

Job Safety Risk Assessment in the Printing Industry using Job Safety Analysis method and offering control recommendations

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ABSTRACT

Background: Nowadays, one of the most important problems in various industries is work-related accidents that put a lot of costs on the industry.

Aim: To assess the risk of duties of employees of a printing house by occupational safety analysis method (JSA) also, to provide appropriate control solutions.

Methods: This descriptive cross-sectional study was conducted in one of the printing industries in Iran in 2020. Information was collected in the JSA checklist through visits, observations, and interviews with staff. Then the stages of the work were determined, and the existing or potential hazards (ergonomic, electric, chemical, and mechanical) related to each stage were identified and determined. The risk level of each activity was determined according to the MIL-STD-882E standard.

Results: In these eight stages, twenty-three risks were identified, of which ten risks were undesirable, and eleven risks were acceptable with the need for revision. Also, two risks were acceptable while no revision was required for it. The stage of transporting cargo to the warehouse with four hazards was the highest. Besides stapling and working with the sewing machine, each with two hazards gained the lowest number of hazards in risk assessment.

Conclusion: The main hazards identified in this study are mechanical hazards that teaching ergonomic principles to individuals, using the safety and ribbed shoes, carrying two people, and observing the principles of manual handling can be useful to reduce or control these types of hazards.

Keywords: Job Safety Analysis, Hazard, Safety, Accident

INTRODUCTION

Nowadays, one of the most important problems in various industries is work-related accidents¹. The International Labor Organization defines an occupational accident as an unplanned and unexpected work-related event that results in the death, illness, or injury of one or more workers². These accidents cause a lot of damage to the labor force, property and assets, reputation, and credibility of organizations³. Occupational accidents are currently the third leading cause of death in the world and the second leading cause of death in Iran^{4,5}. The International Labor Organization represents that accidents at work kill an estimated 350,000 workers each year⁶. Also, in Iran, 14,000 work accidents occur annually, most of them are related to the industry⁷. Statistics show that about four percent of a country's gross domestic product is spent directly on direct and indirect costs from occupational accidents, but work-related accidents are still one of the most preventable health problems worldwide⁴. The risks of the work environment can be identified and reduced by analyzing occupational accidents. Also, a safe environment can be provided for workers. Finally, their productivity can be increased⁸. One of the main pillars of a health and safety management system is risk assessment, which aims to identify, assess and control risk factors that affect the health and safety of employees, so the role of risk assessment in the management of activities in many industries is well accepted⁹. The type of risk, the probability of occurrence, the sort of injury, and its severity is systematically determined by risk assessment¹⁰. One of the methods of accurate and systematic study to identify the

existing or potential hazards of any job is the Job Safety Analysis (JSA) method, which is recommended in the operation and usage phase to identify and analyze the risks. This method is implemented with minimal equipment, financial resources, and only with careful study and based on the ability of the assessment team and the experience of the accountants (workers and operators). Thus, all people, including managers and workers in proportion to their information from the results, will benefit and increase employees' understanding of the level of risk. Besides, it will have a positive impact on their behavior, which in turn will reduce workers' exposure to many job hazards. As well, OSHA recommends that the right thing to do occupational safety analysis can prevent many injuries and diseases and determine technical and managerial control measures, training needs, personal protective equipment required, and executive instructions for each activity¹¹⁻¹³. The job safety analysis method has been used in various jobs and industries¹⁴. In 2019 Albrechtsen et al. Conducted a study to examine the practices and benefits of occupational safety analysis (JSA) in construction projects. Finally, they concluded that occupational safety analysis techniques have benefits, such as retrospective and prospective accountability, organizational learning in communities, practices and loss prevention in dynamic systems¹⁵. Thepakorn et al. Used the JSA method in a cross-sectional study in 2017 to assess and identify potential hazards in sawmills in Thailand¹⁶. In another study in 2015, the same method was used to identify the occupational hazards in an Iran Khodro dealership, which after identifying the hazards, control solutions were presented to eliminate or reduce the level of risks¹⁷. The printing industry

is one of the most important industries in Iran. Workers who work in this industry, in addition to exposure to chemicals and solvents, are involved in extensive occupational accidents due to the type of process and their duties. The final product in the printing industry affects the rate of accidents and occupational diseases in this industry, as this share in the newspaper printing industry and the book printing and bookbinding industry respectively include 13% and 40% of the total printing industry. Important tasks in the printing industry that usually put a person in difficult situations and cause unsafe behaviors to include cleaning and preparing the printing machine, embedding paper, fixing the printing machine, maintaining the equipment, monitoring the printing process, moving printed paper, cutting and paper binding¹⁸. Therefore, this study was conducted to evaluate the occupational safety risks in the printing industry by the occupational safety analysis method.

