
RISK PRIORITIZATION OF ENVIRONMENTAL ASPECTS AND OCCUPATIONAL HEALTH SAFETY IN TEXTILE INDUSTRIES OF GAZIPUR INDUSTRIAL AREA, BANGLADESH

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ABSTRACT

Though textile industries are the backbone of country's economy; it possesses the environmental and occupational health safety risks also. After the Rana Plaza tragedy, the environmental and occupational health safety regulations become started to come spotlight. However, still there found anomalies that threaten environmental and occupational health safety. So to get an overview of present risk levels in different industries, the aim of this study was set to evaluate the risk prioritization for both environmental aspects and occupational health safety. A total of 10 textile industries were selected and a direct field survey along with an interview from workers to top management was done to conduct the study. Risk assessment results for environmental aspects showed that water pollution shows a moderate risk rating value while air quality, soil quality, noise, waste generation, hazardous material handling, and miscellaneous use showed low risks. Again calculated results for occupational health safety showed that necessary action is recommended to avoid future risk in all-hazard categories of different types except for electrical hazards. Controlling measures were suggested in accordance with the risk priority. Thus it is high time to explore and evaluate the risk level and take necessary action on the resultant priority basis.

Keywords: Environmental Aspects, Occupational Health Safety, Risk, RPN, Textile Industry.

INTRODUCTION

Textile industries play a pivotal role in the rapid economic growth of Bangladesh (World Bank, 2012). The contribution of the textile sector to the country's total export revenue is more than 80% that is 28 billion USD/year and the projected revenue is 50 billion USD by the year of 2021 (Hossain et al., 2018). However, this great success comes with environmental deterioration along with occupational health safety risks. Different types of environmental aspects like water discharge, air quality, soil

quality, noise, waste generation, energy consumed, a resource used, hazardous materials storage, and miscellaneous issues were considered to be major sources of environmental impacts in the Gazipur industrial area. Heavy metals like Cr, Ni, Zn, Hg, Pb, Cu, Cd, As, etc. are released from the textile industries that pollute the river, soil, and consequently the food chain when this polluted water is used for irrigation purpose to cultivate the seasonal crops (Islam et al., 2013). Several occupational health hazards are found in the textile industries of Bangladesh. Some of them were so drastic that international textile market trade was likely to fall on its edge. One of the worst examples is the Rana plaza accidental disaster in 2013 that killed over 1100 workers and the devastating fire of Tajreen garments in 2012 killed over 100 workers (Khan, 2017). So risk leveling of environmental aspects and occupational health safety along with their remedial measures is very important to avoid the disaster. However, enforcement of these remedial in perspective of risk rating is very much challenging. The reasons for enforcement hindrance are insufficient resources (knowledge, human resource, and funds), the unwillingness of industry owners, economic corruption, political imbalance, and inadequate coordination among the concerned agencies. Since there is no sufficient data for risk evaluation of environmental aspects and occupational health safety hazards, this study could act as a baseline survey for further rigorous study regarding the environmental and occupational compliance sector of Bangladesh.

METHODOLOGY

This study was conducted to confine the current status of environmental aspects and occupational health safety scenarios in the scale of risk evaluation to develop a research hypothesis. A total of 10 different textile industries in the Gazipur area were selected to conduct the survey. This survey was designed to collect information about the environmental aspects and occupational health safety practices in the selected industries directly from the field survey as well as interviewed from the worker to top management. All the collected data were processed and analyzed chronologically. One of the real constraints of the investigation was their privacy maintenance. Taking pictures and gathering information inside the factory premises were very much challenging since the authorities didn't want to disclose their in site scenario publicly. Therefore none of the names of studied industries are disclosed in this manuscript.

Data Responders

A total of 490 respondents were selected from 10 industries where 100 data responders (10 from each industry) from management and 390 respondents (39 from each industry) from the worker level. In this analysis, about 98% (38 out of 39 respondents) of management body know very well about environmental and occupational compliance while only 15% (59 out of 390 respondents) workers know about these compliances in very primary level and rest of 85% (331 out of 390 respondents) workers know nothing about this matter.

