Analysis of Workplace Accident Potential in the Spinning Department at PT. Panca Bintang Tunggal Sejahtera, Indonesia Using the HIRA and SCAT Methods

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Abstract. Occupational accidents frequently occurred in the spinning department of PT. Panca Bintang Tunggal Sejahtera, Indonesia, in the past year. The purpose of this study is to minimize the number of work accidents in the department by knowing the risk value, sequence of events, and incidents factors. The research method used is the HIRA method for classifying the risk level of each hazard and the SCAT method for finding factors causing work accidents. According to the HIRA approach, 28 hazards were found in 7 yarn spinning process activities in the spinning department including 3 potential hazards with extreme risk (11%), 10 potential hazards with high risk (36%), 8 potential hazards with medium risk (28%), and 7 potential hazards with low risk (25%). From the SCAT implementation, it is revealed that all activities require control and changes, especially in work process activities where there are hazards with extreme risk. The proposed improvements are to complete the procurement of PPE, add OHS signs, provide outreach and training to all employees related to OHS, and form an inspection team to supervise workers related to OHS.

1 Introduction

An accident is an event that occurs unexpectedly, unwanted, and there is no element of planning that can cause losses, even fatalities and disasters (1). Work accidents not only cause casualties (see, for example, a report by (2)) and material losses for workers and employers (see, for example, (3)), but can also disrupt the overall production process, damage the environment which will ultimately have an impact on the wider community (4)(5). Occupational Disease is a health disorder both physically and mentally that is caused or aggravated due to work activities or work-related conditions (6). It is therefore vital to have a safe working environment (7)(8). Occupational accidents and occupational diseases in the industrial sector in Indonesia are still not well recorded, as one of the factors causing their frequent occurrence is due to lack of worker awareness and inadequate knowledge and skills of workers (9). Based on data from the International Labor Organization (ILO), it is stated that almost every day people die from work accidents or occupational diseases and more than 2.78 million people die every year due to occupational accidents or diseases, including 2.4 million workers (86.3%) die related to occupational diseases and 380,000 workers (13.7%) die due to work accidents, it is estimated that globally lost working days are equivalent to 4% of Global Gross Domestic Product (GDP) and even in some places reach 6% (2).

The occurrence of work accidents starts from the malfunction of management in the company in an effort to implement Occupational Health and Safety (OHS). OHS management that is not running properly in the company will affect the quality of all aspects of the company, both in the quality of its workers and the work environment, so that it will have the potential to create various cases of accidents and occupational diseases that have the potential to cause moral, material and even fatalities. From these problems, so that work accidents are often caused by unsafe behavior (unsafe action) of workers, and unsafe work environment conditions (unsafe conditions), as well as human-related factors such as lack of knowledge and skills (10)(11)(12). The risk of occupational accidents can be reduced by occupational health and safety training (13). The higher the knowledge of workers about OHS, the smaller the risk and vice versa. Occupational Health and Safety is a form of effort to create a workplace that is safe, healthy, free from physical, mental, and environmental pollution, so as to protect workers from work accidents and occupational diseases which will increase work efficiency and productivity. Therefore, it is necessary to have an optimal, effective, and comprehensive OHS management in a
company in order to create a safe and healthy workplace (14,15).

PT. Panca Bintang Tunggal Sejahtera is one of the companies in Sukoharjo Regency, Indonesia engaged in textile. The company has two departments, namely the spinning department and the weaving department. The spinning department is a department that carries out the yarn spinning production process, namely from processing cotton fiber into yarn finished products.

In the yarn spinning production process in the spinning department, the company is aware of the higher potential for occupational accidents and diseases caused by several factors, namely cotton fiber dust and noise, to the potential for accidents. The company has implemented an occupational health and safety management system as evidenced by the existence of the Occupational Safety and Health Committee and the Personal Protective Equipment (PPE) provided by the company. Although the company has formed the Occupational Safety and Health Committee to carry out and handle safety and health efforts in the workplace, but in its implementation of the OHS system the company is still not optimal. It is known that the procurement of PPE in the company is still incomplete; awareness of workers in the use of PPE is lacking, OHS signs are absent; the condition of the work environment is full of a lot of cotton fiber dust flying and high noise; an inspection team with OHS experts who monitor and inspect workers regarding their health and safety when doing work does not exist; and inspection activities are only carried out by the shift head to check the SOP for production implementation. Likewise, based on company data, there is still a fairly high number of work accidents in the spinning department over the past 5 years and even in the form of minor work accidents or accidents that cause total disability. These lead to the need of managing all the risks in the department.

