Analysis of Potential Hazards in the Production Process of Railway Passenger Benches Using Hazard Identification, Risk Assessment and Risk Control (HIRARC) and Fault Tree Analysis (FTA) Methods Case Study: PT. Empat Putera Utama Bersama

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Abstract

The increasing competition of companies requires a company to optimize all existing human resources (HR) to minimize risks that can hinder production process activities, PT. Four Putera Utama Bersama is a company engaged in the production of train passenger seats. There are several activities, namely preparation, production, assembly and finishing. The purpose of this study is to find out the type of hazard, and risk assessment with the HIRIARC method, while the FTA method is used to find the root cause of the problem. The results of the analysis will be used to mitigate any risk activities that occur in the production process of train passenger seats. The results of the study showed that there were 4 work activities and 11 work sub-activities that had potential dangers in activities. Risk assessment was obtained 3 activities with potential hazards in the extreme category, 2 activities with potential hazards in the high category, 2 activities with potential hazards in the moderate category and 4 activities with potential hazards in the low category, risk control was carried out on potential hazards that had extreme categoriesnamely pinched by the bench, hands hit by cutters and hands scratched by the bench frame that is still sharp.

Keywords: HIRARC, FTA, *Risk Rating*

1. Introduction

Increasing corporate competition requires a company to optimize all human resources (HR). This is to minimize risks that can hinder production process activities. HR is a human being who works in a company as a driver, thinker and planner to achieve a goal of the company. Human resources play an important role in the success of an organization/company. Occupational safety and health (K3) is to improve and maintain the highest degree of physical, mental and social welfare of all workers in all types of work, avoid the occurrence of health problems caused by work, protect workers at work from risks that arise. Efforts to control risks in the work environment and accident rates vary by industry. Occupational safety and health are good, safe and healthy practices for the work environment and its environment [1][2][3][4] . Occupational safety and health (K3) is able to realize a good work culture, motivation and coaching for employees on the importance of occupational safety [5].

PT. Four Putera Utama Bersama is a company engaged in the production of train passenger seats. In carrying out production activities, companies use production machines and tools that involve workers in controlling and operating them so that production activities have a risk of danger to workers. Work activities include: preparation, production, assembly and finishing.

Preparation is the initial stage of the production process of train passenger benches including: the removal of train passenger benches, the transportation of benches to pick-up to the warehouse and the removal of seats from the bench frame. After the preparation stage, then the production includes: cutting Oscar fabric, setting cisamfoam and cutting the iron frame of the bench. Then the assembly process was carried out including: welding the bench frame, sewing cisamfoam on the oscar fabric and installing the seat on the bench frame. After everything is completed, the finishing stage is carried out, namely: transporting the train passenger bench to Balaiyasa and installing the train passenger bench on the carriage.

Based on data on work accidents at PT. Four Joint Principal Sons in 2021 - 2023 It is known that there are several cases that occurred in the production process of train passenger seats, the number of work accidents that occurred was 10 cases. The purpose of this study is to identify risks, assess risks using the Hazard Identification, Risk Assessment and Risk Control (HIRARC) method, the next step is to find the root cause of the problem using the Fault Tree Analysis (FTA) method, and then conduct a risk assessment of the hazard. Work accidents that occur in the preparation, production and assembly sections. The number of cases that occur is due to worker and environmental factors. Efforts to control the risk of potential hazards identified are expected to minimize the occurrence of work accidents by using the Hazard Identification, Risk Assessment and Risk Control (HIRARC) method and the Fault Tree Analysis (FTA) method.

2. Literature Review

Risk

Risk is an opportunity that causes deviations for something unwanted to arise and occur because it causes losses to the company. Risk is an event that can occur due to actions that are not in accordance with normal conditions that have effects on certain people, systems and objects. Risks can occur because there are possibilities that have impacts that can be measured qualitatively and quantitatively [6].

Work Accidents

A work accident is a direct result of work, or an accident occurs at a time when work is being carried out that is unexpected. Accidents in companies clearly harm the company in terms of time and cost. The factors that cause accidents come from human factors and work environment factors such as fatigue and lack of knowledge of workers about their work. K3 is very important for companies to carry out the production process, so that it can run well [7][8].

Occupational Safety and Health

Occupational safety is safety related to several important factors such as machine tools and supporting equipment, raw materials, production processes, and the work environment. Awareness of K3 culture in companies is still low, this results in a high number of work accidents in the industrial world, the main cause is the negligence of operators or workers when doing work. K3 is a regulation that has a legal basis that must be implemented by companies, workers and related parties. Occupational safety and health is an effort to protect workers to carry out work activities in the company so that it can ensure health and safety, so as to create high productivity performance [9][10].