Risk Evaluation for Environmental Aspects

The identification of environmental aspects and impacts is important to the selection of environmental safeguards and work methods for operational activities. Risk evaluation of environmental aspects depicts the magnitude of potential consequence (level of environmental impacts) and the likelihood (level of probability of occurrence) (PERSEUS, 2012).

$$\text{Risk (R)} = \text{Likelihood (L)} \times \text{Consequence (C)}$$

This C×L matrix displays the qualitative or semi-quantitative rating of consequence and likelihood that specific data will occur to generate a risk score and risk rating. Risk rating data shows the level of risk in absence of a controlled environment and is arrived at after measuring the likelihood and the consequence of an event occurring (Endeavour Technical Limited, 2015).

Risk Evaluation for Occupational Health Safety

The Failure Mode and Impact Analysis (FMEA) method are followed for occupational risk safety analysis (Yari, 2017; Wang et al., 2018). This method enhances the safety and reliability level by providing early detection and elimination of failures (SAE International, 2020). In this way, risk prioritization is done by taking into the multiplication of severity, probability, and detectability that is known as Risk Priority Number or RPN (Yang & Wang, 2015; Zhang & Chu, 2011).

$$RPN = \text{Severity} \times \text{Probability} \times \text{Detectability}$$

Here, severity is the consequence of the failure; occurrence is the probability or the frequency of failure occurring, and detection is the probability of the failure being detected before the impact of the effect is realized. If the RPN result crosses 100, necessary action is recommended. The maximum value of RPN is 1000 (Kumar et al., 2014).

RESULTS AND DISCUSSION

Risk Rating for Environmental Aspects

Environmental aspects can be attributed to the activity that interferes with the natural environmental condition called the impact that is the resultant of an aspect (Susanto & Mulyono, 2018).

Table 1. Risk Assessment Level of Environmental Aspects

Environmental Aspects	Potential Impacts	Identified Risk	Risk Evaluation				Risk Rating		Control Measures/Mitigation
			Likelihood		Consequence		Score	Level of Risk	
			Condition	Score	Condition	Score			
Water Discharge	Water Pollution	>Disposal of chemical. >Effluent from ETP. >Disposal of used oil for machine maintenances. >Sewage discharge	Possible	3	Moderate	2	6	Moderate Risk	>Chemical store should be maintained properly. >Optimization of Effluent Treatment Plant (ETP) operation is highly recommended.
Air Quality	Air Pollution and Dust Emission	Dust and other exhaust atmospheric emission i.e. emission of SO ₂ , NO _x , CO, SPM, etc. occur due to the stack gas of generator and vehicular movement in and outside of the factory area.	Possible	3	Minor	1	3	Low Risk	>Factory chimney should be functional 24/7. >Water spraying can be done to reduce dust pollution on the nearby road. >Ensuring vehicles, generators, compressors are well maintained. >Proper ventilation system should be designed. >Use of PPE like a mask, apron should be used mandatorily
Soil Quality	Soil Pollution	>Leakage of oil from vehicles	Unlikely	2	Moderate	2	4	Low Risk	>Proper solid waste management should be followed

	and Erosion	and other maintenance works >Maintenance work that excavates soil. >Chemical spillage							
Noise	Noise Pollution	>Noise is generated from vehicle movement, operation of the generator, compressor, and other heavy vibrating types of machinery.	Possible	3	Minor	1	3	Low Risk	More use of PPE like earplug/ear muffs in noisy workplace
Waste Generation	Surrounding Environmental Pollution	>Impact of disposal waste >Hazardous chemical/biomedical waste. >Non-persistent material e.g. paper, cardboard, etc. >Persistent material e.g. plastic, scrap, etc. >E-waste. >Kitchen waste.	Possible	3	Minor	1	3	Low Risk	>Introducing 3R (Reduce, Reuse, Recycle) waste management. >Medical waste generated by the factory should be handed over to the local hospital.
Energy Used	Power Consumption	>Chemical/oil spillage in the generator room. >Pb, Cd, Hg pollution from scrap battery and solar panel	Unlikely	2	Minor	1	2	No-Risk	>Handling of chemicals and oil should be done properly. >Older battery and solar panel should be disposed of properly
Resources Used	Infrastructure Development	>Land. >Building. > types of machinery. >Tools. >Trees etc.	Unlikely	2	Minor	1	2	No-Risk	>Land management and building design should be done properly.
Ecological View (Flora & Fauna)	Loss of Habitat of some Flora and	>Unplanned constructi	Unlikely	2	Minor	1	2	No-Risk	>Maintain maximum vegetation. >Implementation of agroforestry techniques well adapted to the site.