METHODOLOGY

The present study is descriptive and was conducted cross-sectionally in one of the printing industries in Iran in 2020.

Because the occupational safety analysis must be performed by a team, an executive team consisting of the researcher, the occupational health officer, and the person in charge of the work or the workshop supervisor was formed. Information was collected through visits, observations, and interviews with staff on the JSA checklist. Then the stages of the work were determined, and the existing or potential hazards (ergonomic, electric, chemical, and mechanical) related to each phase were identified and assessed. The risk level of each activity was determined according to the MIL-STD-882E standard. This method is one of the most famous techniques of semi-quantitative risk assessment in industries in which intensity and probability are classified qualitatively. Based on this method, the probability of an accident was calculated using Table 1, and the severity of the accident was computed using Table 2. Then the severity and probability of the accident were combined, and the level of risk was obtained (Table 3). Finally, high-risk tasks were prioritized based on the risk index by using Table 4⁸. In the last step, control measures were presented based on the identified hazards

Table 1. Probability levels

PROBABILITY LEVELS			
Description	Level	Specific Individual Item	Fleet or Inventory
Frequent	A	Likely to occur often in the life of an item.	Continuously experienced
Probable	B	Will occur several times in the life of an item.	Will occur frequently.
Occasional	C	Likely to occur sometime in the life of an item.	Will occur several times.
Remote	D	Unlikely, but possible to occur in the life of an item.	Unlikely, but can reasonably be expected to occur.
Improbable	E	So unlikely, it can be assumed occurrence may not be experienced in the life of an item.	Unlikely to occur, but possible.
Eliminated	F	Incapable of occurrence. This level is used when potential hazards are identified and later eliminated.	Incapable of occurrence. This level is used when potential hazards are identified and later eliminated.

Table 2. Severity categories

Severity categories		
Description	Severity Category	Mishap Result Criteria
Catastrophic	1	Could result in one or more of the following: death, permanent total disability, irreversible significant environmental impact, or monetary loss equal to or exceeding \$10M.
Critical	2	Could result in one or more of the following: permanent partial disability, injuries or occupational illness that may result in hospitalization of at least three personnel, reversible significant environmental impact, or monetary loss equal to or exceeding \$1M but less than \$10M.
Marginal	3	Could result in one or more of the following: injury or occupational illness resulting in one or more lost work day(s), reversible moderate environmental impact, or monetary loss equal to or exceeding \$100K but less than \$1M.
Negligible	4	Could result in one or more of the following: injury or occupational illness, not resulting in a lost work day, minimal environmental impact, or monetary loss less than \$100K.

Table 3. Risk assessment matrix

Severity	Catastrophic	Critical	Marginal	Negligible
Probability	(1)	(2)	(3)	(4)
Frequent (A)	1A	2A	3A	4A
Probable (B)	1B	2B	3B	4B
Occasional (C)	1C	2C	3C	4C
Remote (D)	1D	2D	3D	4D
Improbable (E)	1E	2E	3E	4E
Eliminated (F)	1F	2F	3F	4F

Table 4. Decision criteria based on risk index

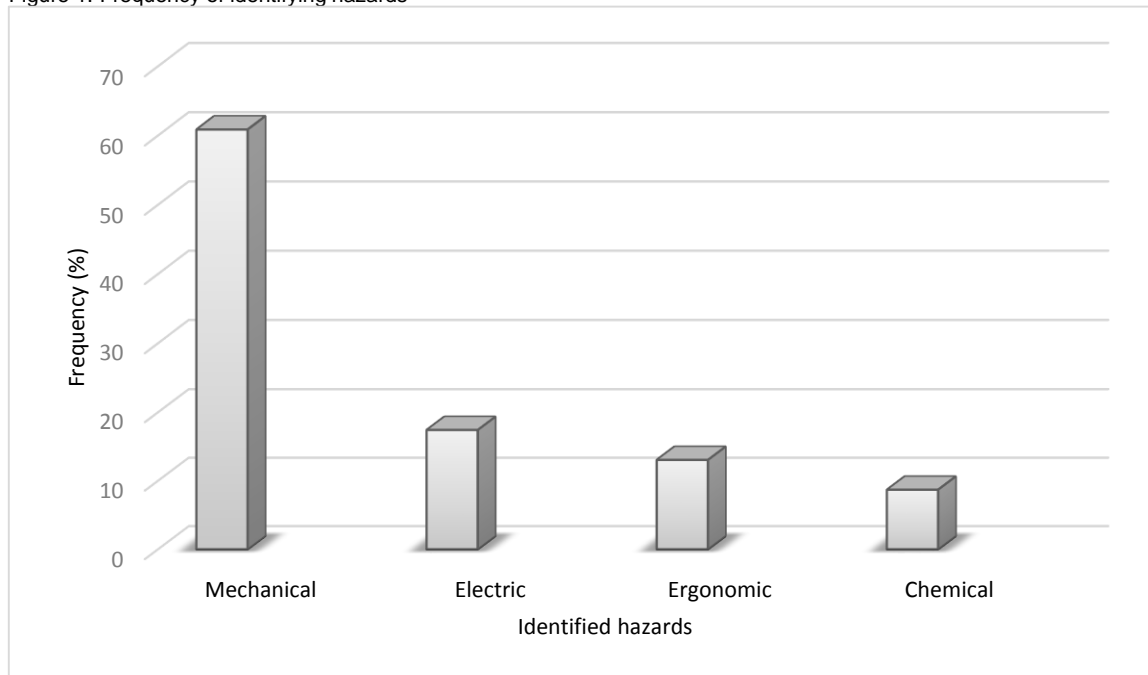
Risk criteria	Risk classification
Unacceptable	1A, 1B, 1C, 2A, 2B
Undesirable	1D, 2C, 3A, 3B
Acceptable with review by management	1E, 2D, 2E, 3C, 3D, 3E, 4A, 4B
Acceptable without review	4C, 4D, 4E