In reducing potential hazards that cause accidents in the spinning department and can have an impact on the production process and company revenue, a risk management is needed, including hazard identification and risk assessment and the cause of accident description. Identifying the hazards and assessing the risks can be carried out by using the HIRA (Hazard Identification and Risk Assessment) method, whereas the SCAT (Systematic Cause Analysis Technique) method enables us to in describing the cause of accidents directly by looking for the root of the problem in the production process by identifying deficiencies in the work safety program. HIRA is one method of analyzing work accidents in order to prevent or minimize the occurrence of work accidents, namely by identifying potential work hazards and defining the characteristics of the hazards that occur, and evaluating the risks that may occur through risk assessment using a risk assessment matrix (16). The SCAT method, in the meantime, is an analytical method used to evaluate and investigate incidents by identifying direct causes, underlying causes, and weaknesses in management controls using the SCAT chart which consists of five parts that affect each other (17).

Research using the HIRA method has been conducted by (18), who examined hazards in the steelmaking industry and found 26 risks classified based on potential hazards, namely 9 High (H) category risks, 7 Moderate (M) category risks and 10 Low (L) category risks, where many work accidents occur are hands injured by work equipment, exposed to dust and heat radiation and exposed to hot metal splashes. Recommendations are given by conducting detailed mitigation of High (H) and Moderate (M) category risks until the risk level drops to the Low (L) category. (19) conducted hazard research by combining HIRA and HAZOP methods in the batik making process in the Batik Merak Manis Laweyan industry. 20 potential hazards were obtained at the printing station with a low risk level of 15%, medium risk level of 15%, and high risk of 65%, with potential hazards originating from the workplace, work attitude, work tools, work procedures, and physical work environment. The proposed corrective actions include technical and administrative improvements. While (20) conducted research on SCAT to identify the causes of work accidents in the vulcanized production process at CV. Wira Vulcanized. The findings of the most frequent causes of work accidents are dangerous work equipment (sharp blades), not using PPE, being hit by tire debris, being hit by heavy loads, and slipping. The recommendation given is to make improvements to the OHS management system at CV Wira Vulcanized. (21), in the meantime, conducted research on work accidents in the paper industry by combining the HIRARC and SCAT methods. 30% of hazards with high risk, 60% medium risk, and 10% low risk were found, and the direct causes of work accidents were obtained, namely worker carelessness, dangerous equipment (sharp knives), and not using PPE. Most of the research analysis conducted in studies using HIRA and SCAT methods only focus on one of the methods, or with the additional help of seven tools analysis. Different from these works, this study analyzes the potential for work-related accidents by integrating the HIRA and SCAT methods, which have never been done before, and also at PT. Panca Bintang Tunggal Sejahtera there has never been research on Occupational Health and Safety (OHS) to analyze the potential for work accidents in the yarn spinning process in the spinning department. Therefore, this research intends to provide information related to the importance of OHS in the yarn spinning industry with proposed controls that are expected to minimize the number and impact of work accidents and create safe work actions in the company.

2 Method

2.1 Object of research

The research was conducted at PT. Panca Bintang Tunggal Sejahtera located in Sukoharjo Regency, Central Java, Indonesia. Research on work accidents was only conducted in the spinning department with the research subjects being operators and workers on duty in the spinning department, while the objects of research were the types, causes, frequency, and severity of work accidents that occurred in the spinning department. There
are 7 activities (see Fig. 1) in the whole yarn spinning process in the spinning department that will be analysed.

![Diagram of yarn spinning process]

**Fig. 1. Flow of yarn spinning process**

### 2.2 HIRA method

HIRA is one of the methods of analyzing work accidents to prevent or minimize the occurrence of work accidents (16). HIRA aims to identify potential hazards in a company to assess the chances of an accident or work loss (22). In the HIRA method, the first step taken is to identify hazards. From this, all the potential dangerous events in each work step contained in the spinning department will be known. The results of hazard identification are then put at a risk assessment process by finding the value of the risk relative (RR), which is the result of multiplying the likelihood value by the severity value of each hazard, so that the risk level (risk rating) is determined. Likelihood shows how likely the accident is to occur, while severity shows how severe the impact of the accident is (23).

The likelihood and severity values will be used to determine the risk rating. Risk rating is a value that indicates whether an existing risk is at a low, medium, high, or extreme level (23). The risk levels are grouped into four, namely, extreme risk (12-25), high risk (6-12), medium risk (3-6), and low risk (1-3). Table 1, Table 2, and Table 3 (24) provide likelihood criteria, severity criteria, and risk matrix scale used in this research.