Hazard Identification, Risk Assessment and Risk Control (HIRARC)

The HIRARC method is a OSH management system to identify, assess and mitigate risks that may occur in the workplace. The HIRARC method is a structured approach to identify, evaluate, and control hazards that may occur when workers perform their work, aiming to achieve work productivity [11].

3. Methods

This type of research is used and designed using a qualitative approach that aims to analyze the risk of work accidents that may occur based on the potential hazards that exist during the production process activities of PT. The Four Principals Together use the Hazard Identification, Risk Assessment and Risk Control (HIRARC) and Fault Tree Analysis (FTA) methods.

The FTA method is an analysis technique that can be used to identify the root cause of potential risks and find solutions to mitigate them [12]. Fault Tree Analysis (FTA) is an analytical tool that graphically translates the combination of faults that cause system failures. This technique is useful for describing and assessing events within the system, the causative factors will be displayed on the error tree [13].

Table 1. Hazard Identification

No	Activity	Sub Activities	Potential Hazards	Risk
1	Preparation	1. Removal of train passenger benches from carriages	1. Eye affected by grinding debris	1. Vision impairment 2. Eye irritation
		2. Transport of benches to pick-up to warehouse	2. Slip 3. Hit by a train passenger bench	3. Sprained leg 4. Minor injury
		3. Removal of the seat from the bench frame	4. Pinched bench	5. Injured hand
2	Production	4. Oscar cloth cutting	5. Hand cut by a cutting tool	6. Sliced hands
		5. Cisamfoam setting	6. Hand hit cutter	7. Scratches
		6. Bench frame iron cutting	7. Eyes exposed to grinding splashes	8. Vision impairment 9. Eye irritation
3	Assembly	7. Bench frame welding	8. Electrocuted 9. Hand ignited welding machine	10. Burns
		8. Cisamfoam sewing on oscar fabric	10. Hand exposed to sewing machine	11. Torn hands
		9. Seat mounting on the bench frame	11. Hands scratched by the frame of the bench that is still sharp	12. Torn hands 13. Scratches
4	Finishing	10. Transportation of train passenger seats to Balaiyasa	12. Slip 13. Slipped on the train passenger bench	14. Sprained leg 15. Minor injury
		11. Installation of train passenger benches on carriages	14. The floor of the train car caught fire due to being hit by a welding machine	16. Burns

Based on table 1, it can be seen that there is a potential danger from the production of train passenger seats. It was found that there were 4 activities, namely preparation, production, assembly and finishing. From the table, it consists of 4 activities, 11 sub-activities, 14 potential hazards and 16 risks. The risk assessment calculates the degree of likelihood (likelihood) with the severity (severity) of the following risk assessment table 2.

Table 2. Risk Assessment

No	Activity	Sub Activities	Potential Hazards	Risk	Code	L	S	(LxS)	Level Risk
1	Preparation	1. Removal of the train passenger bench from the carriage	Eye affected by grinding debris	Vision problem, Eye irritation	P1	2	3	6	M
		2. Transportation of benches to pick-up to the warehouse	Slip, Hit by a traiPassenger bench	Sprained leg, Minor injury	P2	2	2	4	L

		3. Removal of the seat from the bench frame	Pinched bench	Injured hand	P3	3	4	12	And
2	Production	4. Oscar cloth cutting	Hand cut by a cutting tool	Sliced hands	PR1	2	2	4	L
		5. Cisamfoam Setup	Hand hit cutter	Scratches	PR2	2	5	10	And
		6. Cutting of bench frame iron	Eyes exposed to grinding splashes	Vision impairmen Eye irritation	PR3	3	3	9	H
3	Assembly	7. Bench frame welding	Electrocuted, Hand ignited welding machine	Burns	PE1	2	2	4	L
		8. Cisamfoam sewing on oscar fabric	Hand exposed to sewing machine	Torn hands	PE2	3	2	6	M
		9. Seat mounting on the bench frame	Hands scratched by the frame of the bench that is still sharp	Torn hands, Scratche	PE3	4	3	12	And
4	Finishing	10. Carriage of train passengers to Balaiyasa	Slip, Hit by a train passenger bench	Sprained leg, Minc injury	F1	2	4	8	H
		11. Installation of benches on carriages	The floor of the train car caught fire due to being hit by a welding machine	Burns	F2	1	2	2	L

It is known that from the risk assessment in the production process of train passenger seats, preparation activities for the release of train passenger seats from carriages have a category of moderate With a value of 6, the transport of benches to pick-up to the warehouse has the category Low With a value of 4, the removal of the seat from the bench frame has a category Extreme with a score of 12. Oscar fabric cutting production activities have categories Low With a value of 4, Cisamfoam setting has a category Extreme With a value of 10, the bench frame iron cutting has a category High with a score of 9. The assembly activities of bench frame welding have categories Low With a value of 4, Cisamfoam sewing on Oscar fabric has a category moderate With a value of 6, the installation of seats on the bench frame has a category extreme with a score of 12. Finishing activities for transporting train passenger benches to balaiyasa have a category high with a value of 8, the installation of train passenger benches on carriages has a category Low with a value of 2.