RESULTS

The results are as follows: In this printing house, a total of eight stages of the work were under job safety analysis. These steps included 1) taking the load, 2) transporting the load to the warehouse, 3) placing the load inside the warehouse, 4) four-color and two-color offset printing, 5) working with letterpress printing machine, 6) working with cutting machine, 7) stapling, and 8) working with the

sewing machine. In these 8 stages, a total of 23 hazards was identified, and the stage of transporting cargo to the warehouse with 4 hazards was the most and stapling, and working with the sewing machine each with two hazards were the least hazardous in the risk assessment. The results of Figure 1 showed that mechanical hazards (60.86%) and chemical hazards (8.69%) had the highest and lowest frequencies, respectively.

Figure 1: Frequency of identifying hazards



Out of 23 identified hazards, 10 were considered undesirable, 11 were accepted with review by management, and 2 were accepted without review. It should be noted that no hazard with unacceptable risk level was identified (Figure 2).

Figure 2: Number of risk indicators for each activity

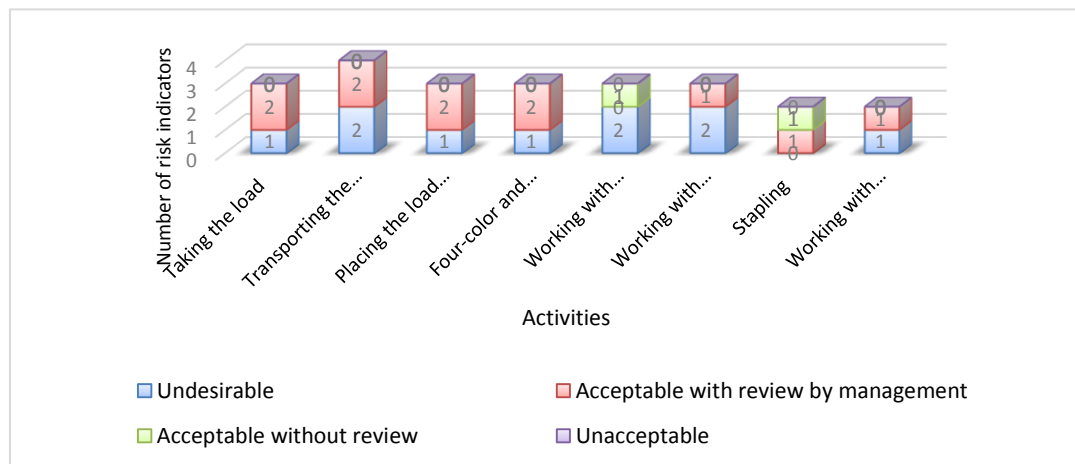


Table 5: potential hazards of activities with undesirable risk criteria, type of hazards, consequences, and control strategies