#### Table 1. Likelihood criteria in the AS/NZS 4360 standard

<table>
<thead>
<tr>
<th>Level</th>
<th>Category</th>
<th>Qualitatively</th>
<th>Explanation</th>
<th>Quantitatively</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Rare</td>
<td>Almost never</td>
<td>Happens but not only in extreme circumstances.</td>
<td>The time span is once in more than 5 years.</td>
</tr>
<tr>
<td>2</td>
<td>Unlikely</td>
<td>It's rare</td>
<td>but it happens at times.</td>
<td>The time span is once in 5 years.</td>
</tr>
<tr>
<td>3</td>
<td>Possible</td>
<td>May happen</td>
<td>Occasionally.</td>
<td>The time span is 5 years (once in 1-5 years).</td>
</tr>
<tr>
<td>4</td>
<td>Likely</td>
<td>It happens</td>
<td>often, and can happen easily.</td>
<td>The time span is 1 year (≥ once in 1 year).</td>
</tr>
<tr>
<td>5</td>
<td>Almost</td>
<td>Happens all</td>
<td>the time, appears in the most common circumstances.</td>
<td>The time span is 1 month (≥ once in 1 month).</td>
</tr>
<tr>
<td>certain</td>
<td></td>
<td>certain</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Table 2. Severity criteria in the AS/NZS 4360 standard

<table>
<thead>
<tr>
<th>No.</th>
<th>Category</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Minor injury</td>
<td>Covers first aid cases or medical treatment required but does not result in work restrictions or loss of working hours.</td>
</tr>
<tr>
<td>2</td>
<td>Moderate injury</td>
<td>Requires medical treatment that causes work restrictions or loss of working hours ≤ 24 hours.</td>
</tr>
<tr>
<td>3</td>
<td>Severe injury</td>
<td>1 case of injury requiring medical treatment resulting in loss of working hours ≥ 24 hours or temporary inability to work and causing production disruption.</td>
</tr>
<tr>
<td>4</td>
<td>Fatal events</td>
<td>There was a case of serious injury or caused 1 case of permanent disability or death and the cessation of all activities.</td>
</tr>
<tr>
<td>5</td>
<td>Disaster</td>
<td>Causes more than 1 case of permanent disability or death.</td>
</tr>
</tbody>
</table>

#### Table 3. Risk matrix scale in AS/NZS 4360 standard

<table>
<thead>
<tr>
<th>Likelihood</th>
<th>Severity</th>
<th>Minor injury</th>
<th>Moderate injury</th>
<th>Severe injury</th>
<th>Fatal events</th>
<th>Disaster</th>
</tr>
</thead>
<tbody>
<tr>
<td>Almost certain</td>
<td>5</td>
<td>L</td>
<td>M</td>
<td>H</td>
<td>E</td>
<td>E</td>
</tr>
<tr>
<td>Likely</td>
<td>4</td>
<td>M</td>
<td>H</td>
<td>E</td>
<td>E</td>
<td></td>
</tr>
<tr>
<td>Possible</td>
<td>3</td>
<td>L</td>
<td>M</td>
<td>H</td>
<td>H</td>
<td>E</td>
</tr>
<tr>
<td>Unlikely</td>
<td>2</td>
<td>L</td>
<td>M</td>
<td>M</td>
<td>H</td>
<td></td>
</tr>
<tr>
<td>Rare</td>
<td>1</td>
<td>L</td>
<td>L</td>
<td>L</td>
<td>M</td>
<td>M</td>
</tr>
</tbody>
</table>

**Description:**

- **Red** = *Extreme*
- **Orange** = *High*
- **Yellow** = *Medium*
- **Green** = *Low*
The risk assessment can be calculated using the following formula:
L x S = Risk Relative .................................................... (1)

Example:
Likelihood value (L) = 4
Severity value (S) = 4
L x S = 16 (Located in the red color, so classified as “Extreme”).

2.3 SCAT method

SCAT is a tool or analysis method developed by ILCI (International Loss Control Institute) which is used to evaluate and investigate incidents by identifying direct causes, underlying causes, and weaknesses in management controls using the SCAT chart which consists of five interrelated parts (17). In the first part, namely the description of the incident which is the condition of the consequences caused by the incident, both humans and objects that experience the incident. The second section contains categories of contact activities about various things that can trigger an incident, this trigger is a direct contact to the incident. The third section contains direct causes that generally lead to an incident/accident which are divided into two categories, namely unsafe acts and unsafe conditions. Unsafe actions are activities carried out by humans that are suspected of causing work accidents such as not using PPE, while unsafe conditions include the work environment or equipment such as work areas with high noise exposure. The fourth section contains the basic causes of an incident/accident caused by three factors, namely, individual factors are all actions taken by humans such as lack of concentration or negligence, work factors related to work methods carried out by workers such as lifting heavy loads manually, management factors or weak control from the company such as lack or absence of supervision from company management. The last part is looking for preventive measures for work accidents (lack of control), which provides recommendations in the form of actions to prevent work accidents and control company losses. The actions taken are actions that are indispensable and can be implemented immediately in order to minimize or eliminate the same or similar events (25).

