SITEKIN: Jurnal Sains Teknologi dan Industri, Vol. 20, No. 2, June 2023, pp.657 - 665
ISSN2407-0939 prints/ISSN 2721-2041 on line

The Influence Of The Work Environment On Employee Comfort Using The Method Failure Mode And Effect Analysis (FMEA)

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ABSTRACT

Employee performance is a very influential factor in the work system. Therefore, to reduce the wrong side of employee performance, it is necessary to have employee comfort and a work environment to improve a company's quality and optimal performance. This study aims to analyze the effect of employee comfort and work environment on employee performance (at PT. Danwood Nusantara) using the methodFMEA (Failure Mode and Effect Analysis). The types of data used are primary data and secondary data. Data processing using the FMEA method, fishbone diagrams and productivity level calculations. The study results show that from the data obtained through interviews, three variables have a small value (must be corrected): comfort with lighting, room temperature, and noise. Data processing using the Results Analysis method Failure Mode and Effect Analysis (FMEA) shows that three types of work accidents have high RPN values: cutter scratches, pinched storage racks, and sprains when lifting goods. The productivity level in the warehouse is 0.99741 of the 16688 working hours that should have been lost due to work accidents 43 hours 10 minutes. The impact of work accidents can reduce employee productivity, thereby indirectly harming the company.

Keywords: Employee performance, employee comfort, work environment, quality, performance and FMEA method

Introduction

Labor productivity compares the results obtained by labor with the inputs used. The level of labor productivity is influenced by enthusiasm and work comfort factors, which are also affected by work environment factors. In this study, the work comfort is for manual workers. Instead, the course of the production process depends on the workers (operators), for example, because it requires precision. From the description above, it is essential to handle or design a work environment so that it is conducive for workers to carry out their work in a safe and comfortable atmosphere[1]–[9].

The work accident data taken is a history of work accidents throughout 2021 which has been collected based on the results of interviews as follows:

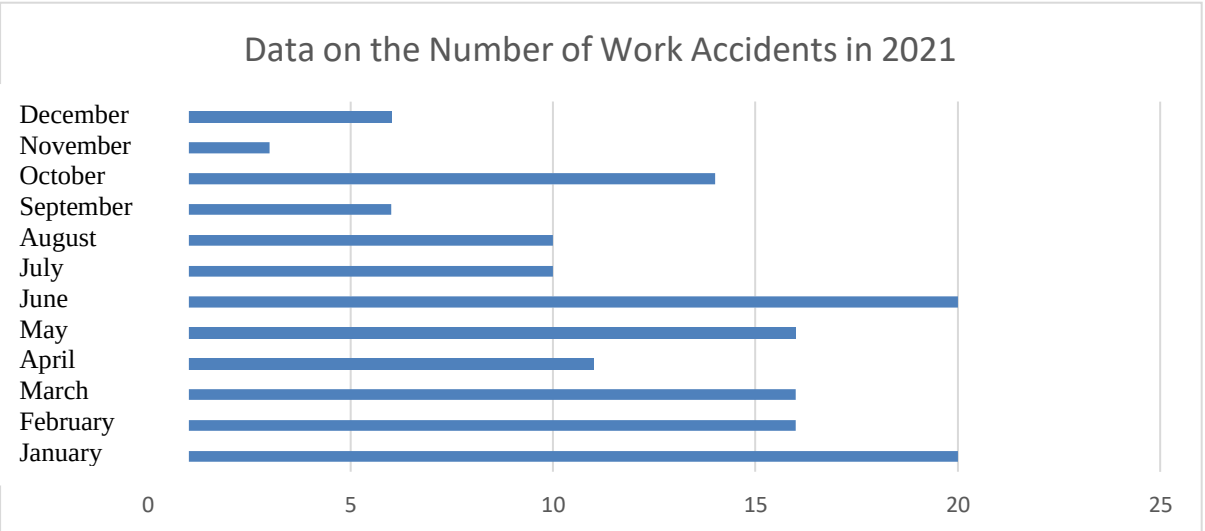
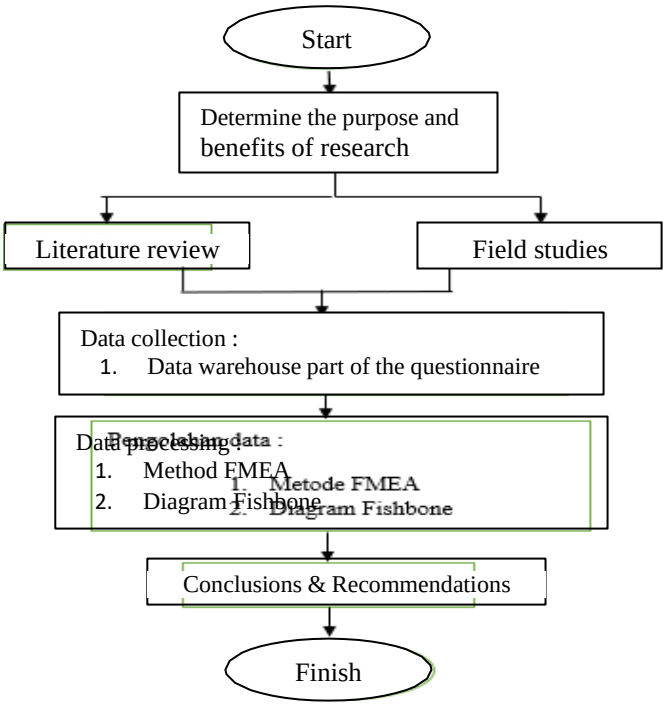


