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Analysis of the Causes of Defects in the Timber Production Process Using the FMEA (Failure Mode Effect Analysis) Method Approach at PT. KQW

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ABSTRACT

PT. KQW is related to quality. Some problems occur during the production process and product results, which are associated with the level of defects in the production process. From historical production data for April 2022 – June 2022, glulam wood products contribute the most defects, both congenital physical defects of the material itself and during the production process. This study aims to identify the level of defects in wood products, determine the factors that cause defects in wood products, and determine the efforts made to reduce the level of damage to wood products. The formulation of the problem in this study is how to control the damage/defects of wood products faced by PT. KQW. This research method uses FMEA. This research resulted in defects in the production process of glulam wood cracks, holes and breaks. The highest types of defect are hollow wood. Identification of the causes of every kind of defect, the order of the highest RPN value for each NG defect. There are 3 solution recommendations based on the highest RPN value for each defect. For cracked wood defects, the highest RPN is because the workers are less thorough (100). Then for hollow wood defects, the highest RPN is due to poor raw materials (147). The highest RPN for broken wood defects is due to less engine pressure (224).

Keywords: *FMEA, Timber Production Process, RPN, Defect, Failure*

Introduction

The role of humans that has been shifted by technology is the impact of the global information age. Another impact of this change in the way of work is the form of transformation that is currently taking place. As long as the transformation has a positive impact and the consequences that arise, it must be able to balance the emergence of current opportunities. Merging digital and internet technology with conventional industries to significantly increase productivity, efficiency, and customer service is a concept for the industrial revolution 4.0. There has been a big leap in business, especially in the industrial sector, by fully utilizing information and communication technology. PT. KQW is a manufacturing company that produces glulam wood. The glulam wood produced is distributed to many countries such as Australia, New Zealand, Netherlands and Belgium. The demand for the company's products is always high[1].

Therefore, the quality of the product produced must be according to standards, including good quality products. The types of wood the company provides include matoa tree wood, linggua tree wood, and merbau tree wood. The quality of a product or service to meet consumer desires can provide a solid impetus to establish bonds between consumers and companies. Good relationships with consumers can make companies more concerned about and understand the desires of very dynamic customers. Quality includes meeting or exceeding consumer expectations with products, services, people, processes and the environment. Quality is a condition that is constantly changing.[2].

Product quality has a significant influence on consumer buying interest. PT. KQW is a laminated wood (glulam) manufacturing company located on Jln. Gresik Veterans. This company produces glulam wood, a wood product in the form of laminated boards stacked and then glued together with glue. The main products made are 4 types: post, beam, decking, and solid finger joint. These products are exported to several countries, including Australia, New Zealand, the Netherlands, and Belgium. Based on data from PT. KQW related to quality. Some problems occur during the production process and product results, which are related to the level of defects in the production process[3]. Data on wood product defects at PT. KQW, can be seen in the table below:

Table1. Data on Defects in Wood

Defect type	Information	April	May	June	Total
Cracked	OK	9,450	9,770	6,900	26,120
	NG	135	170	85	390
Broken	OK	6,453	6,450	11,557	24,460
	NG	170	193	90	453
perforated	OK	12,365	6,450	9,325	28,140
	NG	195	167	95	457

Every company has a tolerance limit for the quality of its products. If the quality of the product is outside the tolerance limit, the company must control this situation so that the company does not experience losses. Product quality that is not as expected can occur due to machine, operator, or work environment errors. If an error occurs on the machine, then corrective action must be taken on the machine, as well as the operator and the work environment, if an error occurs in this section, the company must make improvements to the operator and the work environment. Based on data from PT. KQW related to quality, some problems occur during production and product results. These problems are associated with the level of defects in the production process. From historical production data for April 2022 – June 2022, glulam wood products contribute the most defects, both congenital physical defects of the material itself and during the production process[4].

