Work Hazard Risk Analysis and Control in Grey Finishing Department Using HIRARC (Hazard Identification, Risk Assessment and Risk Control)

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Abstract. PT. Primissima (persero) engaged in textile manufacturing. PT. Primissima (persero) processes raw materials cone thread become a grey or calico cloth through weaving process. As a manufacturing industry, workers at PT. Primissima (persero) are integrated with the plant facilities such as the production floor, machines, equipment, and warehouse. It potentially carry hazard risk in the form of work accident and occupational illness. Grey finishing department at PT. Primissima (persero) has a role to ensure product that produced has good quality through inspection and folding activities. Based on observation, there are several potential significant hazard such as air pollution, scrap exposure, and also physiological hazards such as aches to environmental hazards, electrical hazards and fire hazards. So, is necessary to apply a control through hierarchy of control. The results of this research contribute to solve the problem of the and give solutions of the company regarding risk controls.

1. Introduction
In manufacturing industry, high productivity is obtained by considering the activity of transforming raw materials into finished goods. Human labor or workers as the main pillar of the running of the industry. As one of the main resource, the workers often experiencing the risk of occupational health and hazards.

Health, Safety, and Environment (HSE) is important because it has direct and indirect impacts on the company’s productivity. HSE discusses the relationship of workers with equipment, machinery and the environment that have the potential risks to occupational health and safety.

The company is responsible for implementing safety strategy, even if it is simple, it uses as first precaution [1]. By using this concept, the level of safety of employees increases because they dont have to feel worry about occupational illness or accidents that could potentially occur.

PT. Primissima (Persero) is state-owned company engaged in manufacturing fine textiles. PT. Primissima (Persero) processes cone thread become a grey cloth through weaving process. The production of this cloth uses machinery, equipment and environment that have risk of occupational
illness and work accidents. One of the causes is due to lack of awareness and not optimal of supervision and implementation of HSE in the company. Therefore, real efforts are needed to reduce the risk of accidents and occupational illness.

This research was conducted by identifying the potential risks of occupational hazards and work accidents at the grey finishing department of the company. The results of this research contribute to solve the problem of the and give solutions of the company regarding risk controls.

2. Literature Review

2.1 Definition of Hazard Identification and Risk Assessment (HIRA)

Hazard Identification and Risk Assessment (HIRA) is one method of identification of occupational accidents with an assessment of risk level as one of the important points to implement the Occupational Health and Safety Management System [2]. HIRA method aims to identify the potential hazards in a company to assess the chances of an accident or losses. Hazard identification and risk assessment and control must be carried out throughout the company's activities, whether the work is carried out by direct employees or contract employees, suppliers and contractors, as well as facilities or personal activities that enter the workplace.

Hazard identification means defining the potential that cause a loss impact. The potential is in the form of event or exposure to a hazardous situation. Hazard identification involves systematic recognition of all aspects of the project that have potential hazards that affect employee performance [3]. Risk evaluation can be determined into two factors, namely severity of harm and likelihood of occurrence [4]. The risk level is in the form multiplication of severity and likelihood. Risk assessment uses semi-quantitative measurement techniques that provide probabilistic and objective results on potential risk events. Semi-quantitative techniques provide values as a range of levels that use numerical values as impacts and probabilities and combine them to produce a level of risk. Figure 1. shows level of risks. The green color means a low level of risk, yellow means medium, orange means high and red means extremely high. The level of risk should affect the existing hazard control.

| Likelihood   | Negligible (1) | Minor (2) | Moderate (3) | Major (4) | Extreme (5) |
|--------------|----------------|-----------|--------------|-----------|-------------|
| Almost Certain (5) | M               | H         | H            | E         | E           |
| Likely (4)   | M              | M         | H            | H         | E           |
| Possible (3) | L              | M         | M            | H         | H           |
| Unlikely (2) | L              | L         | M            | M         | H           |
| Rare (1)     | L              | L         | L            | M         | M           |

Figure 1. Risk Level Adapted from the AS/NZ 4360 Standard Risk Matrix and NHS QIS Risk Matrix[5]

2.2 Hierarchy of Hazard Controls

Generally, Hierarchy of Controls is used to determine how control can be carried out by implementing feasible and effective solutions. The National Institute for Occupational Safety and Health (NIOSH) is one part of the U.S Department of Health & Human Services developing the Hierarchy of Controls Research Method to become the Hierarchy of Hazard Controls [6].