Figure 1. Work accident data in 2021

From one year, 148 jobs took place in the warehouse department of PT. Danwood Nusantara, and during 2021 the most work accidents occurred in January and June, namely 20 work accidents. Meanwhile, the fewest work accidents were experienced in November.

Research Method

The steps of this research can be seen in the flowchart below:



Results and Discussion

Data on Total Hours of Work of Employees

The data used is from working hours of all employees. Based on the results of the interviews it was explained that the number of employees in the production section was 7 people. While the working hours are 8 hours on Monday - Saturday. Then the working hours of all employees will be totaled each month for 2021. Example of calculation: January 2021 has 31 days, there are 5 Sundays, while 1 red date, namely January 1, 2021 (New Year 2021). So there are 25 active working days in January. The calculation is as follows[6], [9]–[15]*:*

(hours worked X number of days worked) X number of workers

= (8 hours x 25 day) X 7 person

= 200 hours X 7 person

= 1400 hours

The calculation results can be seen in the following table:

Table 2. ***Data on Total Working Hours of Employees for 2021***

Month	Number of Labor (Person)	*Total Working Hours/ Month*
January	7	1400
February	7	1288
March	7	1456
April	7	1400
May	7	1176
June	7	1400

July	7	1456
August	7	1344
September	7	1456
October	7	1400
November	7	1456
December	7	1456
Total Number of Hours Worked in 2021		16688 hours

Data on Number and Hours Lost Due to Accidents

The time needed to handle employees who experience work accidents can be seen in the following table:

Table 3. *Determination of the handling time for the type of work accident*

Accident Type	**Handling Time**	**AmountxHandling**
Sandwiched Storage Rack	10 minute	150 minute
scratched cutter	20 minute	35 minute
Stumble pallet	10 minute	42 minute
Exposed to Machine Heat press	20 minute	30 minute
stepped on wheel Hand Pallet	15 minute	40 minute
Sprain When Lifting Items	15 minute	45 minute

Employee Comfort Data

Employee comfort data was obtained through a questionnaire distributed to PT employees. Danwood Nusantara warehouse department with 7 employees. In the questionnaire, the scale used is 1-5 which indicates a value of 1 (very uncomfortable), 2 (uncomfortable), 3 (neutral), 4 (comfortable), and 5 (very comfortable). Employee comfort data obtained are as follows[6]–[8], [14], [16]–[21]:

Table 4. Employee convenience data

Comfort	**Employee**						
	1	**2**	**3**	**4**	**5**	**6**	**7**
Lighting	3	2	3	3	2	4	2
Room Temperature	2	3	2	3	3	2	3
Humidity	4	3	3	4	4	3	3
Air Circulation	3	4	4	3	5	5	4
Noise	2	1	3	2	2	1	2
Relations With Superiors	4	5	3	4	4	3	5
Relations Between Employees	3	5	4	5	4	3	4

From these data, it can be seen that the smaller the scale value, the more uncomfortable the employees are. Conversely, the more significant the scale value, the more comfortable the employees are. Employee comfort with the smallest scale value means that the level of comfort in that variable must be increased.