Control solution	Consequence	Type of hazard	Risk classification	Severity	Probability	Potential hazard	Activity
Teaching people ergonomic principles and using safety shoes	Bruising and dislocation of leg	Mechanical	3B	3	B	Falling load on the person	Taking the load
Teaching people ergonomic principles and using safety shoes	Bruising and dislocation of hand and leg	Mechanical	3B	3	B	Falling load on the person	Transporting the load to the warehouse
Do not clutter near and around the warehouse	The possibility of falling and breaking and being hit	Mechanical	2C	2	C	Accident	Transporting the load to the warehouse
Using safety shoes and learning the basics of handling cargo	Bruising and dislocation of hand and leg	Mechanical	3B	3	B	Falling load on the person	Placing the load inside the warehouse
Keeping dry around the device - Using electrical insulating shoes and gloves - Using an insulated footrest in the presence of the operator if possible - Checking the earth connection system	Severe shock and muscle cramps and the possibility of death	Electric	1D	1	D	Risk of electrocution	Four-color and two-color offset printing
Installing an electronic eye to prevent an accident when the worker's hand is between the paper guide and the edge - Complete training to work with the device - Making sure that the device is off during repairs.	Risk of severe crushing and contusion	Mechanical	2C	2	C	Risk of getting your hands stuck between the paper guide plate and the edge	Working with letterpress printing machine
Keeping dry around the device - Using electrical insulating shoes and gloves - Using insulated footrest in the presence of the operator if possible	Severe shock and muscle cramps and risk of death	Electric	1D	1	D	Risk of electrocution	Working with letterpress printing machine
The probability is almost zero because the device is equipped with electronic eyes and the chassis of the device is installed in the form of two buttons at the bottom of the device.	Cut off the finger	Mechanical	1D	1	D	Risk of finger amputation	Working with cutting machine
Keeping dry around the device - Using electrical insulating shoes and gloves - Using insulated footrest in the presence of the operator if possible.	Severe shock and muscle cramps and risk of death	Electric	1D	1	D	Risk of electrocution	Working with cutting machine
Keeping dry around the device - Using electrical insulating shoes and gloves - Using insulated footrest in the presence of the operator if possible.	Severe shock and muscle cramps and risk of death	Electric	1D	1	D	Risk of electrocution	Working with the sewing machine

DISCUSSION AND CONCLUSION

The main hazards identified in this study are mechanical hazards that are related to activities such as loading and transporting cargo to the warehouse and placing the load inside the warehouse. To reduce these risks, teaching ergonomic principles to individuals can play a useful role. Based on the results of the present study, 23 hazards were identified that most of them were within the acceptable range with the need for revision. Thepakorn et al. used the JSA method in a cross-sectional study in 2017 to assess and identify potential hazards in sawmills in Thailand and finally identified several high-risk areas in these plants, including high exposure to dust and noise when sawing lumber into sheets¹⁶. In the study of Ebrahimzadeh et al as a result of safety analysis of 22 jobs, a total of 182 occupational hazards was identified, and the results showed that the risk of radiation exposure and the risk of falling rocks with a relative frequency of 42% and 18% is

the most likely hazards, respectively¹⁹. Vikas Kumar Sahu and T. Ramarao used the occupational safety analysis method in the study of safety analysis in the soap and detergent industries. Finally, they concluded that 28.6% of the identified potential hazards are in the unacceptable range²⁰. Also, in the study of Mohammadi et al. after analyzing the risks by occupational safety analysis method, 524 hazards were identified which none of them were at an unacceptable level. Sixty-five risks were undesirable, 257 risks were acceptable with review by management, and 202 risks were acceptable without review. Carpentry, metal turnery, and installation with 81, 75, 72 hazards, respectively, were the most hazardous technical working activities²¹. A total of 232 potential risks was identified in the study by Barkhordari et al. more than a third of these hazards were in the unacceptable range, which can be attributed to work at heights without using proper lifting, lack of equipment of tunneling behavior identification, and

delay in unstable rock mass support¹⁴. According to the identified hazards and the level of risks obtained in the present study, the order of priority of activities to provide control solutions based on the level of risk is as follows:

- 1) Transporting the load to the warehouse
- 2) Working with cutting machine
- 3) Working with letterpress printing machine
- 4) Taking the load and placing it inside the warehouse, four-color and two-color offset printing
- 5) Working with the sewing machine
- 6) Stapling

In the study of Moravveji et al., 25 hazards were identified by the JSA method. After implementing prioritized engineering and management controls, 5 of the risks were controlled. Lifting heavy objects and unsuitable postures had the highest risk decrease²². According to the results of occupational safety analysis in this study, it is expected that some risks can be reduced or controlled by providing appropriate control strategies.

Proposed control solutions: To control or reduce mechanical and ergonomic hazards, strategies such as teaching ergonomic principles to people, using safety and ribbed shoes, carrying two people, and observing the principles of manual handling can be useful. In the case of the risk of electrocution, such risks can be reduced or controlled by solutions such as keeping the area around the device dry, checking the ground system, using electrical insulation shoes and gloves, and if possible, using insulated footrests in the operator's presence. It is also recommended to use a mask and install local ventilation for chemical hazards.

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