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Occupational Health and Safety-Based Hazard Identification and Risk Assessment in Industrial Manufacturing

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Abstract :- This manuscript presents an investigation into the hazards and associated risk levels in one of South India's leading textile industries. The study highlights the need, methodology, and outcomes of applying the Hazard Identification and Risk Assessment (HIRA) technique. The assessment was conducted in the rotary printing and dyeing departments, where risk levels were quantified by multiplying severity and probability values. Control measures were proposed for each activity and area identified with potential safety concerns. The identified hazards were primarily categorized under physical, chemical, ergonomic, material handling, health-related, and electrical risks. The quantified risk assessment provided a systematic basis for prioritizing hazards and implementing appropriate control strategies.

Keywords: Rotary printer, Loop ager, A-Frame, HIRA, ALARP

1. Introduction

The textile industry is often regarded as the backbone of the manufacturing sector, as it constitutes one of the largest contributors in terms of number of units. In Tamil Nadu alone, there are about 1,381 mills, each employing an average of 27 workers. Broadly, the textile industry can be classified into five major functional units: ginning, garment, spinning, dyeing, and weaving.

Faisal Hannan (2015) and Nimkar (2016) developed HIRA (Hazard Identification and Risk Assessment) charts tailored specifically for the textile sector, emphasizing HIRA as an effective safety engineering tool for identifying workplace hazards. A typical HIRA sheet generally consists of the following components: activity under consideration, nature of the task (routine/non-routine), type and description of the hazard, possible consequences or impacts, personnel at risk, existing control measures, risk levels associated with current controls, recommended additional controls, revised risk levels after implementation, and the designation of responsible persons for action.

Nazia Malik et al. (2010) examined textile workers and found that the majority were uneducated, which significantly hindered their understanding of workplace safety practices. The study stressed the need for strong management commitment to address potential safety issues. Similarly, Hafiz Danish Ashraf et al. (2009) highlighted that noise levels within industrial premises should strictly comply with regulatory limits, placing the responsibility on management to mitigate excessive exposure. Tiwari Meenaxi et al. (2012) further reported that musculoskeletal disorders among textile workers often stem from awkward and extreme postures adopted during work activities.

2. Methodology

The HIRA technique is typically implemented through four sequential procedures. **Hazard identification** involves recognizing potential harmful elements present in the workplace. **Risk assessment** is carried out by assigning numerical values, generally ranging from 1 to 25, to represent the level of risk. **Risk analysis** then evaluates the severity of consequences and the likelihood of occurrence. Finally, **monitoring and review** are conducted to develop and implement additional control measures, ensuring continuous improvement in workplace safety.

3. HAZARD IDENTIFICATION AND RISK ANALYSIS IN PRINTING AND DYEING UNIT.

Sl No	Machine/ Location	Hazards	Existing Control measures	Risk Level			Additional Control Measures	Residual		
				P	S	R		P	S	R
MACHINE HAZARDS										
1	Rotary printing machine no.1 trench cover	Trench cover getting rusted and damaged. At any time it can break	No existing control measures	4	3	12	Need to provide new trench cover which should not rust easily.	1	3	3
2	Walking path (near colour room)	Trench cover getting rusted and damaged. At any time it can break	No existing control measures	4	3	12	Need to provide new trench cover which should be rust easily.	1	3	3
3	Rotary printing machine no.2	Machine cover is in the open condition. Rotating parts are inside. Operators may get caught between rotating parts	No existing control measures	3	4	12	Need to close the door once maintenance work has been completed.	1	4	4
4	Rotary printing machine no.1	Steam line insulation damaged	Insulation provided but got damaged	3	4	12	Need to provide full cover insulation.	1	4	4
5	Loop ager machine no.1	Duct exhaust pump insulation damaged	Insulation provided but got damaged	3	4	12	Need to provide full cover insulation.	1	4	4
6	Loop ager machine no.1	Cables are kept backside corner of loop ager 1	Nil	3	3	9	Need to remove cables	1	3	3
7	Rotary printing no.2	Safety guard not fixed in floor. A-frame may damage the motor	Guard is there, but not fixed.	3	3	9	The mechanical team should fix the guard on the floor.	1	3	3
8	Old Color room	Safety material cage not properly maintaining. At the emergency situation, it cannot be used.	Safety material provided but not maintained properly	3	4	12	Department in charge needs to take strict action and keep material safely.	1	4	4

