Waste	Lost product
Excessive transportation	34.00 minute
Total produk	4.000 pcs/day
Cycle time	1980.70 minute
Lost product	$=\frac{4000\times 34.00}{1980.70}$
	= 69 pcs/day

b. *Waiting*

It is known that there are two types of waste waiting, namely waiting between processes and waiting during the production machine repair process. The following is a calculation of lost products caused by waste waiting shown in Table 2.

Table 2. Lost product waiting**.**

Waste	Calculation	Total (pcs/day)
Waiting between process	$=\frac{4000\times 979}{1980.70}$	1,977
Loss time machine	$=\frac{114.72\times 60}{1980.70}$	960
Total lost product		2,937

Table 2 shows the calculation of lost product waiting, it was found that the company experienced product loss of 1,977 products per production for waiting between processes and 960 pcs of products per one month of production for waiting for loss time machines, which means that in 3 months, the company experienced a loss of 145,224 products.

c. *Inappropriate processing*

Waste includes inappropriate processing, namely re-drying, re-putty, re-jointing, re-sandering, and re-grading. However, this waste cannot be measured because the company has never made a reprocessing record.

d. *Unnecessary motion*

The unnecessary waste motion does not occur because operators and workers carry out activities or work following existing provisions, which means that unnecessary motion is not discussed further.

e. *Overproduction*

During the last three months, there has been waste overproduction on work in process (WIP) goods, is in the form of excess production of core and face/back veneer as many as 410,081 pcs that are not processed and are at risk of being damaged.

f. *Unnecessary inventory*

All 2.7 x 1,220 x 2,440 product production is a stock order buyer. Because product buildup is only transitory because the stock will be decreased later to be sold to purchasers, superfluous inventory is unimportant for further discussion.

g. *Defect*

Based on the results of the Pareto diagram, three types of product failures are obtained below 80%, namely delamination, core void/broken, and overlapped. The number of types that cause the largest defect is delamination, with a defect frequency of 3,939 products. Meanwhile, the second type of defect is core void/broken with a defect frequency of 2,357 products. Furthermore, the third type of defect causes overlapped with a defect frequency of 1,956 products.

After calculating the lost product for each waste indicator, it is necessary to determine the critical waste to determine which type of waste is the most influential by considering the resulting losses. The following is a recapitulation of the cost of losses from the identified waste shown in Table 3.

Table 3. Recapitulation of waste loss**.**

Waste	Lost product	Loss
Waiting	175,007	Rp 1,512,750,000
Transportation	4,936	Rp 317,659,529
Overproduction	410,081	Rp 4,872,960,000
Defect	16,058	Rp 1,026,766,650
Total		Rp 7,730,136,179

Table 3 shows the calculation of cost losses for each waste, so a Pareto diagram is made. Based on the recapitulation results of each waste shown on the Pareto graph, the percentage of the number of products lost can be used to determine the most influential and critical wastes are overproduction, waiting, and defects. Figure 2 shows seven types of waste in the production process: overproduction, waiting, defect, transportation, inappropriate processing, motion, and inventory. The largest amount of wastage loss was overproduction of Rp. 4,872,960,000. While the second amount of waste loss is waiting for Rp. 1,512,750,000. While the third amount of wastage loss is a defect of Rp. 1,026,766,650.

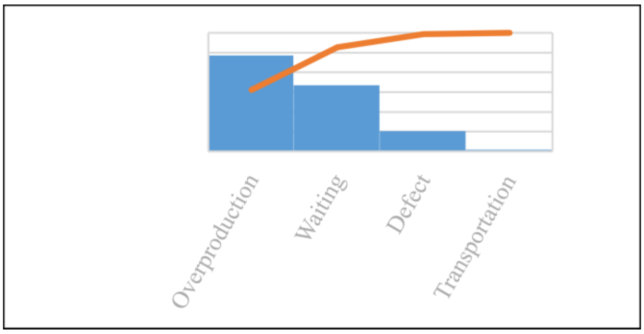


Figure 2. Seven waste.

