Jurnal Kesehatan
Vol. 17, No. 2, September 2024, pp. 185~193
p-ISSN: 1979-7621, e-ISSN: 2620-7761, DOI: 10.23917/jk.v17i2.2145

Dangers and Risks of Plastic Screen Printing Work in Bolon Village, Colomadu District, Karanganyar Regency, Central Java Province

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How to cite: Wartini, Ani, N., & Puspito Sari, D. Dangers and Risks of Plastic Screen-Printing Work in Bolon Village, Colomadu District, Karanganyar Regency, Central Java Province. Jurnal Kesehatan, 17(2), 186–193. https://doi.org/10.23917/jk.v17i2.2145

Article Information

Article History:
Submission: 09 July 2024
Revision: 04 September 2024
Receiption: 05 September 2024

Keywords: Hazard, Risk Assessment, Risk Management

ABSTRAK

Introduction : The screen printing process is carried out in a sitting working position and uses chemicals in the form of ink and thinner, with working hours starting from 07.00-17.00, depending on the amount of plastic being screen printed. The more plastic screen-printed, the longer the working hours will be used. Screen printers will face danger in every work activity. The risks that arise are poisoning due to the use of chemicals, experiencing musculoskeletal disorders due to ergonomic hazards, and work fatigue. **Methode** : The type of research used is qualitative with a case study research design. The sampling technique was purposive sampling with three informants: The owner, Workers who took work home, and Workers who worked at the business owner's place. The variables studied include danger and the risk of danger to screen printing. Data collection techniques used interviews, observation, and literature study with triangulation methods. The instruments used were an interview guide, HIRA form, voice recorder, and camera. The collected data is analyzed by reducing, presenting, and concluding/verifying. **The research results** show that the dangers arising from plastic screen-printing work are chemical hazards and ergonomic hazards. Risk analysis in plastic screen printing showed a high risk, namely central nervous system symptoms, and respiratory problems due to exposure to thinner (chemical) as a solvent. In contrast, the moderate risk was for ergonomic hazards with the risk of musculoskeletal complaints due to non-ergonomic work attitudes and twisting loads during the screen-printing process. Potential dangers in screen printing work are chemical hazards with a high risk and moderate risks for ergonomic hazards. It is hoped that this research can provide input to workers on using respirator personal protective equipment when working.

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INTRODUCTION

The number of informal workers in Indonesia continues to increase. The Central Statistics Agency (BPS) recorded that the number of informal workers reached 78.14 million people in February 2021, an increase of 2.64 million people compared to August 2020 which was 77.68 million people (BPS, 2021). Data on work accidents in Indonesia in the second quarter of 2020 reported 3,174 accidents and occupational diseases reported as many as 46 cases (BPJS Ketenagakerjaan, 2020). Hazard control in the workplace is carried out to reduce the risk of accidents and resulting diseases. Hazard identification is the first step in developing K3 risk management, then conducting a risk assessment and recommending the safest way of working to prevent risk (Noor et al., 2018).

The plastic screen printing process in Bolon Village, Colomadu District, Karanganyar Regency uses a manual method. The screen printing process is the process of transferring a stencil design onto a flat surface using a mesh screen, ink, and cleaning tools made of rubber, the basic method involves creating the stencil on a fine mesh screen, then pushing ink or paint, to create a design print on the surface below (Kurniawan, 2020).

The screen-printing process is carried out in a sitting work position, and uses chemicals in the form of ink with working hours ranging from 07.00-17.00 depending on the amount of plastic being screen-printed. The more plastic that must be done, the longer the hours of work done by workers. Screen printing workers use chemicals in the form of thiner and ink and without proper personal protective equipment. Risks that may arise are poisoning due to the use of chemicals, experiencing musculoskeletal disorders due to ergonomic hazards and work fatigue. In March 2023, there is 1 screen printing worker who is hospitalized with symptoms of low red blood cells in the blood and causes the worker to experience a weak condition and unable to work. This can be possible because of exposure to thiner and paint as the main ingredients for the screen-printing process, besides that workers work in closed houses so that the air concentration in the room is more concentrated than workers who work in the open (outdoors) so that the risk received will be higher because there is no dilution of the air concentration in the workplace space. Hazard control in the workplace is needed to reduce the risk of accidents and occupational diseases, so it is necessary to identify hazards is the first step in developing K3 risk management, then conduct a risk assessment and recommend the safest way of working to prevent risks (Noor et al., 2018).