Based on the background explanation above, the authors are interested in conducting further research on quality control and reducing product defects with the title "Analysis of the Causes of Defects in the Timber Production Process Using the FMEA (Failure Mode Effect Analysis) Method Approach at PT. KQW. FMEA is a technique used to define, identify, and eliminate failures and problems in the production process. It performs value weighting and sorting based on the Risk Priority Number (RPN).[5],[6]. Failure Mode And Effect Analysis (FMEA) is a structured procedure to identify and prevent failure modes that may occur. A failure mode includes a defect, a condition outside of established specifications, or a change in the product that causes the product to malfunction.[7],[8].

Research Methods

This study uses secondary data from direct interviews with respondents whom the researcher has determined and to obtain historical product data and product defects. This study uses the FMEA method, FMEA is a structured procedure to identify and prevent as many failure methods as possible. FMEA is used to identify the sources and root causes of a quality problem. FMEA employs a tabling method to aid the thought process used for engineering to identify potential failure modes and their effects. FMEA is a technique of evaluating a system's level of reliability to determine the system's effects of failure. The following is a flowchart image from research on companies. Figure 1 is a research stage[9].

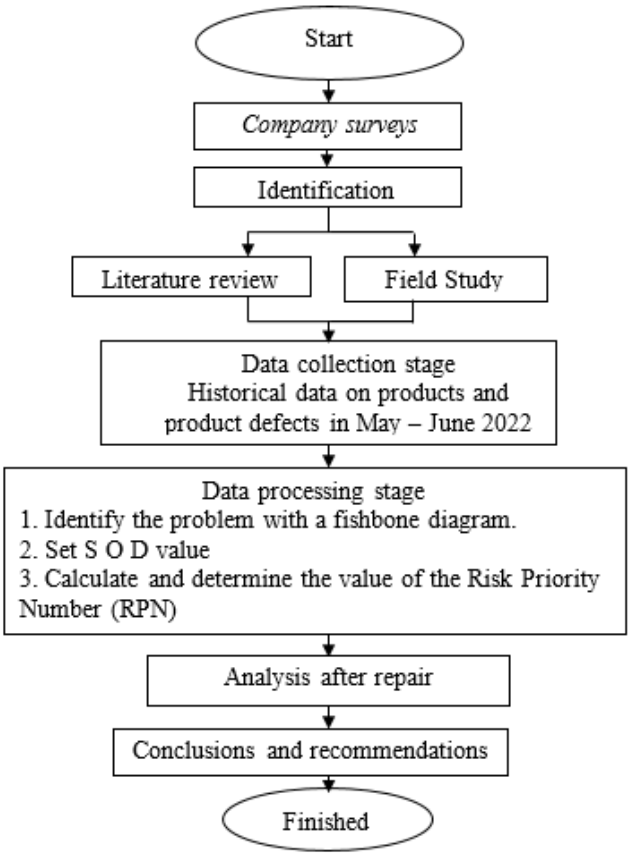

Figure 1. Research Stage

Company Survey

At this stage, the initial survey is needed because it is intended to find out the real conditions to be studied. This avoids any discrepancy between the aims of the researcher and the condition of the research object[10].

Formulation of the problem

The problem formulation is done after identifying the problem, and identifying the problem is done to formulate the issue at hand[11].

Library Studies

A literature study is a collection of literature as supporting material for the problem-solving process. Literature study information is taken from reference books and research journals that will help with research steps and problem-solving [12].

Field Study

Field observation studies are company research used to find out the situation and conditions that exist in the company so that problems can be found[13].

Data collection

At this stage, data is collected and later used in data processing. The data used are historical production data and product defect historical data[14].

Data processing

Furthermore, based on the data collection stage, which includes procedures for implementing FMEA, including determining the Severity value, setting the Occurance Value, setting the Detection Value, and calculating and determining the Risk Priority Number (RPN), the value of Severity, Occurrence and Detection is obtained then calculating the Risk Priority Number (RPN) value. by multiplying the values of Severity (S), Occurance (O), and Detection (D).

