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 tear 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, Ob, 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 livelihood 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).

\[ \text{RPN} = \text{Severity} \times \text{Probability} \times \text{Detectability} \]

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 | Likelihood | Consequence | Score | Level of Risk |
|------------------------|-------------------|-----------------|------------|-------------|-------|---------------|
| Water Discharge        | Water Pollution   | Disposal of chemical, Effluent from ETP, Disposal of used oil for machine maintenance, Sewage discharge | Possible | Moderate | 3 | Moderate Risk |
|                        |                   |                 |            |             |       |               |
|                        |                   | Disposal of used oil for machine maintenance | Unlikely | Moderate | 2 | Low Risk |
| Air Quality            | Air Pollution and Dust Emission | Dust and other exhaust atmospheric emission i.e. emission of SO₂, NOx, CO, SPM, etc. occur due to the stack gas of generator and vehicular movement in and outside of the factory area. | Possible | Minor | 3 |           |
| Soil Quality           | Soil Pollution    | Leakage of oil from vehicles | Unlikely | Moderate | 2 |           |
| and Erosion and other maintenance works | Possible | Minor | 1 | 3 | Low Risk | More use of PPE like earplug/ear muffs in noisy workplace |
| 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 |
| Waste Generation Surrounding Environmental Pollution | Impact of disposal waste | Possible | 3 | Minor | 1 | 3 | Low Risk |
| Energy Used Power Consumption | Chemical/oil spillage in the generator room. | Unlikely | 2 | Minor | 1 | 2 | No-Risk |
| Resources Used Infrastructure Development | Land, Building, types of machinery, Tools, Trees etc. | Unlikely | 2 | Minor | 1 | 2 | No-Risk |
| Ecological View (Flora & Fauna) Loss of Habitat of some Flora and Fauna | Unplanned construction | Unlikely | 2 | Minor | 1 | 2 | No-Risk |

- **Noise**: Noise is generated from vehicle movement, operation of the generator, compressor, and other heavy vibrating types of machinery.
- **Waste Generation**: Impact of disposal waste, hazardous chemicals/biomedical waste, non-persistent material (e.g., paper, cardboard, etc.), persistent material (e.g., plastic, scrap, etc.), E-waste, Kitchen waste.
- **Energy Used**: Chemical/oil spillage in the generator room, Pb, Cd, Hg pollution from scrap battery and solar panel.
- **Resources Used**: Land, Building, types of machinery, Tools, Trees etc.
- **Ecological View**: Unplanned construction.
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, Producton loss, Visual appearanc e, 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. |
|                 | Electrical Hazard | Improper Earthing | Trip occurs | 3×2×3=18                          | Not Required       | >Should check earthing connection properly. |
|                 |             |              |                                    |                    | >Air Circuit breaker and motor circuit breaker should be installed. |
|                 | Short Circuit | A common source of the fire accident | 5×3×6=90            | Not Required       | All circuits should be |
|                 | Improper Isolation | Electric shock | 3×3×4=36                      | Not Required       |                    |
| Hazard Type                        | Material          | Symptom                                      | Calculation | Action Required | Notes                                                                 |
|-----------------------------------|-------------------|----------------------------------------------|-------------|-----------------|------------------------------------------------------------------------|
| **Motor Rotation in High Voltage** | Problems occur in machine performance | 3 × 3 × 3 = 27                               | Not Required| > Individual circuit breaker should be installed.                      |
| **Old Wiring**                    | Anomalies in current flow               | 6 × 4 × 4 = 96                                | Not Required| Check for old wiring to avoid accidents.                               |
| **Power Input-Output Imbalance**  | Power shut down                              | 3 × 4 × 2 = 24                               | Not Required| > Wiring should be done according to the standards.                    |
| **Chemical Hazard**               | Dyes                                          | Skin and lung disease                        | 8 × 6 × 8 = 384 | Action Required | > ETP must be installed with optimization                               |
| **Different Types of Chemical**   | Skin and lung disease                        | 7 × 6 × 6 = 252                              | Action Required| > Proper handling and storage should be followed.                      |
| **Used oil and grease**           | Skin and lung disease                        | 6 × 5 × 5 = 150                              | Action Required| > Proper handling and storage should be followed.                      |
| **Ergonomic Hazard**              | Uncomfortable Work station                  | Leg and hand pain                            | 4 × 4 × 3 = 48  | Not Required      | > Should give importance to ergonomics                                 |
| **Repetitive Strain Injuries**    | Wrist, neck, shoulder, knee pain            | 6 × 5 × 6 = 180                              | Action Required| > Proper working procedure should be followed.                         |
| **Improper Handling of Material** | Wrist, neck pain                             | 4 × 4 × 4 = 64                               | Not Required | > Proper handling and storage should be followed.                      |
| **Poorly Designed Work Practice** | Hand pain, back pain                         | 2 × 3 × 4 = 24                               | Not Required | > Proper working procedure should be followed.                         |
| **Long Time sitting**             | Headache, dizziness, nausea                 | 5 × 5 × 6 = 150                              | Action Required| > Should take a break at least 5 minutes after 1-hour documental work |
| Hazard Type                  | Hazard Details                                                                 | RPN Calculation | Action Required | Remarks                                                                                      |
|-----------------------------|--------------------------------------------------------------------------------|-----------------|-----------------|---------------------------------------------------------------------------------------------|
| Heavy Weight Lifting        | Back pain                                                                      | 3 × 3 × 3 = 27  | Not Required    | Should not uplift the heavy weight alone.                                                    |
| Unsafe Work Place           | Accidents may occur                                                            | 3 × 3 × 4 = 36  | Not Required    | Working place should be designed with safety measures.                                      |
| Psychosocial Hazard         | Not Interested to Work willingly due to lack of Motivation                      | 7 × 5 × 6 = 210 | Action Required | Working department should be favorable. Holiday, bonus, salary should be given properly.    |
| Production Target           | Stress                                                                          | 6 × 5 × 5 = 150 | Action Required | The working department should be favorable.                                                  |
| Increased Workload          | Stress, heart rate changes                                                     | 7 × 6 × 6 = 252 | Action Required | The workload should be distributed evenly.                                                   |
| Night Shift                 | Headache, dizziness, nausea                                                    | 5 × 4 × 5 = 100 | Action Required | The working department should be favorable.                                                  |
| Over Time                   | Stress, tiered                                                                  | 5 × 5 × 5 = 125 | Action Required | The working department should be favorable.                                                  |
| Biological Hazard           | Contagious Diseases: Fever, pox, TB, Covid-19                                   | 5 × 5 × 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 > 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 resultants 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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