

Case Report

Effects of Industrial Operations on Socio-Environmental and Public Health Degradation: Evidence from a Least Developing Country (LDC)

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Abstract: Socio-ecological consequences emanating from inadequate compliance of environmental standards by the business firms' operations in institutionally weak developing countries must be included in the research on organizations and their relationship with the natural environment. Business firms should be held accountable for the socio-ecological degradation generated from their unsustainable business operations. To improve our understanding of the environmental degradation created by polluting manufacturing firms in developing countries, we have adopted an exploratory qualitative research approach. Results of this study indicate that polluting industries' (e.g., tannery, pulp & paper, fertilizer, textile, and cement) unsustainable practices have enormous impact on human health and the natural environment, resulting in enormous socio-ecological problems that ultimately create huge social costs in countries such as Bangladesh. Corporate environmental responsiveness is largely nonexistent in the polluting industries in Bangladesh.

Keywords: socio-ecological problems; industrial firms' operations; institutional pressure; corporate environmental responsiveness; developing country; Bangladesh

1. Introduction

The World Trade Organization (WTO) agreement, Generalized special preferences (GSP), and Global value chain (GVC) have promoted industrialization in the selected developing countries where availability of low-cost manpower, a basic industrial base, and institutional flexibility are available. Many labor-intensive and polluting industries have been relocated to these countries. Many of these activities' only objective is to create profit without calculating the socio-environmental consequences of their activities. The objective of this paper is to explore and evaluate industrialization in developing countries and its consequences on socio-environmental degradation. Boons [1] argues that socio-ecological problems relating to business operations need to be incorporated into research on organizational performance and the natural environment. Socio-ecological problems are created when business firms conflictingly interact with local ecosystems (e.g., nearby rivers, wetlands, lakes, or forests) [2]. Business organizations are directly or indirectly connected with biophysical ecosystems [3] because business organizations and societies largely depend on ecosystem resources [3,4]. Unfortunately, business firms', especially industrial firms', operations are greatly responsible for the depletion of ecosystem resources, resulting in large costs on both society and the economy in developing countries [5]. According to Ling and Issac [6], developing countries have

benefited from industrialization, however side by side with these benefits they face socio-ecological problems caused by industrial firms' operations. Furthermore, untreated industrial effluents from industrial firms' operations have adverse impacts on human health, the natural environment, and socio-economic aspects [7–11]; that is, industrial pollution is greatly responsible for environmental degradation, one of the prime concerns of society today [12].

Corporate business leaders have become more responsive towards society's institutions and natural ecosystems because of the recent failures of many large businesses associated with lack of corporate social responsibility [13–16]. Industrial firms (i.e., polluting industries) are facing tightened government regulations as environmental issues are now a major social concern [17]. That is why the language of greening has become an integral part of business across a wide range of industries [18]. A question remains though: What is the major corporate responsiveness towards environmental sustainability? We define corporate responsiveness as the way that corporations can either prevent or find a way to restore the damage created by industrial activities. Researchers [19–21] argue that there are three major aspects of corporate environmental responsiveness: (i) pollution prevention, (ii) pollution control, and (iii) environmental restoration. It is noted here that environmental restoration focuses on addressing the environmental harm created by a firm's operations. Organizations can respond to environmental sustainability by implementing environmental actions, such as pollution prevention, pollution control, and environmental restoration [21,22]. Wartick and Cochran [23] argue that corporate environmental responsiveness to institutional pressure is enhanced when top management's commitment to the natural environment is high. It is clear that unsustainable operations of industrial firms create socio-ecological problems [24], which need to be addressed through corporate environmental responsiveness (i.e., pollution prevention, pollution control, and environmental restoration).

2. Institutional Pressure and Environmental Management Practices

Since the 1960s, business firms have been facing increasing institutional pressure to attend to environmental sustainability in their corporate agenda [25]. Further, business firms have also been facing institutional pressures to surpass local social responsibility requirements because of rapid globalization [26,27]. The institutional environment (e.g., government, society, and community groups) imposes significant pressure on firms to justify their strategic actions and outputs [27,28]. According to researchers [29,30], organizations must respond to a variety of institutional pressures and demands embodied in regulations, norms, laws, and social expectations. Further, organizational scholars have recognized organizational responsiveness to institutional pressures as a strategic choice [29,31]. Institutional pressures may expedite firms to participate in strategic alliances in order to gain social legitimacy or acceptance within society as conformity to social expectations [32–36]. Social legitimacy is a key factor in determining a business facility's long-term profitability and survival [35]. Environmentally legitimate firms can attract customers and employees more successfully than poor performers [17]. According to institutional and ecological theories, legitimating linkages to well-established societal institutions to reduce the likelihood of organizational failure [33]. The institutional perspective assumes that in seeking social legitimacy, a firm will abide by all essential formal environmental regulations or informal environmental protection demands [19,37]. However, because of an institutional void and lack of adequate awareness in developing countries, firms do not feel pressurized to respect institutional perspectives [38].