Method of Failure Mode and Effect Analysis

1. Identify Failure Modes

This is the first step in completing the FMEA method. Identification of failure modes or forms of failure is obtained from observations and also interviews that have been conducted. The identification produces several potential hazards, the potential hazards obtained are based on the hazards that arise in the work process and also from several types of accidents that have occurred. The results of the predetermined hazard potential will later become a failure mode in the FMEA process. The results of the failure mode identification are as follows:

Table 5.*Failure mode*

Parts of body	**Failure Mode**	**Explanation**
Hand	Sandwiched Storage Rack	Hands can get caught in storage shelves
	Scratched cutter	Hands can be scratched by the cutter when cutting plastic
	Sprain When Lifting Items	Sprained hand when lifting objects

	Exposed to Heat Press Machine	Hands blistered from the heat of the electric press
Foot	Stepped on the Hand Pallet Wheel	Feet stepped on heavy hand pallet wheels
	Tripped over the pallet	Feet can trip over pallets in warehouses

Identification of failure modes is carried out to look for hazards that exist throughout the work process from start to finish. After observing and discussing with the workers concerned, six types of hazards were found in the work process. The six types of hazards were grouped into 2, namely accidents that usually occur on the hands and feet. Four types of hazards can occur in hands: pinched by a storage rack, scratched scatter, sprained when lifting goods, and exposed to the heat of a press machine. Meanwhile, two types of hazards can occur on the feet: being caught by a hand pallet wheel and tripping over a pallet.

Identification *Failure Effect, Cause,* dan *Control*

After identifying the failure mode, the next step is identifying the failure effect, cause, and control. The purpose of identifying the failure effect is to find out the effect caused by each failure mode, while the cause is to find out the cause of the failure mode, and control is to find out the control measures that must be done in detecting each failure mode. This identification was obtained through the process of interviews and discussions that have been carried out. The results of the interview are as follows:

Table 6. Identification *failure effect, cause* dan *control*

Failure Mode	Effect	Reason	Control Measures in the Company
Sandwiched Storage Rack	It can cause skin peeling hands	Workers are not focused	Do first aid, then go to the clinic
Scratched cutter	Can tear the skin of workers	No special gloves	Do first aid, then go to the clinic
Sprain When Lifting Items	The sprained part can be swollen	Workers are not strong	Do first aid, then go to the clinic
Exposed to Heat Press Machine	Causes burns	Workers are not focused	Do first aid, then go to the clinic
Stepped on the Hand Pallet Wheel	Bruises on the legs if the load is heavy	The Hand Pallet Driver does not see	Do first aid, then go to the clinic
Tripped over the pallet	Can peel toenails	Workers are not focused	Do first aid, then go to the clinic

Identification Severity Level (*Saverity*)

The saverity failure mode indicates the severity or seriousness of the effects resulting from the failure mode. Meanwhile, the saverity rating is obtained based on the results of discussions that have been carried out with the workforce concerned to produce an assessment sheet that can be seen in the attachment section. The results of the assessment will be used to identify the level of severity as follows:

Table 7. *severity*

Bagian Tubuh	*Failure Mode*	Efek *Failure Mode*	*Saverity*
Hand	Sandwiched Storage Rack	It can cause skin peeling hands	3
	Scratched cutter	Can tear the skin of workers	3
	Sprain When Lifting Items	The sprained part can be swollen	4
	Exposed to Heat Press Machine	Causes burns	2
Foot	Stepped on the Hand Pallet Wheel	Bruises on the legs if the load is heavy	3
	Tripped over the pallet	It may cause leg pain	1

From Table 7, it can be seen that the highest saverity value is sprained when lifting goods that have a safety value of 4. This is because the resulting impact is quite severe, causing swelling in the sprained hand, and recovery of the sprained hand can take 2-3 weeks, during the worker's recovery period. Unable to do the job to the fullest. While the type of accident that has the lowest score is tripping over a pallet with a safety value of 1 because the resulting impact only causes the victim to experience temporary pain in the leg.

Identification of the Level of Frequency (Occurance)

Occurance is the frequency of how often this form of failure occurs due to certain causes. Meanwhile, the occurrence assessment is obtained based on the results of discussions carried out with the workforce concerned to produce an assessment sheet that can be seen in the attachment section[22]–[26]. The results of the assessment will be used to identify the level of frequency as follows:

Table 8. *occurance*

Parts of body	*Failure Mode*	Cause of Failure Mode	*Incident*	*Occurrence*
Hand	Sandwiched Storage Rack	Workers are not focused	Small chance	2
	Scratched cutter	No special gloves	It happens very often	5
	Sprain When Lifting Items	Workers are not strong	Small chance	2
	Exposed to Heat Press Machine	Workers are not focused	Often occur	3
Foot	Stepped on the Hand Pallet Wheel	The Hand Pallet Driver does not see	Small chance	1
	Tripped over the pallet	Workers are not focused	Small chance	2

Based on Table 4 of the results of the occurrence assessment, it can be seen that the type of accident that has the highest occurrence value is a cutter's scratched hand which has an occurrence value of 5 because employees often experience this accident in 2021 alone it has occurred 79 times. At the same time, a hand pallet wheel is stepping on the type of accident with the lowest occurrence value with an occurrence value of 1. This is because employees do not often experience this accident, in 2021, it will only occur ten times.