3 Results and discussion

3.1 HIRA implementation

Hazard identification was carried out on 7 production processes in the spinning department and environmental conditions at each workstation, where 28 types of hazards were obtained. While the risk assessment for each hazard is contained in Table 4.

<table>
<thead>
<tr>
<th>No.</th>
<th>Process</th>
<th>Activity</th>
<th>Hazard</th>
<th>Risk</th>
<th>Risk assessment matrix</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Preparation</td>
<td>Start up the production machines. The process of transporting cotton fiber bales from the raw material warehouse to the production room using a forklift. Transporting and pushing cotton fiber bales with a hand truck trolley to the mixer. Picking up and feeding cotton fiber raw materials in bales to the lattice feed via conveyor (mixing).</td>
<td>Hearing impairment. Forklift accidents <em>(forklift crashes into the surrounding environment or forklift collapses/rolls over).</em> Leg crushed by a hand truck trolley. Fine fiber dust enters the eyes and breathing.</td>
<td>Loss of concentration, deafness. <em>The forklift operator fell/was thrown to injury or death.</em> Fractured leg bones, bruises, pain Red eyes, eye irritation, cough, shortness of breath, lung and respiratory diseases.</td>
<td>5 2 10 <em>(H)</em> 5 3 6 <em>(M)</em> 2 3 6 <em>(M)</em> 5 2 10 <em>(H)</em></td>
</tr>
<tr>
<td>2</td>
<td>Blowing</td>
<td>Pushing the new cotton fiber wipe into the roll feeder of the blowing machine using a wooden stick.</td>
<td>Wooden stick misses and hand gets ground into the roll feeder of the blowing machine. Wooden sticks enter the roll feeder of the blowing machine.</td>
<td>Bleeding, laceration, fracture, severed hand, amputation. Fire.</td>
<td>4 4 16 <em>(E)</em> 2 5 10 <em>(H)</em></td>
</tr>
<tr>
<td>No.</td>
<td>Process</td>
<td>Activity</td>
<td>Hazard</td>
<td>Risk</td>
<td>Risk assessment matrix</td>
</tr>
<tr>
<td>-----</td>
<td>------------------------------</td>
<td>---------------------------------------------------------------------------</td>
<td>------------------------------------------------------------------------------------------</td>
<td>-----------------------------</td>
<td>------------------------</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Separating the cotton fiber wipe rolls from the machine parts, and reassembling the machine parts on the blowing machine components.</td>
<td>A finger was pinched by a blowing machine component.</td>
<td>4 3 12</td>
<td>(H)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Tying and lifting cotton fiber wipe rolls for transfer to the weighing device.</td>
<td>Slipping and falling while walking.</td>
<td>4 1 4</td>
<td>(M)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Placing cotton fiber wadding wipe rolls on carding machine parts</td>
<td>A leg was crushed by a roll of rags.</td>
<td>3 1 3</td>
<td>(L)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Gently feed the cotton fiber wadding cloth into the carding machine plate.</td>
<td>Hands scratched by carding machine plates.</td>
<td>5 1 5</td>
<td>(M)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Making carding slivers, from the cotton fiber lumps that have been broken down by the carding machine and then inserting the cotton fiber description into the carding sliver suction pipe to produce slivers that will rotate on the turn table to be placed in the can.</td>
<td>A finger was pinched by the carding sliver suction pipe.</td>
<td>5 2 10</td>
<td>(H)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cleaning fly waste.</td>
<td>He hit his head on the carding machine.</td>
<td>3 1 3</td>
<td>(L)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Machine maintenance</td>
<td>Ergonomic disorders due to continuous bending and squatting to clean fly waste.</td>
<td>5 2 10</td>
<td>(H)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Each sliver from the 8 cans is drawn and passed over the sliver conveyor, brining roll pair, sliver delivery scoop, and traverse guide while climbing the drawing machine ladder.</td>
<td>A finger was pinched by the carding machine.</td>
<td>4 4 16</td>
<td>(E)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Drawing-Roving</td>
<td>Slipping, tripping, and falling down the drawing machine ladder, and hitting your head on the machine.</td>
<td>4 3 12</td>
<td>(H)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Twisting the sliver from being pulled and pressed by the roll pair in the drafting zone to be fed into the coiler, and correct any lapping.</td>
<td>A finger was pinched by a component in the drafting zone of the drawing machine.</td>
<td>3 2 6</td>
<td>(M)</td>
</tr>
</tbody>
</table>
Based on the results of the risk level determination process in provided in Table 1, of the 28 hazards in the 7 activities of the yarn spinning process in the spinning department, there are 3 potential hazards in the Extreme category (11%), 10 potential hazards in the High Risk category (36%), 8 potential hazards in the Medium Risk category (28%), and 7 potential hazards in the Low Risk category (25%). The extreme risk categories are (a) hands being ground into the roll feeder of the blowing machine; (b) fingers being pinched by the carding machine during grinding; (c) workers’ hair or hoods being caught in the winding of the yarn, which can be seen in Fig. 2.