Stages of Data Analysis

At this stage, the Risk Priority Number (RPN) is sorted to determine the priority for improvements that must be made. From the sorting results, an analysis of each value will be carried out to find out which values contribute to the achievement of the RPN value. The study's results will then be used as a reference in making product improvement suggestions[15].

Conclusions and recommendations

Conclude the overall work steps and analysis of the results that have been carried out[16].

Results and Discussion

Data collection

Data collection was carried out in April - June 2022 in the form of historical data on products and product defects, in which the data was obtained through secondary data collection techniques. The data collection is used as a basis for analysis of the data obtained to calculate the percentage of products that comply with the specifications or standards set by the company.[17].

Data on Number of Failures and Defects

In the wood production process, several defects occur in the period from April to June 2022.

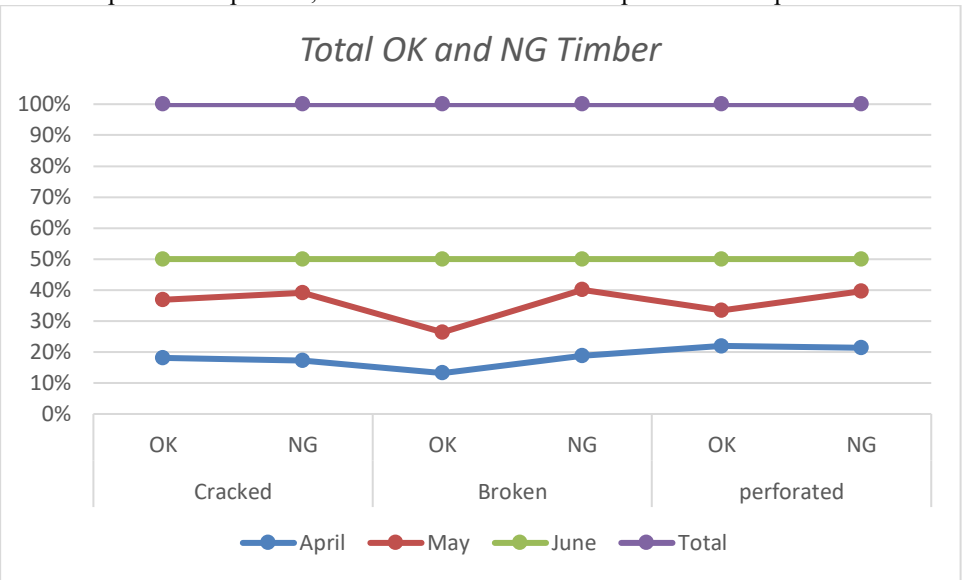

Figure 2. Total OK and NG Timber During April – June 2022 at PT. KQW

Information :
NG = Not Good (disabled)
OK = OK (good, good)
The following is the amount of data on each type of defect in each product at PT. KQW as follows:

Table2. Monthly Disability Recapitulation During April – June 2022 at PT. KQW

Month	Number of Defects of Wood	Defective types of glulam wood products		
		Rprint	Lpit	Broken
April	500	200	160	140
May	530	215	175	140
June	278	108	90	80
Total	1,308	523	425	360

Sources and Root Causes of Defects

Sources and root causes of defects in wood will be identified in this sub-chapter. The method used to determine the root of this problem is brainstorming direct interviews with Mr. M. Imron as the production supervisor, Mr. Arul Harahab as the Quality Control supervisor and Mr. Rusdiyanto as the most senior operator who has mastered each production process and has sufficient experience and has the ability in identifying the sources and root causes of defects in the wood production section.