3. Research Methodology

Data collected from observation of production process flow, identification of hazards and risks, and interviews of accident experiences in the grey finishing department. The data were processed using the Hazard Identification and Risk Assessment (HIRA) method, the results of data collection were used to identify hazards that might occur. After the hazard risks have been identified, a risk assessment was carried out to determine the level of the risks that. After the hazard risk has been assessed, the recommendations were made in accordance with the hazard control analysis using the Hierarchy of Hazard
Control method. Through this method, the existing controls should be eliminated, need improvement or need a new control.

3.1 Production Process Flow
There are two types of products produced, grey cloth and cambrics. Where the process of making grey cloth are the weaving and spinning activities. The flow of the production process of making grey cloth and cambrics can be seen in the Figure 2. below.

![Production Process Flow](image)

**Figure 2.** Production Process Flow of Grey Cloth and Cambrics

3.2 Potential Hazards and Risks
The potential hazards in this observation were reviewed based on direct observation and the results of interviews with two department supervisors and three machine operators. Here is the results of the identification of hazards and risks at Table 1.

| No  | Work Station                          | Task                  | Hazard Identification                  | Risk                                      |
|-----|---------------------------------------|-----------------------|----------------------------------------|-------------------------------------------|
| 1   | Inspecting Repair Machines Line       | Semi-finished grey cloth inspection | Noise Hazard                          | Hearing loss and headache                 |
|     |                                       |                       | Hazard of cotton scrap                 | Sneezeing, shortness of breath, allergies |
|     |                                       |                       | Physiological hazard                  | Aches, varicose veins                      |
|     |                                       |                       | Machine hazard                         | Scratched, pinched, broken bones, broken fingers |
| 2   | Folding Machine Line                  | Folding inspected grey cloth | Noise Hazard                          | Hearing loss and headache                 |
|     |                                       |                       | Hazard of cotton scrap                 | Sneezeing, shortness of breath, allergies |
|     |                                       |                       | Physiological hazard                  | Aches, varicose veins                      |
|     |                                       |                       | Machine hazard                         | Scratched, pinched, broken bones, broken fingers |
| 3   | Grey Finishing Department Office       | Administration and data storage of defective goods | Electrical Hazard | Electricity Shocked |
| 4   | Temporary Storage                     | storage of semi-finished and finished grey cloth | Falling Objects Hazard | Broken bones, bruises, injuries |

3.3 Accident Experience
Based on interviews with the head of the grey finishing department, information was obtained that almost all employees had suffered minor injuries such as scratches. But there was once an incident where an Inspecting Repair machine operator suffered a fracture due to procedural errors when installing cloth rollers on an Inspecting Repair machine. Then there was also the incident of a folding operator whose nail was broken and even had to be amputated on one of his fingers due to procedural errors when operating the machine.
4. Result

4.1. Hazard Identification

The results of hazard identification at the grey finishing department are as follows:

1. Equipments and locations: inspecting repair, folding machines, passageways, grey finishing department offices, and temporary storage areas.

2. The following is a description of the existing activities:
   a. Inspecting Repair Machine
      It is a machine to inspect the defects. The machine automatically curls the fabric in front of a bright screen, then the operator inspects whether there is a defective cloth roll. The operator uses the Inspecting Repair machine in a standing position.
   b. Folding Machine
      Folding machine is a machine to fold fabric that has been completed by inspecting repair machines. Folding machines have rotational drive with chains. The operator works in standing position.
   c. Grey Finishing Office Department
      The department office is the administrative part where there are important documents related to the process of finishing grey cloth.
   d. Temporary storage is a storage place for grey cloth that has been inspected.

3. The method/approach used in this study is the Hazard Identification and Risk Assessment (HIRA) with a descriptive analysis involving workstations in the Grey Finishing Department. Subject of this study are the heads of departments, operators and machine technicians.