3.2.2 CTQ Measurement

a. *Waiting*

Based on the percentages in Table 4, it is known that 1 CTQ is waiting, which is the most influential. The significant waste waiting is the waiting between processes, with 142,344 pcs wasted owing to waiting and a rate of 98.02 percent. Based on Table 4, it can be seen that the occurrence of critical waste waiting is the waiting between processes with the number of products lost due to waiting as many as 142,344 pcs with a percentage of 98.02%. Then there are 1 CTQ waiting that most often occurs.

Table 4. Types and total waste waiting**.**

Type of *waiting*	Total	Percentage
Waiting between process	142,344	98.02 %
Waiting loss time machine	2,880	1.98 %
Total	145,224	100 %

b. *Overproduction*

Identification of the type and total overproduction from August 2020 to October 2020 is carried out to measure the CTQ that causes overproduction. Based on the type and total overproduction, overproduction waste only has one type of overproduction, so that the cause of critical overproduction waste is WIP overproduction.

c. *Defect*

Based on Table 5, it is known that there is 1 CTQ defect that has the most influence. The critical waste defect is delamination, with as much as 3,939 pcs wasted owing to flaws and a proportion of 47.73 percent. Based on Table 5, it can be seen that 47.73% of the causes of critical waste defects are delamination, so there is 1 CTQ defect that most often occurs.

Table 5. Types and total waste defects**.**

Defect	Total	Percentage
Delamination	3,939	47.73 %
Core void	2,357	28.56 %
Press mark	1,956	23.70 %
Total	8,252	100.00 %

3.2.3 Pengukuran DPMO dan Level Sigma

a. *Waiting*

The following is a calculation to determine the value of defects per million opportunities (DPMO) and the sigma level shown in Table 6.

Table 6. Sigma waste waiting level calculation**.**

No	Action	Value
1	Number of products produced	287,529
2	Number of products lost	142,344
3	Failure rate = (2)/(1)	0.495
4	Number of CTQ	1
5	Probability of failure rate per CTQ = (3)/(4)	0.495
6	Chances of failure per one million chance = (5)*1000000	495,059
7	Convert DPMO to sigma level	1.52

b. *Overproduction*

The following is a calculation to determine the value of DPMO and the sigma level shown in Table 7.

Table 7. Calculation of the level of sigma waste overproduction**.**

No	Action	Value
1	Number of products produced	28,.529
2	Number of products lost	410,081
3	Failure rate = (2)/(1)	1,426
4	Number of CTQ	1
5	Probability of failure rate per CTQ = (3)/(4)	1,426
6	Chances of failure per one million chance = (5)*1000000	1,426,225
7	Convert DPMO to sigma level	0.00

c. *Defect*

The following is a calculation to determine the value of DPMO and the sigma level shown in Table 8.

Table 8. Sigma waste defect level calculation**.**

No	Action	Value
1	Number of products produced	287,529
2	Number of products lost	3,939
3	Failure rate = (2)/(1)	0,0136
4	Number of CTQ	1
5	Probability of failure rate per CTQ = (3)/(4)	0,0136
6	Chances of failure per one million chance = (5)*1000000	13,699
7	Convert DPMO to sigma level	3,71

3.3. Analyze

3.3.1 Fishbone diagram

At the analysis stage, an analysis is carried out to determine the cause of the waste in each of the most influential CTQs using RCA tools, namely, cause and effect diagrams.

a. Cause of waiting

Based on the results of the CTQ measurement, the waste waiting between processes is the selected waste for analysis of the causal factors. The following is a fishbone waste waiting between process diagram shown in Figure 3. Based on the results of the fishbone diagram analysis, it is known that the waste waiting between process occurs due to long conditioning of veneer and plywood, waiting for a forklift, no preparation of material inputs, material hooks, hot working environment, and others.