According to institutional theory, institutions consist of formal rules (laws and regulations) and informal constraints (cultures, customs, and norms) [39,40]. Institutions have three aspects or pillars or models: regulative, normative, and cognitive [28,41]. Regulative (or legal) aspects are based on the legal sanction of firms, and also cover government regulations, protests, lawsuits, political lobbying, and stakeholder negotiation [39,41,42]. Normative (or social) aspects of institutions generally take the form of rules-of-thumb, standard operating procedures, and occupational standards [43]. Cognitive

(or cultural) aspects or models of institutions recognize the role of social classification and cognition as elements of everyday social reality [39,42].

According to institutional theory, institutionalized activities happen because of influences on three levels: individual, organizational, and inter-organizational [34]. This study emphasizes how institutionalized activities occur due to influence at the inter-organizational level. At the inter-organizational level, pressures come from government, industry alliances, and societal expectations (e.g., rules, norms, and standards about product quality, occupational safety, or environmental management) [34,35]. Institutional pressures at the inter-organizational level or inter-firm level influence firms to adopt environmental management practices [44]. Jennings and Zandbergen [45] were pioneers who first applied institutional theory to explain firms' adoption of environmental management practices [44]. Institutional theory has been extensively used in the study of organizational responsiveness to environmental issues [19–21,42–50]. Further, institutional theory has also been applied in analyses of corporate sustainability [51], sustainability reporting [52–54], and environmental management standards [55–57]. Jennings and Zandbergen [45] argue that “the type of institutional pressure, be it coercive, mimetic, or normative, influences the rate at which sustainability practices diffuse among firms” [20].

The main objectives of this study are as follows.

1. To examine the extent to which human health related factors are affected by the firms' operations in an industrial zone at Chittagong, Bangladesh.
2. To examine the extent to which natural environment-related factors are affected by the firms' operations in an industrial zone at Chittagong, Bangladesh.
3. To examine the extent to which socio-economic factors are affected by the firms' operations in an industrial zone at Chittagong, Bangladesh.

3. Institutional Pressures and Environmental Management Practices in Bangladesh

3.1. Regulatory Pressure

Approximately two hundred environmental regulations exist around the protection and conservation of the natural environment in Bangladesh [58]. According to Reazuddin & Hoque [59], the chief environmental regulation policies are the National Environmental Policy (1992), National Environmental Action Plan (1992), Forest Policy (1994), Environmental Conservation Act (1995), Environmental Conservation Rules (1997), National Conservation Strategy (1997), Bangladesh Environment Conservation (Amendment) Act (2000), and Environmental Court (Amendment) Act (2002). These environmental regulations deal with the protection of environmental health, the control of environmental pollution, and the conservation of natural and cultural resources [60]; they are enforced and implemented by the Ministry of Environment and Forestry (MoEF) in Bangladesh [61]. However, these regulations are routinely broken due to lack of enforcement by the relevant agencies which appear to be corrupt, weak, and ineffective [62,63].

3.2. Normative Pressure

Now, what are the firms' efforts to reduce their negative environmental impacts of their industrial operations? Do they make adequate efforts to mitigate environmental harms due to their firms' operations? In Bangladesh, the Department of Environment (DoE) identified 903 polluting industrial installations, which later increased to 1317 [64]; while treatment of industrial effluents has not been given priority [65]. Most of the industries are not equipped with treatment facilities and they discharge untreated effluents into the country's rivers, canals, and lakes [8,66,67]. More than 200 tannery plants are located in Hazaribagh (Dhaka); none of these plants have a waste treatment facility, nor is there a central waste treatment plant [8,68]. It is clearly evident that the institutional pressure (e.g., the regulatory approach) from the government of Bangladesh does not work adequately to mitigate the industrial pollutants that usually generate during the time of firms' operations.

The government of Bangladesh signed and ratified a number of international conventions, treaties, and protocols relating to conservation and protection of its natural environment [69,70]; however, the government's commitment to conserve and protect the natural environment has not been performed sufficiently due to its lack of local implementation.

3.3. Cognitive Pressure

In the last decade, environmental issues have been given their due importance by society [71]. In Bangladesh, there is a rich history of civil society organizations with activity dating back to colonial times some 240 years ago [72,73]. In Bangladesh, civil society has an important role in creating the necessary social movements that protect the natural environment [74–76]; and some pro-environmental organization initiatives in pollution prevention have proved successful in several areas [74]. To exemplify, the Bangladesh Environmental Lawyers Association (BELA), the Bangladesh Poribesh Andolon (BPA), the Forum of Environmental Journalists of Bangladesh (FEJB), and the Bishwa Shahitya Kendra are pioneers in playing their role as pro-environmental organizations in their protection of the natural environment through creating and influencing environmental awareness [74,77].