   Data analysis starts from process of identifying potential sources of hazards that cause occupational accidents and occupational illness. Result of hazard identification are carried out a risk assessment to determine the level of risk and review of the control efforts that have been made. Data analysis refers to Undang-undang No. 1 tahun 1970 concerning Work Safety and Peraturan Pemerintah No. 50 Tahun 2012 concerning the Implementation of the Occupational Health and Safety Management System.

4. Person affected of the research as follow:
   a. Factory Production Employee (production line operator and mechanic)
   b. Staff (grey finishing department staff and head of grey finishing department)

4.2 Potential Significant Hazards

Potential Significant Hazards were obtained after hazard identification has been carried out as Table 2.

| No | Work Station       | Task                        | Hazard                        | Significant Hazards                                                                                                           |
|----|--------------------|-----------------------------|-------------------------------|-----------------------------------------------------------------------------------------------------------------------------|
| 1  | Inspecting Repair Machines Line | Semi-finished grey cloth inspection | Noise                         | Exposed to noise without using adequate earplugs resulting in hearing loss and headaches                                   |
|    |                    |                             | Hazard of cotton scrap        | Exposed to factory waste so that it can experience respiratory distress (sneezing, shortness of breath, itching due to allergies and eye infections due to exposure to the remaining scrap spinning and inspection activities) |
|    |                    |                             | Physiological hazard         | Experiencing aches and even varicose veins due to prolonged standing                                                        |
|    |                    |                             | Machine hazard               | Pinched roll roller calico cloth, pricked by a needle                                                                     |
| 2  | Folding Machine Line | Folding inspected Grey cloth | Machine hazard               | Pinched chain machine                                                                                                        |
|    |                    |                             | Noise                        | Exposed to noise without using adequate earplugs resulting in hearing loss and headaches                                   |
|    |                    |                             | Hazard of cotton              | Exposed to factory waste so that it can experience respiratory distress (sneezing, shortness of breath, itching due to allergies and eye infections due to exposure to the remaining scrap spinning and inspection activities) |
| No | Work Station                      | Task                                      | Hazard                  | Significant Hazards                                                                 |
|----|-----------------------------------|-------------------------------------------|-------------------------|-------------------------------------------------------------------------------------|
|    |                                   |                                           | scrap                   | respiratory distress (sneezing, shortness of breath, itching due to allergies and eye infections due to exposure to the remaining scrap spinning and inspection activities) |
|    |                                   |                                           | Physiological hazard    | Experiencing aches and even varicose veins due to prolonged standing                |
| 3  | Grey Finishing Department Office   | Administration and data storage of defective goods | Environment Hazard    | Difficult to emergency evacuation, flammable                                         |
|    |                                   |                                           | Electrical Hazard       | Electricity shocked                                                                |
| 4  | Temporary Storage                 | Storage of semi-finished and finished grey cloth | Falling Objects Hazard | Falling piles of grey cloth causes bruises and even broken bones                    |
|    |                                   |                                           | fire Hazard             | Flammable goods                                                                    |
4.3 Risk Assessment

Risk Assessment is a systematic method and analytical technique used to define a variety of business, trade and industry needs in the context of occupational health and safety, the application is focused on identifying, assessing and controlling risks to minimize all hazards that can occur in the workplace. The following Table 3. a risk assessment of the hazards were identified in the grey finishing department.