Identification of Detection Mode Level of Control (Detection)

Detection is a detection mode or control action that is carried out to detect the occurrence of each failure mode. Meanwhile, the detection assessment is obtained based on the results of discussions with the workforce concerned to produce an assessment sheet that can be seen in the attachment section. The results of the assessment will be used to identify the level of control as follows:

Table 9. *detection*

Parts of body	*Failure Mode*	*Detection Method*	*Detection*
Hand	Sandwiched Storage Rack	The possibility of the cause occurring is still high. Prevention methods are less effective. The causes are still recurring.	4
	Scratched cutter	The probability of this happening is high. Prevention methods are less effective. The causes are still recurring.	5
	Sprain When Lifting Items	The probable cause of its occurrence is moderate. Prevention methods may sometimes cause it to happen.	3
	Exposed to Heat Press Machine	The probable cause of its occurrence is moderate. Prevention methods may sometimes cause it to happen	3
Foot	Stepped on the Hand Pallet Wheel	The probability of this happening is very low.	2
	Tripped over the pallet	The possibility of the cause occurring is still high. Prevention methods are less effective. The causes are still recurring.	4

Based on Table 5, the results of the detection assessment show that the type of accident with the highest score is a scratched cutter with a detection value of 5. This is due to the lack of lighting in the cutting area and an uncomfortable workplace which makes this work accident common. Meanwhile, the type of accident with the lowest detection value is being stepped on by hand pallet wheels, which have a detection2 value because the controls that have been carried out are easy to detect errors.

Calculation of Risk Priority Number (RPN)

This calculation is performed to determine which sequence of failure modes should be prioritized first. The RPN value is determined by multiplying each failure mode's saverity, occurrence and detection values sequentially. The saverity, occurrence and detection values used are based on the results of level identification. severity, frequency and control. The RPN calculation can be calculated through the RPN value, namely the failure mode stuck in a storage rack with a saverity value of 3, occurrence of 2, and detection of 4.

RPN = S x O x D
= 3 x 2 x 4
= 24

The calculation results can be seen in the following table:

Table 10. RPN

Failure Mode	*Severity*	*Occurrence*	*Detection*	*RPN*
Sandwiched Storage Rack	3	2	4	24
Scratched cutter	3	4	4	48
Sprain When Lifting Items	4	2	3	24
Exposed to Heat Press Machine	2	3	3	18
Stepped on the Hand Pallet Wheel	3	2	2	12
Tripped over the pallet	2	2	4	16

Based on the table above, the results of sorting priority for work accident handling, it is known that 3 types of work accidents are the most dominant and have a fairly high RPN value. These types of work accidents include being scratched by a cutter with an RPN value of 48, pinched storage racks and sprained when lifting goods, each of which has an RPN value of 24

Handling Priority Sequence

After calculating the RPN value, the next step is to sort the failure mode based on the largest RPN value to the smallest. This is intended to make it easier to prioritize the handling of work accidents that occur. The priority handling order is determined based on the calculation of the RPN value. The priority order of handling can be seen in the following table:

Table 11. Urutan prioritas penanganan kecelakaan kerja

Failure Mode	*Saverity*	*Occurance*	*Detection*	*RPN*
Scratched cutter	3	4	4	48
Sandwiched Storage Rack	3	2	4	24
Sprain When Lifting Items	4	2	3	24
Exposed to Heat Press Machine	2	3	3	18
Tripped over the pallet	2	2	4	16
Stepped on the Hand Pallet Wheel	3	2	2	12

Diagram *Fishbone*

After knowing the sequence of types of work accident hazards based on the RPN value in the FMEA method, the next step is to find the root causes of the most dominant types of work accidents. The types of work accidents taken are from the top three, where the three types of accidents have RPN values high enough. The types of work accidents include the hand being scratched by an iron plate, the finger being caught by a machine knife and the foot tripping. The three types of accidents will be categorized as potential hazards whose root causes will be sought through a fishbone diagram. The benefit of this diagram is that it can help find the root cause of the problem based on several factors. Four main factors influence the problem: humans, machines or equipment, work methods, and the environment.