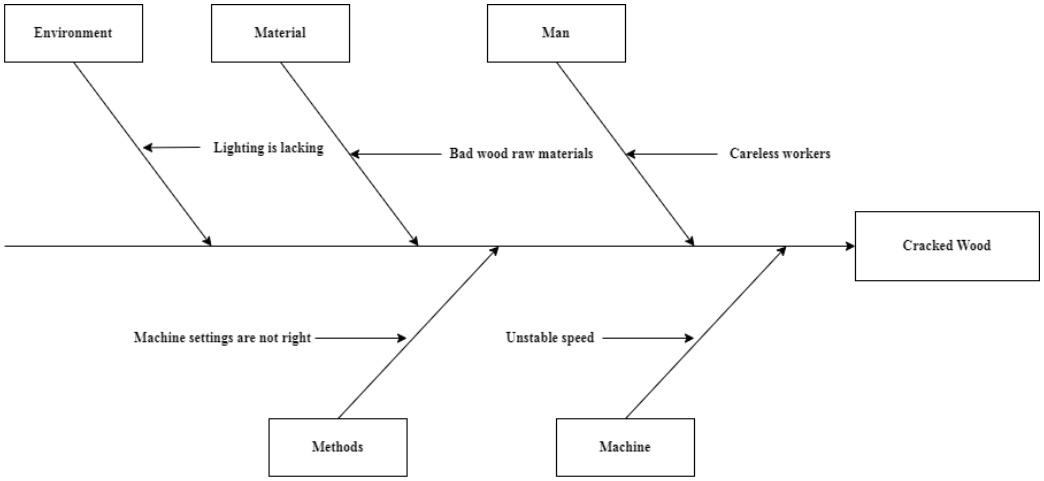

Figure 3. Diagram of Identification of the Occurrence of Cracks in Wood

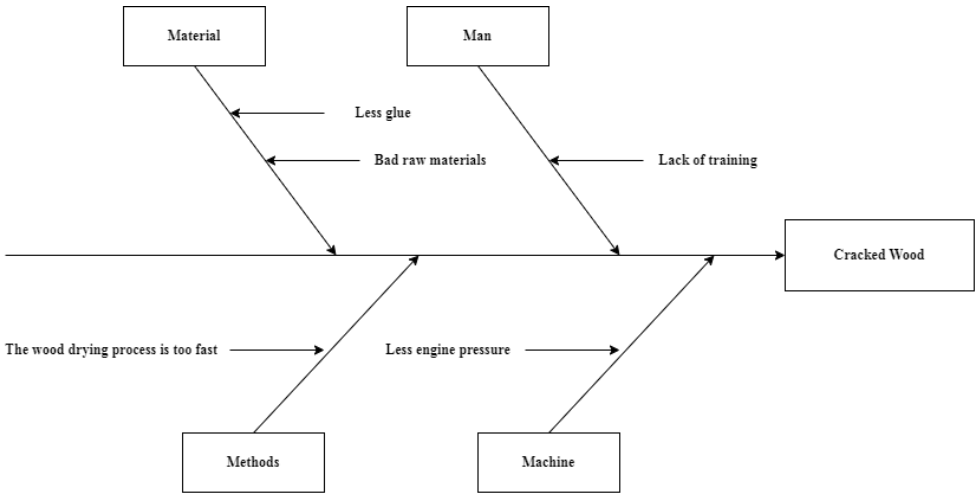

Figure 4. Diagram of the Identification of Cracks in Wood

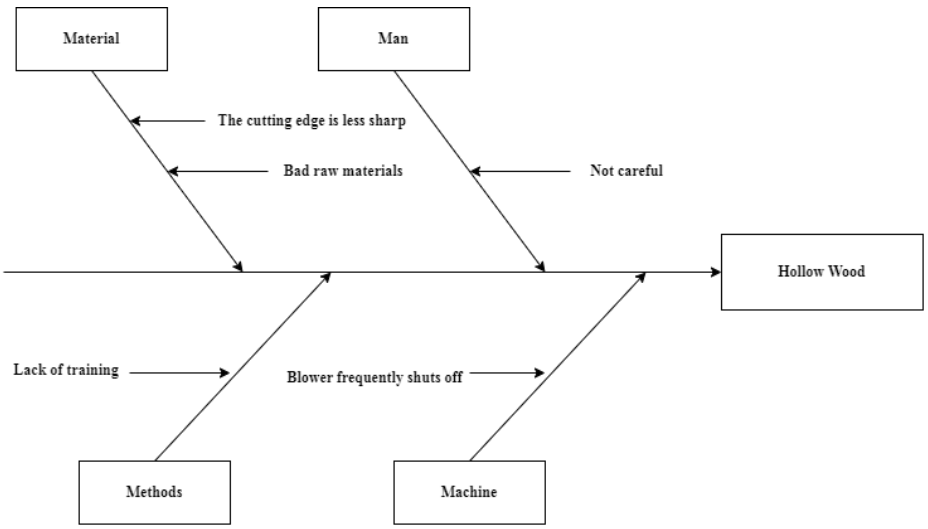

Figure 5. Diagram of Identification of the Occurrence of Holes in Wood

Table 3. Causes of Cracked Wood Product Problems

Defect Type	Cause of Damage
Wood productsRprint	Careless workers
	Bad raw material
	Lighting is lacking
	*Speed*mesin is unstable
	*Fake*the machine doesn't fit

Table 4. Causes of Perforated Wood Product Problems

TypeDisabled	Cause of Damage
Perforated Wood Products	Bad raw materials
	Not Careful
	The cutting edge is less sharp
	Blower frequently shuts off
	Lack of training

Table 5. Causes of the Wood Product Splintering Problem

Type Disabled	Cause of Damage
Wood Products Broken	Less glue
	Bad raw materials
	Less engine pressure
	Lack of training
	The wood drying process is too fast

Data processing

The first stage of data processing is to determine the priority of a form of failure by first evaluating the 3 factors of Severity, Occurrence, and Detection. The final result is the multiplication of the values of the three factors in the form of a Risk Number for those who fill in the importance of the three factors, namely, Mr. Arul Harahab as the Quality Control supervisor, Mr. Imron as the production supervisor, and Mr. Rusdiyanto as a senior operator who has had quite a long experience (5 years) and can assess the condition of defective products in the area (Glulam wood production). If there are gaps when filling in the values of the three factors, brainstorming will be carried out with joint interviews[18].

Severity

Severity is the first step to assess how much impact an event has on process output. The impact assessment is carried out by giving a score on a scale of 1 to 10 which is the worst impact[19].

Table 6. Severity Value of Cracked Wood Products