This research is expected to identify the types of *hazards* and risks that arise in plastic screen printing work so that it can make preventive efforts against the risks that arise.

LITERATURE REVIEW

Potential hazard is a substance that hits workers continuously during the worker's work, the effect of which can cause health problems. Work environment factors that cause illness or the onset of occupational diseases are as follows: (Iwan Muhammad Ramdan, 2013)

a. Physical factors such as noise, radiation, room temperature, lighting.
b. Chemical factors; dust, metal vapors, chemicals, gases and fog
c. Biological factors; bacteria and viruses
d. Physiological factors; Machine construction errors, poor posture, excessive workload, wrong way to do work
e. Psychological factors; Poor working relationships between fellow workers, or between subordinates and superiors, monotony or a dull atmosphere.

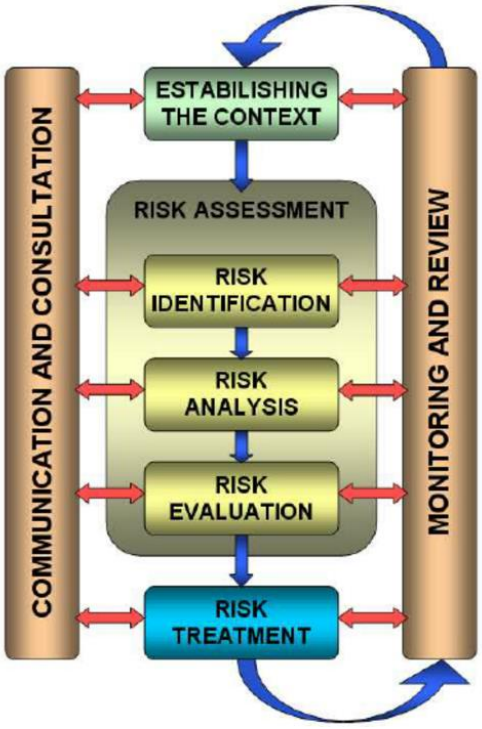
Hazard identification can be done by *the hazard identification and risk assessment* (HIRA) method. HIRA is a method or technique to identify potential occupational hazards by defining the characteristics of possible hazards and evaluating risks that occur through risk assessment using a risk assessment matrix (Sibuea, 2022).

Tabel 1. Nilai Likelihood dan Consequence

Consequence / Likelihood		Insignificant	Minor	Moderate	Major	Catastrophic
		1	2	3	4	5
Almost Certain	E	Moderate	High	High	Extreme	Extreme
Likely	D	Moderate	Moderate	High	High	Extreme
Possible	C	Low	Moderate	Moderate	High	Extreme
Unlikely	B	Low	Moderate	Moderate	High	High
Rare	A	Low	Low	Moderate	Moderate	High

Source : *Adapted from the AS/NZ 4360 Standard Risk Matrix and NHS QIS Risk Matrix* (Ramli, 2010).
Information: *Extreme*= Very high risk; *High*= High risk; *Moderate*: Medium Risk; *Low*: Low Risk

Process Flow Risk Management



Source: ISO 31000:2018

Risk management according to (Haworth & Hughes, 2012) can be done with control options:

a. risk reduction, namely reducing or reducing risk with hierarchical efforts to control risk;
b. transfer risk, which is transferring risk to another party;
c. avoiding risks, i.e. not taking risks;
d. accept risk, which is to fund the risk if it really happens.

Control can be done with the following risk control hierarchy:

a. Elimination is removing a hazardous material/process stage;
b. Substitution consists of: 1) replacing powder form material with paste form; 2) the sweeping process is replaced by vacuum; 3) solvent materials are replaced with detergent ingredients; 4) the spray-painting process is replaced by dyeing;
c. Engineering/ Enggenering Control consists of: 1) installation of machine protective equipment (machine guarding); 2) installation of general and local ventilation; 3) automatic sensor device installation;
d. Administrative Control consists of: 1) location separation; 2) change of work shifts; 3) formation of the working system; 4) employee training;
e. Personal Protective Equipment (PPE) is the use of personal protective equipment tailored to the potential hazards of the work of each work unit. PPE that can be used include; Helmets, masks, ear plugs, ear muffs, aprons, safety googles, safety shoes, etc.