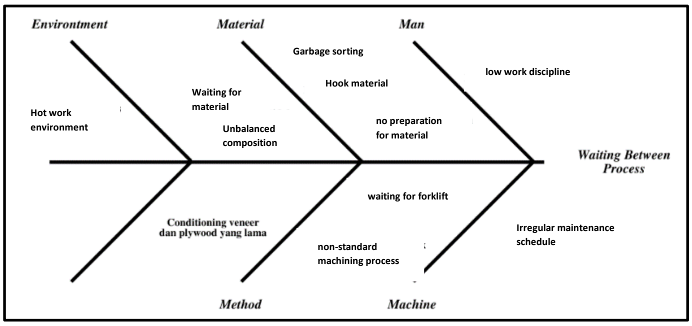


Figure 3. Fishbone waiting between process diagram.

b. Cause of defect

Based on the results of CTQ measurements, delamination waste is the selected waste for analysis of the causal factors. The following are the factors that cause delamination, shown in Figure 4.

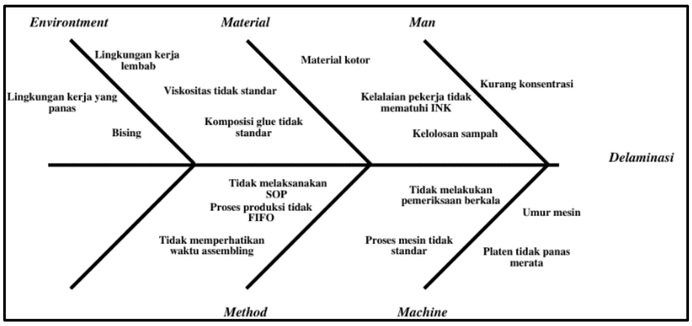


Figure 4. Fishbone defect diagram.

Based on the fishbone diagram analysis, it is known that the waste defect delamination occurs because the production process is not FIFO, the machining process is not standard, the glue composition is not standard, the negligence of the workers does not comply with the INK, the work environment is too hot or humid, and so on.

c. Cause of overproduction

Based on the results of CTQ measurements on overproduction waste, the waste chosen to be analyzed for causes is waiting for overproduction WIP. The following is a fishbone waiting for an overproduction WIP diagram shown in Figure 5. Based on the fishbone diagram analysis results, it is known that the WIP overproduction waste occurs due to not carrying out regular inspections, the quality of the logs is not following the grading log, not controlling the production plan non-standard machine processes, and so on.

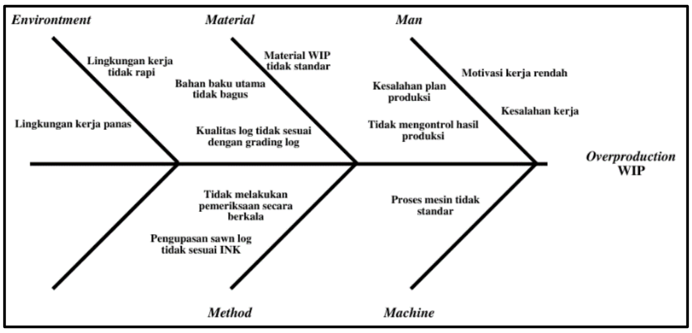


Figure 5. Fishbone overproduction diagram of WIP.

3.4. Improve

3.4.1 Failure Mode and Effect Analysis (FMEA)

FMEA is a methodology used to identify potential failures and prevent errors from occurring (failure mode). FMEA will seek to increase the product's reliability by eliminating the failure mode. The following are the results of the FMEA assessment to determine the priority recommendations for improving the plywood production process, as shown in Table 9. Besarnya nilai RPN menyatakan bahwa apabila nilai suatu RPN semakin besar maka semakin tinggi tingkat urgensi untuk memperoleh penanganan. Berdasarkan Tabel 8 dapat dilihat nilai RPN tertinggi pertama adalah *waste overproduction* sebesar 96 yang diakibatkan oleh kelebihan produksi *work in process* (WIP), nilai RPN tertinggi kedua adalah *waste waiting* sebesar 75 yang diakibatkan oleh menunggu antar proses, dan nilai RPN tertinggi ketiga adalah *waste defect* sebesar 72 yang diakibatkan oleh cacat produk delaminasi.