<table>
<thead>
<tr>
<th>No.</th>
<th>Process</th>
<th>Activity</th>
<th>Hazard</th>
<th>Risk assessment matrix</th>
</tr>
</thead>
<tbody>
<tr>
<td>Close the top arm and cover of the drawing machine in the draftzone section.</td>
<td>Hands are crushed by the top arm or cover of the drawing machine.</td>
<td>Bruised hands, pain.</td>
<td>2 1 2 (L)</td>
<td></td>
</tr>
<tr>
<td>Carrying several rovings on a trolley. Hanging the roving on the hanging rack. Passing the sliver roving to the introductory ring spinning frame machine for the roving spinning process, namely the process of stretching, antihan, and winding where the resulting yarn will be rolled on the bobbin.</td>
<td>The foot tripped over a hole in the floor.</td>
<td>Falls, bruises, sprains, strains, fractures</td>
<td>4 1 4 (M)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Struck by roving.</td>
<td>Scrapes, bruises, pain.</td>
<td>5 1 5 (M)</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Ring Spinning Frame</td>
<td>A finger was pinched by a ring spinning frame machine component.</td>
<td>Bruises.</td>
<td>3 1 3 (L)</td>
</tr>
<tr>
<td></td>
<td>Offing the bobbin tube to remove the bobbin from the spindle of the ring spinning frame machine.</td>
<td>A worker's hair or veil is caught in the winding of the yarn on the ring spinning frame.</td>
<td>Hair is pulled to the point of falling out and the scalp peels off until it bleeds.</td>
<td>4 4 16 (E)</td>
</tr>
<tr>
<td></td>
<td>Picking up bobbin tubes that fell on the floor during the dopping process.</td>
<td>Ergonomic disorders due to bending and squatting to pick up the fallen bobbin tube.</td>
<td>Back pain, injury to the muscles around the neck, joint and bone disorders of the hands and shoulders.</td>
<td>5 2 10 (H)</td>
</tr>
<tr>
<td></td>
<td>Putting the bobbin tube on the creel.</td>
<td>Ergonomic disturbance during the process of placing the bobbin tube on the creel.</td>
<td>Back pain, injury to the muscles around the neck, joint and bone disorders of the hands and shoulders.</td>
<td>5 2 10 (H)</td>
</tr>
<tr>
<td>6</td>
<td>Winder</td>
<td>Men-doffing cone thread.</td>
<td>The yarn cone was thrown into the eye.</td>
<td>3 1 3 (L)</td>
</tr>
<tr>
<td></td>
<td>The process of packing yarn cones with plastic sacks and cardboard boxes.</td>
<td>The foot was crushed by a box containing a cone of yarn.</td>
<td>Bruised eyes, red eyes.</td>
<td>3 1 3 (L)</td>
</tr>
<tr>
<td></td>
<td>The process of transporting plastic sacks and cardboard boxes containing yarn cones to the yarn warehouse using a hand pallet truck.</td>
<td>The foot fell off the yarn cone.</td>
<td>Bruises, chipped fingernails.</td>
<td>3 1 3 (L)</td>
</tr>
<tr>
<td>7</td>
<td>Packing</td>
<td>Leg crushed by a hand truck trolley.</td>
<td>Bruises, pain, fractured leg bones.</td>
<td>2 3 6 (M)</td>
</tr>
</tbody>
</table>

*Description: L (Likelihood), S (Severity), RR (Risk Relative), E (Extreme), H (High Risk), M (Medium Risk), L (Low Risk)
3.2 SCAT implementation

From 28 types of hazards in 7 yarn spinning process activities that occur in the spinning department at PT. Panca Bintang Tunggal Sejahtera, the incidents of work accidents that occur will be investigated and evaluated by identifying direct causes, root causes, and tracing weak management controls (lack of control) using the SCAT method, which is described in the form of a SCAT diagram. The results of the identification of SCAT diagrams for hazards with extreme risks found in the spinning department, namely hands crushed by the roll feeder of the blowing machine, fingers pinched by the carding machine during grinding, and workers’ hair or hoods caught in the winding of yarn can be seen in Fig. 3, Fig. 4, and Fig. 5.