	Fauna and Biodiversity Reduction	on and design >Inappropriate control of weeds							
Hazardous Materials Storage and Handling	Occurrence of accidents	Accidental spillage and fire occur due to personal error or natural events.	Unlikely	2	Moderate	2	4	Low Risk	>Proper inspection of maintenance and storage of hazardous goods should be monitored regularly.
Miscellaneous Issues	Others Incidents	>Imbalance of political condition. >Worker imbalance >Production loss. >Visual appearance.	Unlikely	2	Moderate	2	4	Low Risk	>Management should be aware of workers legal demand

There is a significant amount of water, energy and other resources are consumed by the studied industries. Based on an environmental point of view, a list of environmental; aspects, their risk rating along controlling measures are organized in Table 1. A moderate risk rating was found for water pollution impacts. Though there was ETP in most of the studied industries, there showed some anomalies like ETP did not run 24 hours, lack of ETP servicing hindered the ETP efficiency, personal error, maintenance, and chemical cost and last but not least is the lack of ETP performance optimization. Other environmental aspects like soil quality, air quality, noise, waste generation, hazardous material handling, and miscellaneous issues though were found to be possessed low risk, they could be upgraded to more negative risk levels in the near future if a proper controlling measure is not taken immediately. However environmental aspects like energy used, a resource used, and ecological view in the industrial area were found to be relatively at the safe level from risk. All the control measures are given accordingly.

Risk Rating for Occupational Health and Safety

Spinning, weaving, dyeing, printing, and garments sections were studied in the 10 industries. Hazards occurred in these industries are classified into 7 different categories- physical hazard, fire hazard, electrical hazard, chemical hazard, ergonomic hazard, psychosocial hazard, and biological hazard. These categories were subdivided into different hazard types. The consequences of these hazards were rated with an RPN number to recommend whether necessary action would be required or not (Table 2). Remedial measures are also listed in the same table. Risk prioritization is found for most of the hazard types. The highest number of RPN (RPN=384) was found for hazard type of dyes from the chemical hazard category that causes water pollution in the nearby water bodies though ETP was found in almost all the surveyed industries. The cause of this RPN number either the lack of proper operational optimization or lack of proper handling of dyes materials. These dyes material are hazardous to workers' health. For example, dyes can cause skin and eye irritation, lung inflammation, and other respiratory problems (Bansal & Yadhav, 2016).

Table 2. Risk Leveling of Occupational Health Hazards

Hazard Category	Hazard Type	Consequences	RPN (Probability×Detection×Severity)	Necessity of Action	Remedial Measures
Physical Hazard	Noise	Hearing loss	10×6×6=360	Action Required	>Proper servicing of the heavy types of machinery. >Use of soundproof materials and earplug
	Dust	Respiratory Disease	8×7×6=336	Action Required	>Proper housekeeping >Use of PPE widely
	Light	Eye stress	3×3×3=27	Not Required	>Optimized light set up
	Temperature	High temperature create dehydration and blood pressure anomalies	8×6×6=288	Action Required	>High temperature in the working place should be controlled
	Improper Ventilation	Lung function Change	4×3×3=36	Not Required	>Proper ventilation system should be installed
Fire Hazard	Welding	Spark ignition	3×2×3=18	Not Required	>Restrict the welding area for movement
	Smoking	Common accidental source	5×4×5=100	Action Required	>Smoking should be banned in the working place. >Safety sign should be maintained
Electrical Hazard	Improper Earthing	Trip occurs	3×2×3=18	Not Required	>Should check earthing connection properly
	Short Circuit	A common source of the fire accident	5×3×6=90	Not Required	>Air Circuit breaker and motor circuit breaker should be installed.
	Improper Isolation	Electric shock	3×3×4=36	Not Required	All circuits should be