Defect Type	*Impect*	*Severity*
Cracked wood products	The size of the thickness of the wood is not according to specifications	5
	The drying process of wood is too fast	3
	High noise	3
	Hot room temperature	4
	Compression firmness will decrease	3

Table 7. Perforated Wood Product Severity Value

Defect Type	*Impect*	*Severity*
Hollow wood products	Reduces the PH of wood so it can't be used	7
	Uneven wood cutting	5
	Causes defects in wood	7
	The production process has stopped	6
	Often experience product defects	4

Table 8. Severity Value of Broken Wood Products

Defect Type	*Impect*	*Severity*
Broken wood products	The wood is exfoliating	6
	Reduces the PH of wood so that wood cannot be used	6
	Timber failed production	7
	Often experience product defects	5
	The adhesive power of wood is not strong	6

Occurrence

Failure Occurrence is the frequency with which the specified cause of the project occurs and results in an assessment on a scale of 1 (rarely) to 10 (almost often) the rate of occurrence of an Occurrence.

Table9. Occurrence Value of Cracked Wood Products

Defect Type	*Cause*	*Occurrence*
Cracked wood products	Careless workers	5
	Bad raw materials	6
	Lighting is lacking	4
	*Speed*mesin is unstable	7
	*Fake*the machine doesn't fit	6

Table 10. Perforated Wood Product Occurrence Value

Defect Type	*Cause*	*Occurrence*
Hollow wood products	Bad raw materials	7
	Not careful	5
	The cutting edge is less sharp	7
	Blower frequently shuts off	6
	Lack of training	4

Table 11. Occurrence Value of Broken Wood Products

Defect Type	*Cause*	*Occurrence*
Broken wood products	Less glue	7
	Bad raw materials	5
	Less engine pressure	8
	Lack of training	4
	The wood drying process is too fast	7

Detection

Detection is a measurement of the ability to detect failures that occur. Assessment of Detection is carried out by giving a value on a scale of 1 to 10, where 10 is a potential failure that is very weak[20].