Fig. 2. Hazards with extreme risk in the spinning department

(a) Hazard of hand being crushed by the roll feeder of the blowing machine
(b) Danger of fingers being pinched by the carding machine during processing
(d) Danger of workers’ hair or veils being caught in the winding of the thread
**Description of incident**
Hand rolled into the roll feeder of the blowing machine when going to give assistance in rolling cotton fiber cloth using a wooden stick, but the wooden stick missed and the worker's hand was positioned close to the machine roll which continued to rotate and resulted in the worker's hand being torn until the hand was cut/severed.

**Categories of contact that could have led to the incident**
The trigger for this incident was caused by workers who were not careful and hurried in winding the new cotton fiber wipes, as well as the use of blowing machines that were not yet modern so that the operation still required manual labor assistance, while the workers were not equipped with hand protection equipment.

**Immediate cause**
- **Unsafe action:**
  - The worker's hand is too close to the blowing machine's roll feeder.
  - Workers do not use personal protective equipment (PPE) in the form of safety gloves.
  - Using inappropriate equipment.
  - Rushing to do work.
  - Not implementing SOP properly.
- **Unsafe condition:**
  - The blowing machine's roll feeder rotation speed is 400 rpm.
  - The machine used is still manual.
  - Not yet providing suitable tools to be used in helping the winding process of cotton fiber wipes.
  - The lack of OHS signs in the work area, there are no OHS signs regarding the danger signs of being pinched, crushed, trapped by machines and signs calling for the use of hand protection.
  - The factory conditions are noisy, disrupting workers' concentration.

**Basic cause**
- **Personal factor:**
  - Fatigue.
  - Workers lack focus and lose concentration, resulting in negligence.
  - Lack of knowledge about the importance of occupational health and safety.
- **Job factor:**
  - The working equipment is inadequate, there is no tool used to help the winding of new cotton fiber wipes so only tools in the form of wooden sticks are used.
  - Demand to achieve yarn production targets.
  - Lack of engineering, simulation and training on good, correct and safe work procedures.
  - The position of work stations is close to each other, resulting in noise.
- **Management factor:**
  - Hand protection equipment for workers is not provided yet.
  - Lack of supervision by the inspection team in terms of occupational health and safety.
  - There has been no action to minimize the noise received by workers.

**Activities for a successful loss control program**
- Taking a short break to stretch your muscles because your work activities are always standing.
- Always be alert and maintain concentration when near moving or rotating machinery.
- Providing complete PPE equipment that suits work needs.
- In work areas with the danger of hands being pinched, crushed or trapped in machines, PPE in the form of safety gloves is provided.
- Providing OHS signs in the work area regarding danger signs of being pinched, crushed, trapped by machines, and signs calling for the use of hand protective equipment.
- Replacing the use of wooden sticks by providing appropriate equipment to assist the production process.
- Conducting periodic reviews of the dangers of being pinched, crushed or trapped by machines.
- Increasing workers' awareness of the importance of work safety and the importance of using PPE through regular outreach, appeals and job training.
- An inspection team is formed to carry out regular checks and supervision regarding OHS on the production floor and the condition of the employees who will carry out the work.
- Replacing production machines with more modern machines.
- Taking measures to minimize noise.

Fig. 3. SCAT chart hand milled roll feeder blowing machine
Description of incident

Fingers get caught in carding machine components when oiling the carding machine, which results in the worker's fingers being cut/severed.

Categories of contact that could have led to the incident

The trigger for this incident was caused by workers who were less focused and less careful in oiling the carding machine. Workers do not pay attention to the condition of other components around the carding machine when drilling, so that the worker's fingers are pinched by the carding machine components, while the worker is not equipped with hand protection equipment.

Immediate cause

Unsafe action:

- The position of the worker's hands are too close to the carding machine components is dangerous.
- Workers do not use personal protective equipment (PPE) in the form of safety gloves.
- Workers do not pay attention to the condition of other components around the machine.

Unsafe condition:

- Dangerous machines because they have many dangerous components that can injure workers.
- There were limited amount of OHS signs in the work area.
- There were no OHS signs regarding the danger signs of being pinched, crushed, trapped in machinery, and signs calling for the use of hand protective equipment.
- The factory conditions are noisy, disrupting workers' concentration.

Basic cause

Personal factor:

- Workers lack focus and lose concentration.
- Workers do not pay attention to the position of their hands close to dangerous carding machine components.
- Lack of worker knowledge about the importance of occupational health and safety.

Job factor:

- There is no method or standard for safe and secure machine maintenance.
- Lack of engineering, simulation and training on good, correct and safe work procedures.
- The position of work stations is close to each other, resulting in noise.

Management factor:

- Not yet providing hand protection equipment for workers.
- Lack of supervision by the inspection team in terms of occupational health and safety.
- There has been no action to minimize the noise received by workers.