METHOD

The type of research used in this study is qualitative. This qualitative research uses a case study research design. Purposive *sampling technique* with informants as many as 3 people, namely workers who work at home takeout, workers who work at the place of business owners and business owners. Data collection techniques use in-depth interviews, types of hazards and are carried out by observation and literature study. The instruments in this study are interview guidelines, HIRA forms, and observation sheets. Information validation is performed by method triangulation (Sandu Siyoto & M. Ali Sodik, 2015).

The data is analyzed with the following steps:

a. First read the data obtained while reducing overlapping or repetitive information;
b. Second, look at the significance or importance of interview data.
c. Third, classify or code data that has similarities or matches with other data.

The results of this data classification are then made labels (*labeling*). The fourth is to look for patterns or themes that are in accordance with the dangers and risks of plastic snuffing work. Fifth, construct a *framework* to obtain the essence of the interpretation of the data to be conveyed (Raco, 2018). Data analysis in research includes: data reduction, data presentation and conclusion/ verification (Sandu Siyoto & M. Ali Sodik, 2015) .

RESULT AND DISCUSSION

The results of the application of HIRA (*Hazard Identification Risk Assessment*) plastic screen printing process are described as follows: a). Preparatory stage: at the preparation stage what needs to be done is to prepare screen printing tools in the form of rakel, *screen*, plastic to be screen printed, ink and thiner. Callers are also required to wear personal protective equipment in the form of aprons and cloth masks. b). Screen printing process stage: at the plastic process stage is placed under the *screen* before *the screen* is cleaned using a thiner then rubbed using a rack so that the image sticks to the plastic. After that, the plastic is drained on a plastic slicing rack to dry. c). *Finishing* stage: The dried plastic is then packed into plastic *packing*.

Potential hazard is a substance / something that hits workers continuously during the worker's work, and its effects can cause health problems. *Hazards* can be physical, chemical, biological, *ergonomic* and psychological hazards. The results of research on plastic screeners found that potential hazards that expose plastic screen-printing workers include exposure to chemicals in the form of thiner and paint, ergonomic hazards in the form of work positions that are not ergonomic. This is in accordance with the information submitted by the informant:

"*Tahu, bahayanya baunya itu lho bu*." (Respondent-2)
"*bau thiner ya dicampur cat, kan catnya juga dicampur thiner. Thinernya juga bau. Kalau ga kuat biasanya sesek sama pusing*" (Respondent-1)

Efforts made by workers to reduce the risk of poisoning are carried out by consuming soda and milk and using personal protective equipment in the form of masks and aprons. This is in accordance with the information submitted by the informant:

"*kadang itu…banyak minum soda putih itu lho sama susu*" (Respondent-1)
"*Apron, biar terhindar dari cipratan cat…*" (Respondent-1)
"*Memang suruh pakai masker, masker itu kadang yo dobel kalau baunya nyengat banget*" (Respondent-2)

The results of interviews and observations of potential hazards can be explained in Table 2.

Table 2. Potential Hazards In Plastic Scanners

No	Process Activities	Danger	Risk	Condition
1	Screen printing preparation	Exposure to chemicals in the form of thiner and ink	Toxicity	Normal
2	Proses menyablon	Exposure to chemicals in the form of thiner and ink, Non-ergonomic work attitude	Toxicity	Normal
3	Penirisan plastik	Ink exposure, Non-ergonomic work attitude	Musculoskeletal *complaints*	Normal
4	Packing plastik	Non-ergonomic work attitude	Musculoskeletal complaints	Normal

Based on table 2, it is known that the process of screen-printing activities includes preparation, processing, plastic slicing and plastic packing. This activity has the potential to create hazards of exposure to chemicals and awkward/ non-ergonomic attitudes that can have an impact on poisoning and the incidence *of Muscoskeletal Disorder* (MSDs).