| No | Work Station                  | Task                        | Hazard Identification       | Risk                                      | Likelihood | Severity | Criteria | Score | Risk Value | Risk Level |
|----|--------------------------------|-----------------------------|----------------------------|-------------------------------------------|------------|----------|----------|-------|------------|------------|
| 1  | Inspecting Repair Machines Line | Semi-finished grey cloth inspection | Noise Hazard | Hearing loss and headache | Almost Certain | Minor | 2 | 10 | High |
|    |                                 |                             | Hazard of cotton scrap | Sneezing, shortness of breath, allergies | Almost Certain | Minor | 2 | 10 | High |
|    |                                 |                             | Physiological hazard | Aches, varicose veins | Unlikely | Minor | 1 | 2 | Low |
|    |                                 |                             | Machine hazard | Scratched, pinched, broken bones, broken fingers | Possible | Moderate | 3 | 9 | Medium |
| 2  | Inspecting Repair Machines Line | Semi-finished grey cloth inspection | Noise Hazard | Hearing loss and headache | Almost Certain | Minor | 2 | 10 | High |
|    |                                 |                             | Hazard of cotton scrap | Sneezing, shortness of breath, allergies | Almost Certain | Minor | 2 | 10 | High |
|    |                                 |                             | Physiological hazard | Aches, varicose veins | Unlikely | Minor | 1 | 2 | Low |
|    |                                 |                             | Machine hazard | Scratched, pinched, broken bones, broken fingers | Unlikely | Extreme | 5 | 10 | High |
| 3  | Folding Machine Line            | Folding inspected Grey cloth | Noise Hazard | Hearing loss and headache | Almost Certain | Minor | 2 | 10 | Medium |
|    |                                 |                             | Hazard of cotton scrap | Sneezing, shortness of breath, allergies | Almost Certain | Minor | 2 | 10 | High |
|    |                                 |                             | Physiological hazard | Aches, varicose veins | Unlikely | Minor | 1 | 2 | Low |
| 4  | Grey Finishing Department Office | Administration and data storage of defective goods | Electrical Hazard | Electricity Shocked | Unlikely | Negligible | 1 | 2 | Low |
| 5  | Temporary Storage               | storage of semi-finished and finished grey cloth | Falling Objects Hazard | Broken bones, bruises, injuries | Occasional | Moderate | 3 | 9 | Medium |
4.4 Control Measure
Every identified hazard was observed based on what controls exist in the work station can be seen in Table 4.

| No | Work Station       | Task                                      | Hazard                  | Existing Controls                                                                 |
|----|--------------------|-------------------------------------------|-------------------------|-----------------------------------------------------------------------------------|
| 1  | Inspecting Repair  | Semi-finished grey cloth inspection       | Noise                   | (+) SOP regarding the use of PPE (Earmuffs, disposable masks, special glasses, closed shoes) is complete |
|    | Repair Machine Line|                                           | Hazard of cotton scrap  | (+) The availability of SOP for safe work processes                                |
|    |                    |                                           | Physiological hazard    | (-) No first aid in this work station                                              |
|    |                    |                                           | Machine Hazard          | (-) There are no strict regulations on the use of PPE so workers have not used PPE properly |
|    |                    |                                           |                         | (-) No national standardized PPE from the company                                 |
| 2  | Folding Machine    | Folding inspection of grey cloth          | Noise                   | (+) SOP regarding the use of PPE (Earmuffs, disposable masks, special glasses, closed shoes) is complete |
|    | Line               |                                           | Hazard of cotton scrap  | (+) The availability of SOP for safe work processes                                |
|    |                    |                                           | Physiological hazard    | (-) No first aid in this work station                                              |
|    |                    |                                           | Machine Hazard          | (-) There are no strict regulations on the use of PPE so workers have not used PPE properly |
|    |                    |                                           |                         | (-) No national standardized PPE from the company                                 |
| 3  | Grey Finishing     | Administration and data storage of defective goods | Environment Hazard     | (+) SOP regarding the use of PPE (Earmuffs, disposable masks, special glasses, closed shoes) is complete |
|    | Department Office  |                                           |                         | (+) The availability of SOP for safe work processes                                |
|    |                    |                                           |                         | (+) The availability first aid in this work station                                |
|    |                    |                                           |                         | (+) There is already a safety switch and adequate electrical equipment            |
|    |                    |                                           |                         | (+) Fire Extinguisher is available                                                |
|    |                    |                                           |                         | (-) There are no strict regulations on the use of PPE so workers have not used PPE properly |
|    |                    |                                           |                         | (-) No national standardized PPE from the company                                 |
|    |                    |                                           |                         | (-) There are no danger sign and evacuation routes                               |
| 4  | Temporary Storage  | Storage of semi-finished and finished grey cloth | Falling Objects Hazard | (+) The availability of SOP for safe work processes                                |
|    |                    |                                           |                         | (-) Fire Extinguisher is available                                                |
|    |                    |                                           |                         | (-) No first aid in this work station                                              |
|    |                    |                                           |                         | (-) There are no strict regulations on the use of PPE so workers have not used PPE properly |
|    |                    |                                           | Fire Hazard             | (-) The incomplete SOP regarding the use of PPE headgear and closed shoes        |
|    |                    |                                           |                         | (-) No national standardized PPE from the company                                 |
4.5 Notification of Changes
The following were the notification of changes during the observation:
1. Description of changes to activity/equipment, there is no change in activity or the addition of equipment.
2. New potential hazard associated with changed activity/equipment, because there has been no change in activity or the addition of new tools, so there is no potential for new hazards.
3. Control measures to be implemented, no new controls are needed yet.