Activities for a successful loss control program

- Always be alert and maintain concentration when near moving or rotating machinery.
- Providing complete PPE equipment that suits work needs. During the carding machine oiling process, PPE is provided in the form of safety gloves.
- Providing OHS warning signs in the work area regarding danger signs of being pinched, crushed, trapped by machinery, and signs calling for the use of hand protective equipment.
- Conducting periodic reviews of the dangers of being pinched, crushed or trapped by machines.
- Increasing workers' awareness of the importance of work safety and the importance of using PPE through regular outreach, suggestions and job training.
- An inspection team was formed to carry out regular checks and supervision regarding OHS on the production floor and the condition of the employees who will carry out the work.
- Taking measures to minimize noise.

Fig. 4. SCAT chart of finger pinched by carding machine component during processing
Description of incident
The female workers' hair or headscarves were sucked in and attracted by the winding thread when doffing the bobbin tube to remove the bobbin from the spindle of the ring spinning frame machine, which resulted in the workers' hair falling out and the workers' scalp peeling off and bleeding.

Categories of contact that could have led to the incident
During the doffing process, the worker's head is lowered and close to the rotating ring spinning frame machine components for thread winding, while the worker is not equipped with PPE to cover his head so that workers with long hair and workers wearing headscarves are sucked and attracted by the thread winding machine.

Immediate cause

Unsafe action:
- The worker's position is too close to the machine.
- Workers do not use head protection devices in the form of hair caps, hats or headscarves.
- Workers do not pay attention to the condition of other components around the machine.
- Female workers who have long hair do not straighten their hair by tying their hair, and workers who wear headscarves do not straighten their headscarves properly.
- Not implementing SOP properly.

Unsafe condition:
- Dangerous machine.
- Engine rotation without cover.
- Components of the ring spinning frame machine are close to the worker's position, endangering the worker's safety.
- The OHS signs in the work area are limited.
- There are no OHS signs regarding the danger signs of being pinched, crushed, trapped by machinery, and signs calling for the use of head protection or hair coverings.
- The factory conditions are noisy, disrupting workers' concentration.

Basic cause

Personal factor:
- Workers are careless about their surroundings and do not pay attention to the dangers that may occur.
- Lack of knowledge about the importance of occupational safety and health.
- Ignorance of good and safe work procedures.
- On the production floor, female workers’ uniforms are not wore neatly.
- Not implementing SOP properly.

Job factor:
- Demand to achieve yarn production targets.
- Lack of engineering, simulation and training on good, correct and safe work procedures.
- The position of the ring spinning frame machine components is close to the worker's position, thereby endangering the worker's safety.
- The position of the ring spinning frame machine components is close to the worker's position, thereby endangering the worker's safety.

Management factor:
- Not yet providing head protection equipment in the form of hair covers, hats or hoods for workers.
- Lack of supervision by the inspection team in terms of occupational health and safety.
- There has been no action to minimize the noise received by workers.

Activities for a successful loss control program
- Always be alert and maintain concentration when near moving or rotating machinery.
- Providing complete PPE equipment that suits work needs. In work areas where there is a danger of hands being pinched, crushed or trapped in machines, PPE is provided in the form of hair coverings, hats or hoods.
- Providing OHS warning signs in the work area regarding danger signs of being pinched, crushed, trapped by machinery, and signs calling for the use of head protection or hair coverings.
- Conducting periodic reviews of the dangers of being pinched, crushed or trapped by machines.
- Increasing workers' awareness of the importance of work safety and the importance of using PPE through outreach, appeals, and regular work training.
- Forming an inspection team to carry out regular checks and supervision regarding OHS on the production floor and the condition of the employees who will carry out the work.
- Providing cover for rotating machinery.
- Taking measures to minimize noise.

Figure 5. SCAT chart of worker's hair or hood caught in thread rolling

3.3 Proposed control
Hazard control proposals based on the results of the analysis using the HIRA and SCAT methods are
obtained as recommendations to minimize or eliminate the risk of work accidents through hierarchical control of elimination, substitution, engineering control, administrative, and PPE which can be seen in Table 5.