Risk assessment is used to determine the level of risk in terms of *likelihood* and severity that can be caused (*severity*). *Risk rating* is a value that indicates the existing risk is at a low, medium, high level. The following are the results of the risk analysis that may occur in plastic screen printing workers:

Table 3. Risk Analysis of Plastic Screen-Printing Workers

Activity Process	***Hazard***	**Risk**	**Cond.**	***Likeli -hood***	***Save -rity***	**Risk Value**	***Risk Rating***
Screen printing preparation	Exposure to chemicals in the form of thiner and ink	Thinner and ink poisoning	Normal	5	4	20	High Risk
The process of masking	Exposure to chemicals in the form of thiner and ink, Non-ergonomic work attitude	Thinner poisoning and tinta, Musculoskeletal Complaints	Normal	5	4	20	High Risk
Plastic slicing	Ink display, Work attitude that is not ergonomis	Poisoning and Musculoskel	Normal	4	3	12	Medium Risk

Activity Process	*Hazard*	Risk	Cond.	*Likeli -hood*	*Save -rity*	Risk Value	*Risk Rating*
		etal Complaints					
Plastic Packing	Non-ergonomic work attitude	Musculoskel etal complaints	Normal	4	3	12	Medium Risk

Abbrevation: Cond= condition

Based on Table 3, it is known that the results of risk analysis on plastic screeners with high risk are poisoning due to exposure to thiner and paint (a mixture of paint and thiner). Efforts made by business owners and workers are to use personal protective equipment in the form of aprons and cloth masks to reduce exposure to workers when carrying out the screen-printing process. The plastic screen printing process is carried out in a room with poor air circulation so that in the workplace space it becomes smelly due to the steam / odor released from the solvent used. Exposure to thiner in workers will have a negative effect on health, these negative effects include symptoms of the central nervous system, this is in accordance with what was stated by the informant symptoms experienced include dizziness and shortness of breath. The content of touluene in thiner will negatively affect health, exposure to toluene at 200 ppm in humans for 8 hours will generally produce symptoms such as fatigue that lasts for several hours, weakness, headaches, and *dermal paresthesia*. Exposure to 400 ppm, there will be symptoms of mental confusion and at 600 ppm, extreme fatigue, confusion, excitement, nausea, headache, and dizziness can occur in a short time (Williams et al., 2000). This is in line with research by Agustina and Mukono (2017) which states that respondents of car painting workshops have complaints of diverse central nervous systems. Complaints experienced by respondents include memory, concentration, emotions, tired conditions, headaches, tired hands or feet to interest in sex. Respondents tend to experience complaints of having short memory (forgetfulness), often feeling upset for no particular reason, often feeling depressed for no particular reason, having an abnormal heartbeat, often sweating for no particular reason, frequent headaches (at least 1 time in 1 week), frequent pain, weakness in arms or legs and trembling in the hands (Agustina & Mukono, 2017).

Exposure to indoor air toluene of 18.5726 ppm with urinary hypuric acid levels less than 1.6 g of hipuric acid / g urinary creatinine causes a tendency of central nervous system (CNS) complaints in painting workers at car painting workshops in Surabaya, while exposure to toluents of 1 ppm in administrative and finishing workers relatively does not cause CNS complaints (Agustina & Mukono, 2017). Research by Marganda et al states that working time and smoking habits affect the subjective symptoms of central nervous system disorders in printing workers. Smoking habits have a risk of 8.91 times experiencing complaints of central nervous system disorders while a working period of $\geq$ 2 years has a risk of 4.19 times experiencing central nervous system disorders compared to a working period of less than 2 years (Marganda, et al., 2018). This is in line with research (Ayu et al., 2021) who conducted toluent testing in the work environment on average of 11.3 ± 8.1 ppm with a range of 4.7 – 28.1 ppm. The results of risk analysis from all respondents have not shown any risk to the effects of toluent, but need to be considered in the long term because the risk will increase with the working period if it is not accompanied by good work environment control. The same from the results of the research conducted (Faradisha et al., 2019) That each location will have different health effects depending on the concentration of toluene. The higher the concentration of toluene in the environment, the higher the health risks experienced by its workers. 31.3% of printing workers experienced headaches,