3.4.2 Improvement Recommendations

a. Digitization

Overproduction due to WIP is due to not controlling the planned production plan. According to [16], one way to overcome overproduction is to apply visual control. So the recommendation given is by making a digitization form. The following is an example of a real-time visual control design in a production digitization form shown in Figure 6.

b. Addition of a mini dryer machine

Waiting due to the waiting between processes is due to the long conditioning time of the plywood. According to [17], one way to overcome the waiting between processes is to determine the number of machines used to adjust the capacity and production speed. So, the recommendation for improvement given is by adding a mini dryer. By adding the capacity of the number of mini dryer machines to 2 machines, the production process can be run simultaneously to minimize the queue time. Waiting time after the putty process for 120 minutes can be eliminated so that the NVA time will decrease by 11.85% from 1013 minutes down to 893 minutes. The calculation of the number of machines needed is as follows.

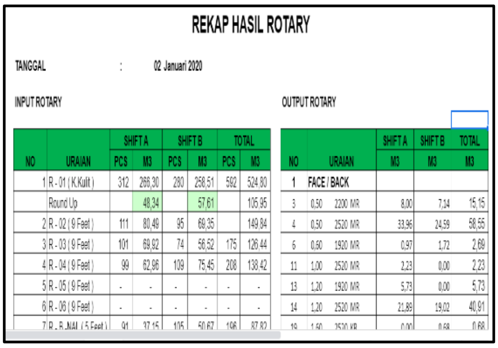
$$P = \frac{pg}{1-p} = \frac{28.13}{(1-0.08)} = 30.58 \text{ m}^3\text{/day}$$

$$N_i = \frac{24.8}{60} \times \frac{30.58}{11 \times 0{,}9} = 1.27 \approx 2 \text{ mini dryers}$$

Table 9. FMEA priority recommendations.

CTQ	S	Factor	O	Improvement recommendations	D	RPN
Waiting between process	5	No material input preparation	2	Preparing materials for the next shift	2	23
		Conditioning veneer and old plywood	4	Adding a mini exhaust fan and dryer	4	74
		Unbalanced composition	3	Carry out control on the grade of the main raw materials	2	33
		Waiting for the forklift to transfer materials	4	Added deck roll work tool	3	56
		The working environment in this company is hot and noisy	3	Adding a fan in every corner	2	25
WIP	7	Not controlling the planned production plan	4	Creating digital forms as a control tool	3	92
		Log quality does not match log grading	3	Controlling grading logs based on standard parameters	2	48
		Stripping sawn logs does not match the soup	3	Applying INK	3	62
		Non-standard machining process	2	Perform machine inspection before processing	2	29
		Environmental conditions and work area are not tidy	2	Putting materials in their proper place	2	29
Delamination	5	Employee negligence and not following INK	4	Employee training and confirming the implementation of INK	2	44
		Non-standard glue composition	2	Checking viscosity after mix	2	21
		The glue melting on the glue spreader machine is uneven	4	Periodically check the availability of the glue load on the rubber roll	3	49
		The production process is not FIFO	5	Implementing the Kanban system	3	71
		The working environment in this company is hot and noisy	2	Adding a fan in every corner	2	22

a.