					installed properly.
	Motor Rotation in High Voltage	Problems occur in machine performance	$3 \times 3 \times 3 = 27$	Not Required	>Individual circuit breaker should be installed.
	Old Wiring	Anomalies in current flow	$6 \times 4 \times 4 = 96$	Not Required	Check for old wiring to avoid accidents.
	Power Input-Output Imbalance	Power shut down	$3 \times 4 \times 2 = 24$	Not Required	>Wiring should be done according to the standards.
Chemical Hazard	Dyes	Skin and lung disease	$8 \times 6 \times 8 = 384$	Action Required	>ETP must be installed with optimization
	Different Types of Chemical	Skin and lung disease	$7 \times 6 \times 6 = 252$	Action Required	>Proper handling and storage should be followed
	Used oil and grease	Skin and lung disease	$6 \times 5 \times 5 = 150$	Action Required	>Proper handling and storage should be followed
Ergonomic Hazard	Uncomfortable Work station	Leg and hand pain	$4 \times 4 \times 3 = 48$	Not Required	>Should give importance to ergonomics
	Repetitive Strain Injuries	Wrist, neck, shoulder, knee pain	$6 \times 5 \times 6 = 180$	Action Required	>Proper working procedure should be followed.
	Improper Handling of Material	Wrist, neck pain	$4 \times 4 \times 4 = 64$	Not Required	>Proper handling and storage should be followed
	Poorly Designed Work Practice	Hand pain, back pain	$2 \times 3 \times 4 = 24$	Not Required	>Proper working procedure should be followed
	Long Time sitting	Headache, dizziness, nausea	$5 \times 5 \times 6 = 150$	Action Required	>Should take a break at least 5 minutes after 1-hour documental work

	Heavy Weight Lifting	Back pain	$3 \times 3 \times 3 = 27$	Not Required	>Should not uplift the heavy weight alone.
	Unsafe Work Place	Accidents may occur	$3 \times 3 \times 4 = 36$	Not Required	Working place should be designed with safety measures.
Psychosocial Hazard	Not Interested to Work willingly due to lack of Motivation	Physiological problem	$7 \times 5 \times 6 = 210$	Action Required	>Working department should be favorable. >Holiday, bonus, salary should be given properly
	Production Target	Stress	$6 \times 5 \times 5 = 150$	Action Required	The working department should be favorable.
	Increased Workload	Stress, heart rate changes	$7 \times 6 \times 6 = 252$	Action Required	The workload should be distributed evenly.
	Night Shift	Headache, dizziness, nausea	$5 \times 4 \times 5 = 100$	Action Required	The working department should be favorable.
	Over Time	Stress, tired	$5 \times 5 \times 5 = 125$	Action Required	The working department should be favorable.
Biological Hazard	Contagious Diseases	Fever, pox, TB, Covid-19	$5 \times 5 \times 5 = 125$	Action Required	Always should be cautious about if a person feels ill or affected by any other disease especially contagious disease.

The least RPN number (RPN=18) was found for improper earthing of electrical hazard. This means that earthing was found to be done properly in all the studied industries. According to the RPN data, the descending order of listed hazards are leveled in the following order- physical hazard: noise>dust>temperature>improper ventilation>light; fire hazard: smoking>welding; an electrical hazard: old wiring>short circuit>improper isolation>high voltage motor rotation>power input-output imbalance; a chemical hazard: dyes>chemicals>used oil and grease; an ergonomic hazard: repetitive

strain injury>long time sitting>Improper material handling>Uncomfortable work station>unsafe work place>heavy weight lifting>poorly designed work practice; a psychosocial hazard: increased work load>willingness to work>production target>over time>night shift. This type of risk prioritization is also done by Kumar et al. (2014); Liu et al. (2012) and Chang (2016). The resultant o these RPN values make the risk understandable and recommend taking necessary action whether it is necessary or not to minimize it to a tolerable level. Infection of COVID-19 also seems to be hazardous (Shuvro & Talukdar, 2020).

CONCLUSION

Textile industries in the Gazipur area are confronted with a number of significant environmental and occupational health safety challenges. However, none of these challenges are unfeasible to overcome. The resultant risk leveling data for both environmental and occupational health safety scenarios would be of great use to policymakers, urban authorities, planners, researchers, and stalk holders of the industries for exploring towards sustainable development of the country.

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