9	Loop ager machine no.1	Oil leakage and insulation also not provided.	No existing control measures	3	4	12	Need to arrest oil leakage and provide insulation	1	4	4
10	A-frame	Due to overload, employees getting strain while moving A- frame.	No existing control measures	3	3	9	Training must be provided for workers on ergonomic practices that are to be followed in material handling.	1	1	1
11	A-frame	Due to overload, A-frame may tilt.	Advised printing department to do not load more than 1000kgs	4	5	20	A-frame should not load more than 1000 kgs. The mechanical team should periodically check the A-frame condition.	1	5	5
12	A-frame	Chances of workers foot getting hit by A- frame during transport of fabric roll.	Safety shoe provided for protection (Many operators were noticed not wearing safety shoe) and safe handling training is given.	3	2	6	Strict compliance to be adopted for the benefit of workers. (Incentive for the day will be cut if the operator is found to be without PPE)	3	1	3

Table.1. HIRA Chart – Old rotary printing process

Sl No	**Hazards**	**Consequences**	**Existing Control measures**	**Risk Level**			**Additional Control Measures**	**Residual**		
				P	S	R		P	S	R
MANUAL CHEMICAL HANDLING, LOADING & STORAGE										
1	While mixing the dyes and chemical there is a chance of chemicals will splash on the eye.	Eye injury, Chemical burn, etc.,	PPE's are given. Chemical safety training is given	3	3	9	Should be regularly trained on the safe handling of chemicals	2	3	6
2	while carrying chemical from store to the machine there is a chance of chemicals will spill.	Eye injury, Chemical burn, etc.,	PPE's are given. Chemical handling safety training is given	3	3	9	Should be regularly trained on the safe handling of chemicals	2	3	6
3	While mixing the dyes and chemical there is a chance of inhalation of dye particles	Respiratory problem	PPE's are given. Chemical handling safety training is given	3	3	9	Stickily adopted to use PPE. Should be regularly trained on the safe handling of chemicals	2	3	6

4	There is a chance of a violent reaction if some of the chemicals get reactive	Scalding accidents	Chemical handling safety training is given. Reactive chemicals kept separately	2	4	8	Should educate the workers about the reactivity of chemicals	1	4	4

HIRA OF DYEING MACHINE

Chances of getting burn injury if touch the machine with bare hand while loading and unloading the fabric into the machine.	Burn Injury	1. Nitrle and PVC gloves are provided.	3	3	9	Operators should be regularly trained and create awareness about hazards.	2	3	6
Chances of hitting the passengers or workers while moving the trolley.	Leg or hand injury	Safety shoes are provided	3	2	6	Strict compliance should be adopted. Operators should be regularly trained.	2	2	4
workers foot may get affected due to chemicals and water spilt on the floor.	Foot injury	Safety shoes are provided	4	3	12	Stagnation water should be cleaned regularly. Strict compliance should be adopted. Operators should be regularly trained and create awareness about hazards.	2	3	6
Chances of getting burn injury if contact with the steam line	Burn Injury	Awareness training is providing regularly.	2	3	6	All steam line should be insulated and barricade the area if it able to touch easily by workers	1	3	3
Chances of operator slip and fall from the stand during operating the machine.	Can lead to head injury/ Body injury	The operator must take precautions.	3	2	6	The slippery surface should be cleaned immediately. Operators should be regularly trained and create awareness about hazards.	2	2	4

4. RESULTS AND DISCUSSION

Risk analysis was carried out for various activities in the dyeing unit and the old rotary printing unit. The quantified risk levels were found to range between **5 and 12** for the dyeing process, and between **6 and 20** for the printing process. In addition, the risks were qualitatively categorized into **low, medium, high, and very high levels** using contour color coding. Based on the findings, multiple hazards were identified, and corresponding practical control measures were proposed for effective risk mitigation.

CONCLUSION

This study identified a range of hazards categorized under **mechanical, electrical, material handling, chemical, ergonomic, and extreme temperature aspects**. Corresponding control measures were recommended in line with the hierarchy of controls, including elimination, substitution, engineering controls, administrative measures, and the use of personal protective equipment (PPE). The analysis revealed that several processes in the dyeing and printing units carry a **very high level of risk**, necessitating immediate intervention. In addition, a number of activities were found to be associated with a **medium level of risk**, for which appropriate control measures have also been suggested.

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