REKAP HASIL ROTARY

TANGGAL : 02 Januari 2020

INPUT ROTARY

NO	URAIAN	SHIFT A PCS	SHIFT A M3	SHIFT B PCS	SHIFT B M3	TOTAL PCS	TOTAL M3
1	R - 01 (K.Kulit)	312	266,30	280	258,51	592	524,80
	Round Up		48,34		57,61		105,95
2	R - 02 (9 Feet)	111	80,49	95	69,35		149,84
3	R - 03 (9 Feet)	101	69,92	74	56,52	175	126,44
4	R - 04 (9 Feet)	99	62,96	109	75,45	208	138,42
5	R - 05 (9 Feet)	-	-	-	-	-	-
6	R - 06 (9 Feet)	-	-	-	-	-	-
7	R - B.NAL (5 Feet)	91	37,15	105	50,67	196	87,82

OUTPUT ROTARY

NO	URAIAN	SHIFT A M3	SHIFT B M3	TOTAL M3
1	FACE / BACK			
3	0,50 2200 MR	8,00	7,14	15,15
4	0,50 2520 MR	33,96	24,59	58,55
6	0,60 1920 MR	0,97	1,72	2,69
11	1,00 2520 MR	2,23	0,00	2,23
13	1,20 1920 MR	5,73	0,00	5,73
14	1,20 2520 MR	21,89	19,02	40,91
19	1,60 2520 KR	0,00	0,68	0,68

b

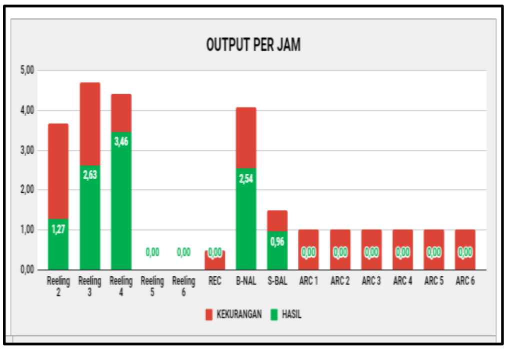
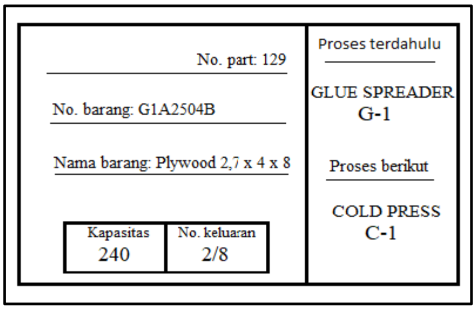


Figure 6. - (a) Digitization form design 1; (b) Digitization form design 2

c. Kanban system implementation

The defect due to delamination is due to the standing time over from the glue spreader to the hot press for more than 4 hours. According to [17], one way to overcome defects is to perform a structured classification and perform a labeling system (Kanban information system). So the recommendation given is to implement the Kanban system. Kanban cards are used to classify the types and quantities of products that must be produced [18]. The design of the retrieval Kanban and the command Kanban for implementing the Kanban system in the related company is shown in Figure 7.

a.



b.

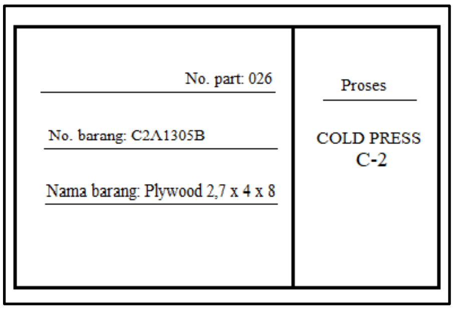


Figure 7. - (a) Kanban card design - take; (b) Kanban card design -command.

4. Conclusion

Based on the data processing results, it can be identified the types of waste in the plywood production process, namely overproduction work in process with a sigma level of 0.00, waiting between processes with a sigma level of 1.52, and defect delamination with a sigma level of 3.71. The factors that cause waste are WIP overproduction waste, including not controlling the planned production plan, waiting between process waste, waiting time for veneer and plywood conditioning, and delamination defect waste, namely standing time over from glue spreader to hot press. Recommendations for improvement for waste to minimize each waste are for overproduction waste, including making digitalization forms, waiting for waste, adding exhaust fans and mini dryers, and defect waste, namely implementing the Kanban system.

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