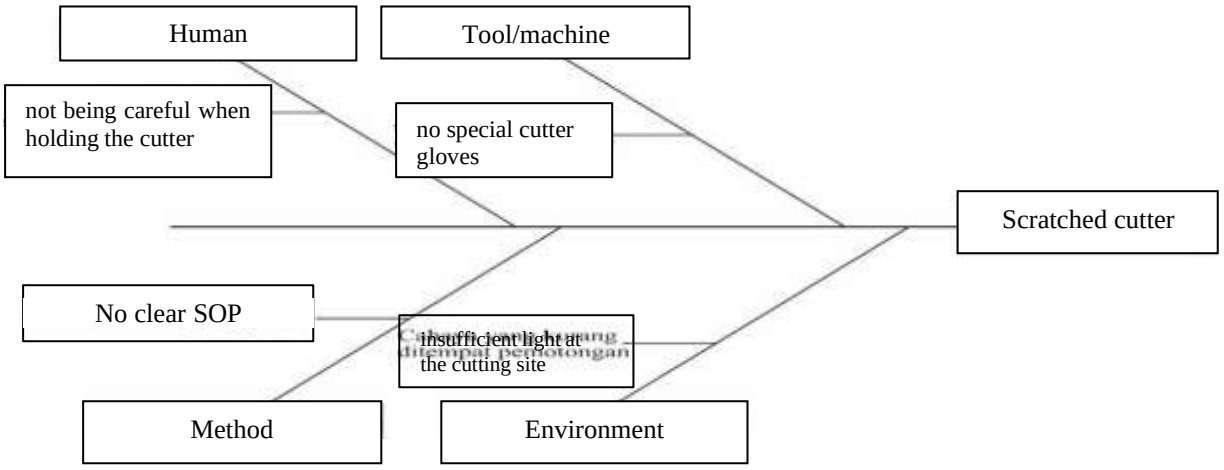


Figure 2. Diagram fishbone scraped cutter

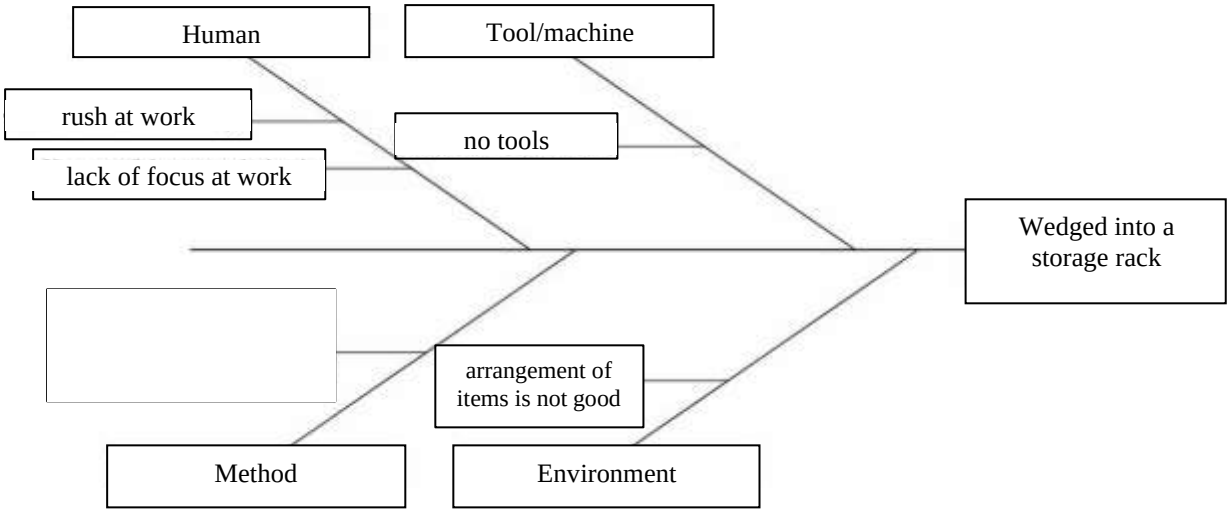


Figure 3. Diagram fishbone wedged into a storage rack

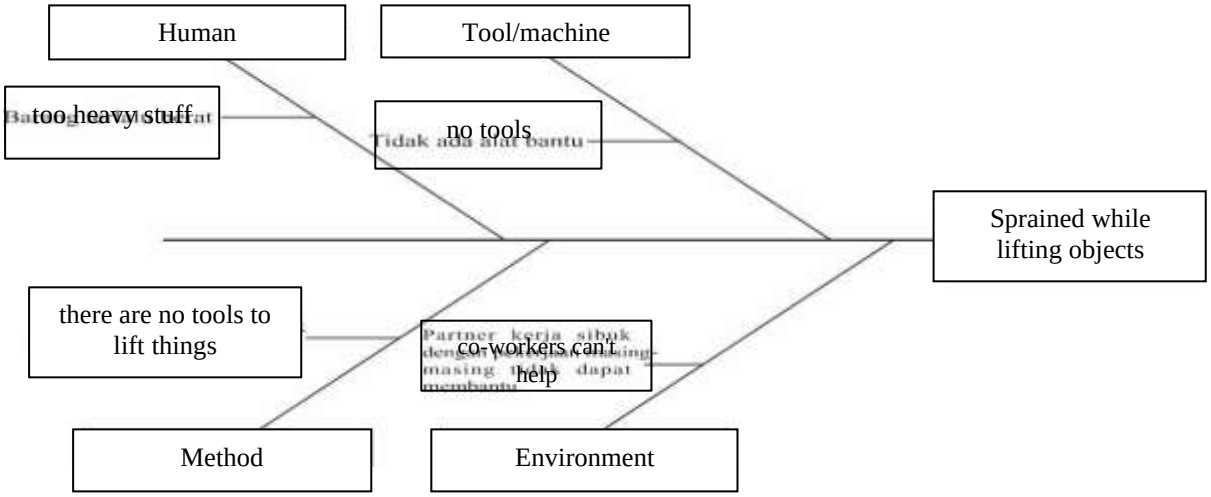


Figure 4. Diagram fishbone sprained while lifting objects

Productivity Calculations

This calculation aims to determine the effect of work accidents on employee productivity. The calculated productivity is per month from January to December 2021. This calculation uses the formula for the number of hours worked by employees/month minus the number of hours lost/month and divided by the total hours worked /month, example:

Formula :(Total hours worked in January – Total hours lost in January) / Total hours worked in January

January = (1400 – 6) / 1400

= 0.995714286

= 0.9957

Productivity calculations can be seen in the following table:

Table 12. Calculation of productivity levels

Month	Number of Working Hours	Number of Hours Lost	Produktivitas
January	1400 hours	6 hours	0,9957
February	1288 hours	4 hours 45 minutes	0,9963
March	1456 hours	4 hours 55 minutes	0,9966
April	1400 hours	3 hours 15 minutes	0,9970
Mei	1176 hours	4 hours 40 minutes	0,9960
June	1400 hours	5 hours 55 minutes	0,9958
July	1456 hours	3 hours 5 minutes	0,9979

August	1344 hours	2 hours 50 minutes	0,9979
September	1456 hours	1 hour 35 minutes	0,9988
October	1400 hours	3 hours 40 minutes	0,9974
November	1456 hours	45 minute	0,9998
December	1456 hours	1 hours 45 minutes	0,9988

Impact Analysis