After conducting a risk assessment by giving a score likelihood and severity , then the value is multiplied so that the results of the risk level assessment are obtained. The analysis using FTAs aims to identify whether the system has failed. This analysis focuses on critical categories. Extreme categories can be seen in the following table 3.

Table 3. Extreme Category Risk Assessment

No	Activity	Sub Activities	Potential Hazards	Risk	Code	L	S	(LxS)	Level Risk
1	Preparation	Removal of the seat from the bench frame	Pinched bench	Injured hand	P3	3	4	12	E
2	Production	Cisafoam setting	Hand hit cutter	Scratches	PR2	2	5	10	E
3	Assembly	Seat mounting on the bench frame	Hands scratched by the frame of the bench that is still sharp	Torn hands Scratches	PE3	4	3	12	E

Table 4. Risk Matrix

Likelihood	Consequence				
	1 (Insignificant)	2 (Minor)	3 (Moderate)	4 (Major)	5 (Catastropich)
5 (Almost Certain)					
4 (Likely)			PE3		
3 (Moderate)		PE2	PR3		
2 (Unlikely)		P2, PR1, PE1	P1	F1	PR2
1 (Rare)		F2			

The results of the matrix preparation above are known that there are 3 potential hazards included in the extreme risk category, namely the activity of removing the seat from the bench frame, setting the cisamfoam and installing the seat on the bench frame. There are 2 work activities in the high risk category, namely cutting the iron frame of the bench and transporting the train passenger bench to Balaiyasa. 2 potential hazards are in the moderate risk category, namely the removal of the train passenger bench from the carriage and the sewing of cisamfoam on the Oscar fabric. Meanwhile, 4 potential hazards are included in the low risk category, namely work activities of transporting benches to pick-up to the warehouse, cutting Oscar fabric, welding bench frames and installing train passenger benches on carriages.

Furthermore, risk mitigation is carried out to prevent and reduce the occurrence of work accidents. mitigation is prepared based on the highest level of risk, namely by improving the standard work procedures (SOP) in each sub-activity. Changes in the way of working are recommended for sub activities, among others. Sanctioning workers who do not wear PPE, giving reprimands to workers who are joking chili sauce, wearing gloves, giving warnings to cisamfoam setting areas, wearing safety glasses, using masks.

4. Results and Discussions

Based on the results of the research conducted, the conclusion is as follows:

The results of hazard identification are known that there are 4 potential hazards found, namely preparation, production, assembly and finishing. And there were 11 sub-activities and 14 potential hazards and 16 risks were found. 4 potential hazards with low risk, 2 potential hazards with moderate risk, 2 potential high risk hazards and 3 potential extreme hazards. Potential hazards with extreme risk categories include: the activity of removing the seat from the bench frame with the risk of hand injury with a value of 12, the activity of setting cisamfoam with the risk of scratches with a value of 10 and the activity of installing a seat on a bench frame that is still sharp with a value of 12.

The results of the risk assessment obtained the findings of 3 extreme category risks , namely in the preparation activity of removing the seat from the bench frame has a likelihood value of 3 and severity of 4 and a Risk Factor Number value of 12, then the cisamfoam setting production activity has a likelihood value of 2 and a severity of 5 and a Risk Factor Number value 10, and the assembly activity of installing seats on the bench frame has a probability value of 4 and a severity of 3 and a Risk Factor Number of 12.

The risk control proposal is carried out on potential hazards with extreme categories. There are 4 risk controls in preparation activities, namely: the company must make strict sanctions rules so that

workers do not underestimate the potential danger of work accidents, in every activity it is necessary to be supervised by production supervisors and give reprimands to workers who are joking and other activities. 3 recommendations for production activities are: the company gives warnings to workers who will later be posted in the work area, clean the work area when the activity is completed and use glasses and masks during activities. 4 control recommendations for assembly activities are: the company provides training and direction and sanctions workers if anyone violates, the company must provide gloves, give directions on safe work procedures and give warnings to be attached to these activities and in this case the company must carry out quality control first.

4. Conclusions

Based on the research that has been conducted, the researcher's suggestions are as follows: The company should monitor the risks identified in the activities that are the most important or that have the potential for extreme hazards. The company reviews standard operating procedures (SOPs) and personal protective equipment (PPE) to ensure comfortable and safe working environment conditions. The researcher considered recommendations for companies to improve occupational safety and health (K3).

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