and 37.5% experienced fatigue. Workers in the printing department with the highest concentration of 31.54 ppm had RQ>1. The amount of toluene exposure depends on the workplace (open or closed) and physical factors such as wind movement, temperature, humidity and air pressure. The same thing happens in the workplace of the manufacturer, there are workers who use closed space (inside the house) and there are also those who use open space (outside the house/ terrace) so that these conditions will affect the concentration of thiner in the workplace environment. The workspace is one of the risk factors for workers so that the workspace needs to pay attention to air circulation to reduce the concentration of thiner in the workspace air besides the use of appropriate personal protective equipment in accordance with the danger will reduce the risks that arise. Poor ventilation is a major cause of complaints about indoor air quality, ventilation problems may increase contamination in the workspace to a level that can interfere with or decrease worker comfort and the impact on health will occur especially on vulnerable workers (Dewi et al., 2021). The health effects on workers will be lower if the work is carried out in a space with adequate ventilation or open air, this allows reducing the concentration of toluene present in the air due to dilution by air until exposure to workers will also be reduced (Faradisha et al., 2019). The condition of screen-printing workers is that some use cloth masks that do not meet the standards and the owner has not provided masks, only urging workers to use masks. This allows for a high risk of workers being exposed to hazardous materials during work (Irmasari, 2015). The concentration of chemicals in the air one of the influential factors is ventilation, ventilation that is less crowded is the main cause of complaints about indoor air quality that interferes with decreased comfort in workers and has a health impact on workers (Dewi et al., 2021).

Another risk of abuse is *musculoskeletal* disorders. *Musculoskeletal disorders* occur due to a sitting position that is not ergonomic. Sitting for long periods of time, diligently working without stretching and twisting position movements when slicing plastic that has been given a picture / color will have a musculoskeletal interference effect on plastic screen-printing workers. Research results (Pramana, 2020) shows that there is a relationship between sitting position and complaints of low back pain in Udayana University medical students. Research by Prahastuti et al states that workers with high ergonomic risks will have a 3 times higher chance of experiencing symptoms of MSDs compared to workers who have moderate ergonomic risks (Prahastuti et al., 2021).

Musculoskeletal Disorders (MSDs) complaints occur because there are factors that influence age and length of work. Sholehah and Sunaryo mentioned that *musculoskeletal system complaints* are felt at the age of between 35-50 years because at the middle age, muscle strength and endurance begin to decline so that the risk of muscle complaints increases (Sholeha & Sunaryo, 2022). Screen printing workers work in a sitting position and twisting weights when slicing screen-printed plastic, this position allows workers to risk *musculoskeletal complaints* due to forced attitudes when placing plastic into the slicing rack. Workers work for 8 hours or even more if orders are high which requires workers to complete screen printing on time. Research by Hutasuhut et al showed a relationship between prolonged sitting and complaints of low back pain in Samratulangi University medical students. Sitting on a computer while studying or working within 2-4 hours is enough to cause discomfort in the lower back area. This discomfort can occur due to sitting for a long time and improper sitting position. When sitting, the body will give a load that is influenced by the force of gravity and will cause a pressure force in the opposite direction as much. Exposure to these pressures affects physical conditions that have an impact on damage to a system in the spine. A long sitting position without a backrest is also at greater risk of low back pain because the pressure on the *intervertebral discs* will be greater when flexing sitting (Hutasuhut et al., 2021). Most musculoskeletal disorders are felt in the neck,

followed by the waist and back. The high prevalence of *musculoskeletal* disorders of the neck, waist and back can be caused because workers have to work in a sitting position for a long time, so it requires constant muscle work to hold the body in a fixed position which can eventually cause fatigue and tension, especially in the neck, waist and back, and increase the risk of *musculoskeletal disorders* (Livandy & Setiadi, 2018). In order to reduce *musculoskeletal* complaints in workers can be done stretching efforts by workers, by stretching can reduce from high, middle and low categories to middle, low and very low categories (Iwan Muhamad Ramdan & Azahra, 2020). Thus, the length of work sitting, sitting posture and age need attention so that efforts can be made to prevent *musculoskeletal disorder*. With this research, it is expected to be able to determine the hazards and risks of work that arise and can be anticipated so that the risks that can be prevented and the identified hazards can be controlled adequately.

CONCLUSION

The results of the analysis found that the types of hazards from plastic screen-printing work include; chemical hazards (thinners and paints), ergonomic hazards (non-ergonomic work attitude). The identified risks are high risk is in preparatory work and screen-printing process work.

ACKNOWLEDGEMENT

The author would like to thank LPPM Univet Bantara as the funder in this research, and plastic screen-printing business owners, workers and parties who contributed to this research.

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