The impact caused by lost working hours in this case study is small at first glance, but several factors can change our mindset toward work accidents, from the case study at PT. Danwood Nusantara when an employee sprains his hand when lifting goods, the sprained hand can experience swelling while the healing period for sprains is 2-3 weeks in the healing; period when the employee cannot lift heavy objects, this can reduce the amount of labor that should be required. Because this research is conducted in the warehouse department, this will result in a harmful domino effect for the company.

Conclusion

The conclusions obtained from data collection and data processing at PT. Danwood Nusantara, there are several important points. In 1 year of work, there are 148 work accidents. 6 types of work accidents often occur: caught in a storage rack, scratched by a cutter, tripped over a pallet, exposed to the heat of a press machine, and stepped on by a hand pallet wheel and stepped on by a hand pallet wheel. From the data obtained through interviews, three variables have small values (must be corrected): comfort with lighting, room temperature, and noise. Data processing using the Failure Mode and Effect Analysis (FMEA) Result Analysis method shows that there are three types of work accidents with high RPN values: cutter scratches, pinched storage racks, and sprains when lifting goods. The productivity level in the warehouse is 0.99741 of the 16688 working hours that should have been lost due to work accidents 43 hours 10 minutes. The impact of work accidents can reduce employee productivity, thereby indirectly harming the company.

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