4.6 Hierarchy of Control
Controls that must be carried out in Table 5.

Table 5. Hierarchy of Control

| No | Hazard                       | New Control                                                                 | Regulation |
|----|------------------------------|----------------------------------------------------------------------------|------------|
| 1  | Noise                        | Apply 5 minutes for safety before work (administrative control)             | [7]        |
|    |                              | Applying inspection to certain times related to the use of PPE (administrative control) | [8]        |
|    |                              | The company prepares earplugs / earmuffs according to SNI (substitution/engineering control) |           |
| 2  | Hazard of cotton scrap       | Apply 5 minutes for safety before work (administrative control)             | [7]        |
|    |                              | Applying inspection to certain times related to the use of PPE (administrative control) | [8]        |
|    |                              | The company prepares earplugs / earmuffs according to SNI (substitution/engineering control) |           |
| 3  | Machine hazard               | Apply 5 minutes for safety before work (administrative control)             | [7]        |
|    |                              | The use of tools according to the standard (Engineering Control)           | [8]        |
|    |                              | Ensure workers are in good condition so workers more focus to the objects around |           |
| 4  | Falling objects hazard       | Apply 5 minutes for safety before work (administrative control)             | [7]        |
|    |                              | The use of tools according to the standard (Engineering Control)           | [8]        |
|    |                              | Ensure workers are in good condition so workers more focus to the objects around |           |
| 5  | Fire hazard                  | Apply 5 minutes for safety before work (administrative control)             | [7]        |
|    |                              | Workers must fill in the permit entry form before do the work.             | [8]        |
|    |                              | The use of tools according to the standard (Engineering Control)           |            |
|    |                              | Ensure workers are in good condition so workers more focus to the objects around |           |

5. Conclusion and Recommendation
The conclusions obtained from research related to workplace hazard risk analysis and hazard control at the grey finishing department of PT. Primissima (Persero) as follows:
1. Potential significant hazards in Grey Finishing Department are exposed to noise pollution that can interfere with hearing and headaches. In addition, exposure to cotton waste has respiratory problems such as sneezing, shortness of breath and allergies [9]. Then the physiological danger that can cause low back and lower extremity symptoms [10], musculoskeletal disorders of the lower limbs [11], negative effects for ankle/foot discomfort [12] due to prolonged standing. The machines also have the potential cause of injury due to
being pinched. Other potential hazards are environmental hazards [13], electrical hazards [14][15] and fire [16] that cause fatal injuries. And also hazard of falling objects that cause injuries such as bruises and broken bones.

2. Based on observations, the existing controls are Standard Operating Procedures (SOP) including the use of PPE, the availability of fire extinguisher, first aid kit and electrical safety equipment which are good but still inadequate. The company has not provided first aid boxes, PPE according to SNI and signs for emergencies according to specifications provided by the Government. That is because there are no special departments for Occupational Health and Safety Management System and high costs of procurement and maintenance of safety equipment.

3. The Risk Assessment show that the highest hazard are noise hazard and hazard of cotton scrap in inspecting repair machines line, and machine hazard in folding machine line.

4. The controls that can be done by the company are administrative controls, substitution/engineering controls according to the hazards that have been identified.

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