Table 12. Value of Detection of Cracked Wood Products

Defect Type	*Detection Method*	*detection*
Cracked wood products	Conduct training Against operators	3
	Caulking the cracked area using the wood filler method	3
	Sand the cracked areas of the wood using aluminum oxide sandpaper	1
	Using super glue and halu wood	2
	Applying wood putty	2

Table 13. Perforated Wood Product Detection Value

Defect Type	*Detection Method*	*detection*
Hollow wood products	Caulking the hollow areas using the wood filler method	3
	Be more careful in choosing raw materials	4
	Replace blade	2
	Repair blowers	3
	Provide training to production operators	4

Table 14. Value of Detection of Broken Wood Products

Defect Type	*Detection Method*	*detection*
Broken wood products	should pay more attention to the dose of glue used	3
	*Repairing*product	3
	Glued and glued using clamps again	4
	Provide training to production operators	3
	Operators must comply with SOP standards	3

Risk Priority Number (RPN)

After the Severity, Occurrence and Detection values are obtained, the next step is to calculate the Risk Priority Number (RPN) by multiplying the values of Severity (S), Occurance (O) and Detection (D), using the following formulation: [21]

RPN = S x O x D ..... (1)

Table 15. The value of the Risk Priority Number of Cracked Wood Products

Failure Modes	Failure Effect	S	Cause of Failure	O	Detection Method	D	RPN	rank
Cracked Wood	The size of the thickness of the wood is not according to specifications	5	Careless workers	5	Conduct training for operators	4	100	3
	The drying process of wood is too fast	3	Bad raw materials	6	Caulking the cracked areas using the wood filler method	3	54	
	High noise	3	Lighting is lacking	4	Sand the cracked areas of the wood using aluminum oxide sandpaper	1	12	
	Hot room temperature	4	*Speed*unstable machine	7	Using super glue and halu wood	2	56	
	Compression firmness will decrease	3	*Fake*the machine doesn't fit	6	Applying wood putty	2	36	

Table 16. The Risk Priority Number of Hollow Wood

Failure Modes	Failure Effect	S	Cause of Failure	O	Detection Method	D	RPN	rank
Hollow Wood	Reduces the PH of wood so it can't be used	7	Bad raw materials	7	Caulking the hollow areas using the wood filler method	3	147	2
	Uneven wood cutting	5	Not careful	5	Be more careful in choosing raw materials	4	100	
	Causes defects in wood	7	The cutting edge is less sharp	7	Replace blade	2	98	
	The production process has stopped	6	Blower frequently shuts off	6	Repair blowers	3	108	
	Often experience product defects	4	Lack of training	4	Provide training to production operators	4	64	

Table 17. The value of the Risk Priority Number of Broken Wood

Failure Modes	Failure Effect	S	Cause of Failure	O	Detection Method	D	RPN	rank
Cracked Wood	The wood is exfoliating	6	Less wood	7	should pay more attention to the dose of glue used	3	126	1
	Reducing the PH of the wood so that the wood cannot be used	6	Bad raw materials	5	*Repairing*product	3	90	
	Timber failed production	7	Less engine pressure	8	Glued and glued using clamps again	4	224	
	Often experience product defects	5	Lack of training	4	Provide training to production operators	3	60	
	The adhesive power of krang wood is strong	6	The wood drying process is too fast	7	Operators must comply with SOP standards	3	126	

Improvement Recommendations

To make recommendations for improvement, one must look at the critical causes that cause defects and are considered the most effective and common in the glulam wood production process. The critical cause is taken from the reason with the highest RPN value for each type of defect[22].