Table 5. Proposed control of work accidents

<table>
<thead>
<tr>
<th>Hierarchy</th>
<th>Causes</th>
<th>Control</th>
</tr>
</thead>
<tbody>
<tr>
<td>Elimination</td>
<td>Workers experience ergonomic problems when lifting cotton fiber wipe rolls from the blowing machine to be transferred to the scales to be weighed in accordance with the provisions.</td>
<td>Improve the layout of production facilities by modifying work areas and work stations to minimize reaching and bending, and providing work surfaces at the right height.</td>
</tr>
<tr>
<td></td>
<td>Workers experience ergonomic problems when performing the process of placing bobbin tubes on the creel of the ring spinning frame machine. Hands were ground into the roll feeder of the blowing machine while assisting with the winding of the cotton fiber wipe using the wooden stick due to the wooden stick missing. The wooden stick missed the worker's grip and entered the roll feeder of the blowing machine and caused a fire.</td>
<td>The company needs to provide more appropriate and adequate tools to replace the use of wooden sticks as auxiliary tools, or the company can update production machines that are still manual by replacing them with more modern machines.</td>
</tr>
<tr>
<td>Substitution</td>
<td>Workers experience ergonomic problems due to lifting 15 kg cotton fiber wipe rolls from the blowing machine to be transferred to the scales. Workers experience ergonomic problems due to cleaning fly waste from cotton fibers that have fallen on the floor by bending and squatting continuously on a regular basis.</td>
<td>The company needs to provide mechanical aids to assist transportation such as using a pallet truck or trolley. The company needs to provide mechanical aids to help scoop up the fallen cotton fibers.</td>
</tr>
<tr>
<td>Engineering</td>
<td>Lack of awareness of the importance of occupational health and safety and the importance of using PPE.</td>
<td>The company needs to increase employees' self-awareness of occupational health and safety and the importance of using PPE through socialization, appeals, and work training related to K3 on a regular basis at least once every two weeks. Personal protective equipment (PPE) is one of the ways that must be done to prevent accidents. By requiring employees to use personal protective equipment (PPE) when doing yarn spinning work in the spinning department will reduce the risk of fatal work accidents. Companies need to implement regulations that require the use of personal protective equipment (PPE), create standard work methods or work safety procedures, and provide signs regarding the appeal for the use of PPE in accordance with the type of work and the risk of harm that can be caused, and strict sanctions for workers who violate the rules and operational standards that have been made.</td>
</tr>
<tr>
<td>Control</td>
<td>There is no requirement to use Personal Protective Equipment (PPE).</td>
<td>Supervision is intended to supervise workers to follow predetermined instructions, namely by supervising and ensuring that workers have used the personal protective equipment (PPE) provided and following work methods correctly and safely. With routine supervision carried out in the company, it will have a good effect on the behavior of the workforce in using PPE. Install OHS signs both at work stations and work equipment or machines that can be used as warning signs so that workers can find out the work area and dangerous machinery and equipment, and as a motivation for employees to always be vigilant in doing work. From the results of direct observations and seeing various types of consequences caused by work accidents, the safety equipment needed in the work of spinning yarn in the spinning department at PT. Panca Bintang Tunggal Sejahtera includes; head protection, hair cover, foot protection, hand protection, face cover, eye protection, mask.</td>
</tr>
<tr>
<td>Administrative</td>
<td>Lack of supervision of employee occupational health and safety</td>
<td>Lack of OHS signs on machines and work areas.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Lack of procurement of Personal Protective Equipment (PPE).</td>
</tr>
</tbody>
</table>
4 Conclusion

The results showed that work accidents that often occur are injuries to the hands such as fingers pinched by blowing machine components, hands scratched by carding machine plates, fingers pinched by carding sliver suction pipes, fingers pinched by carding machines, fingers pinched by components in the drafting zone of the drawing machine, hands crushed by the top arm or cover of the drawing machine, and fingers pinched by ring spinning frame machine components. This is because the work in the yarn spinning process is mostly operated by hand. Likewise, it is known that there are three hazards with extreme risk categories in the hand being ground into the roll feeder of the blowing machine, the fingers being pinched by the carding machine during grinding, and the worker's hair or hood being caught in the yarn winding. These three hazards are categorized into extreme risk because they occur several times based on company history and cause severe injury to permanent disability. Factors causing work accidents are caused by unsafe human acts, such as not wearing PPE, not working according to procedures, working with improper posture, lack of concentration when near moving or rotating machines, fatigue, boredom, and so on. In addition to human factors, it is also caused by environmental factors (unsafe conditions) such as machines without safety guards, inadequate work equipment, high exposure to cotton fibre dust and noise, slippery work floors and damage such as holes, and the lack of K3 signs in the work area. These two factors also occur due to the non-optimal OHS management system, where the current OHS system has no evaluation of improvements, as well as the absence of an inspection team with OHS experts who monitor and inspect workers regarding occupational health and safety during work. The control proposals given are based on the hierarchy of elimination, substitution, administrative, and PPE controls which are expected to prevent, reduce, and even eliminate the risk of work accidents (zero accident) in the company, to create a safe, healthy workplace, and avoid physical, mental, and environmental pollution, so as to protect workers from work accidents and occupational diseases.

References

19. Suhardi B, Laksono PW, V.E. AA, Mohd.Rohani J, *Corresponding author: Eko.Seriantawan@ums.ac.id