Table 18. Recommended Alternatives for Defective Cracked Wood Products

Defect type	Cause with high RPN	Recommendation
Cracked Wood	Careless workers	provide training to each operator, make standard SOPs, so the machine operation standard is the same as that of production operators and sufficient rest time for employees

In this case, this problem can be solved in the way in the table above. The need for insight into the operator during the break time given by the company or when he comes home from work must be appropriately

used to rest so that when working time is focused on carrying out work so that he is thorough in dealing with problems and care about what is it running[23].

Table 19. Recommended Alternatives For Defective Perforated Wood Products

Defect type	Cause with high RPN	Recommendation
Hollow Wood	Bad raw materials	Sorting the raw materials before being put into the production machine and checking the production machine whether the spirit in the machine has been checked and is ready to operate, for the glue part that already has the dosage for the glue mixture it must be right so that when production takes place it will be better and can stick together perfectly

This problem can be solved by the method in the table above. The need for insight into the operator the operation of the machine and must check the tools or machines that will be run before operating so that if there is a spare or other tool that are damaged and need to be replaced immediately, then it must be replaced as soon as possible so as not to hinder the production process[24].

Table 20. Recommended Alternatives for Defective Broken Wood Products

Defect type	Cause with high RPN	Recommendation
Cracked Wood	Less engine pressure	Before running the machine that has been set or the standard settings must be checked again, and what needs to be considered when the machine is running must always be monitored so that if there is excess or lack of pressure, the machine can be immediately re-operated, and before entering the product into the next machine, it must check in advance whether the product can still proceed to the next process or not so that it does not hinder the production process time

In this case, this problem can be solved in the way in the table above. The need for insight into the operator about the operation of the machine and what needs to be paid attention to when the machine is running must always be monitored so that if there is an excess or lack of pressure on the machine it can be immediately set and re-operated so that the problem resolved quickly and does not hinder the production process [25].

As a reference in this study, several previous studies contain data related to the topic proposed by the author and are expected to provide further information regarding the topic of research conducted by the author. Bimby Khrisdamara and Deny Andesta 2022 researched PT Bima using the FMEA and FTA methods for Analysis of the Causes of B44 Head Truck Damage. This study, which targets the problems causing damage to the B44 head truck, uses the FMEA method to show that the failure mode of the B44 head truck unit in the battery section has the highest RPN value of 181 [8]. In contrast to the research that the authors conducted, the authors only used the FMEA method. Macdevis Alala Nasir and Deny Andesta 2022 researched the FMEA Method Approach in the Analysis of Occupational Accident Risk in the Steel Fabrication Unit of PT. XYZ. In this study, we used the FMEA method to show the average RPN value was 43.18 [5]. The difference with this study is that the authors did not identify the risks of work accidents arising from production results. Yohanna Mei Fitriani, Deny Andesta, and Hidayat 2022 researched the Risk Analysis of Damage to FCAW Welding Machines with the FMEA Method Approach PT. Swadaya Graha. The purpose of this study is to analyze the risk of defects from welding machines in the company [6]. The author has a difference, namely, the object of research is very different, and the location of the study is also different.

Conclusion

The conclusions that can be given in this study are defects that occur in the glulam wood production process with cracks, holes and splits, the highest types of defects are hollow wood, identification of the causes of every kind of defect, the order of the highest RPN value for each NG defect, and there are 3 recommended solutions based on the highest RPN value for each defect.

For defects in cracked wood, the causes include inaccurate workers, poor raw materials, insufficient lighting, unstable machine speed, and improper machine settings. Then for defects in wood holes, the causes include harmful raw materials, less sharp cutting edges, blowers often die, and lack of training. As for defects in broken wood, the causes include insufficient dosage of glue, poor raw materials, insufficient machine pressure, lack of training, and the wood drying process being too fast.

For cracked wood defects, the highest RPN is because the workers are less thorough (100). Then for hollow wood defects, the highest RPN is due to poor raw materials (147). The highest RPN for broken wood defects is due to less engine pressure (224).

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