4. Environmental Harm of Industrial Firms' Operations: A Socio-Ecological Problem in Bangladesh

Bangladesh is a South-Asian developing country and one of the most vulnerable countries to climate change in the world, with an extremely fragile natural environment [78,79]. According to the People's Report on the Bangladesh Environment [80], serious degradation of the three components of the natural environment—air, water, and soil—has resulted in adverse consequences for the economy. The dumping of untreated industrial effluents is mostly responsible for the degradation of the natural environment in many areas of Bangladesh [7,9,81,82]. Nishat, Shammin, Faisal, and Junaid [83] showed that on average, the incidence of illness among people living in Hazaribagh (Dhaka) is 16 percent, which is higher than those living in the control area. Adjoining residential areas are also badly and widely affected by the bad smell that emanates from the Hazaribagh Tanneries [84]. The per capita health cost has increased while the price of land has fallen by seven to eight percent in the Hazaribagh area due to pollution from the Tanneries [85]. Toxic water from the nearby dyeing factories has destroyed the 'IRRI' crop in a vast area in Ashulia near the capital [86]. Four factories of Bangladesh Dyeing Mills located at Dhaka have been polluting the natural environment by emitting toxic waste into nearby bodies of water [87]. Such huge harmful impacts have imposed large costs on both society and the economy in other areas outside of Dhaka in Bangladesh. To name but a few examples: Sylhet Pulp and Paper Mills (SPPM) pollutes the 'Surma', 'Kalni', and 'Kushiara' rivers [65]; the effluents from the Natural Gas Fertilizer Factory (NGFF), Sylhet, damages paddy fields and kills the fish [88]; gaseous ammonia from the Urea Fertilizer Factory Ltd. (UFFL), Ghorashal, has proven hazardous to workers' mucous membranes among other physical complaints [7,89]; ammonia from the Jamuna Fertiliser Factory (JFF) at Jamalpur damages crops, trees, livestock, poultry, and fish [90]; effluents from textile mills in Tangail Sadar Upazila pollutes the Louhajang river [91]; untreated liquid waste from dyeing industries in Konabari, Gazipur, poses a serious threat to the environment [92]; effluents, from dyeing factories in Bhaluka Upazila, in Mymensingh, pollutes rivers and canals [93]; and liquid waste from a dyeing factory pollutes the Shitalakhya river in Narayanganj [94]. It is clearly evident that the environmental harm from industrial firms' operations is greatly responsible for the environmental degradation in this South-Asian developing country, namely, Bangladesh. Our study site is in the Chittagong division, home to the largest seaport in the country and important industrial concentration. Thanks to the higher rate of industrialization and seaport-based economic activities, the GDP of Chittagong is approximately four times higher than the average national GDP by city population. Chittagong contributes 21% of the national GDP and has 5.18% (9 million) of national population. The following map/figure 1 shows the area of Chittagong in Bangladesh.

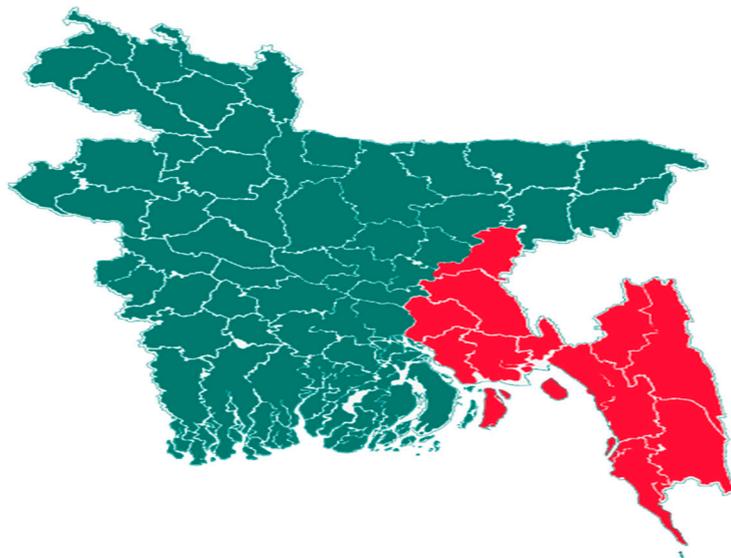


Figure 1. Area in red is the Chittagong division.

World Bank experts use the Industrial Pollution System (IPPS) to select the top ten most environment-polluting industries of Bangladesh [83]. The IPPS depends on sector estimates of pollution intensities, also called emission factors, expressed in pollution per unit of output or employment [83]. The ten most environment-polluting industries are the tannery industry (21%), pulp and paper industry (15%), pharmaceuticals industry (13%), fertilizer industry (12%), industrial chemicals (9%), textile industry (6%), food industry (6%), metal industry (5%), cement industry (4%), petroleum (3%), and others (6%) [83]. In Bangladesh, there are six heavily polluted districts (hot spots)—Dhaka, Chittagong, Gazipur, Khulna, Narayanganj, and Bogra—which represent more than 50 percent of the national pollution load; the Chittagong industrial zone is the second largest industrial zone in the country [95], where researchers had better access than any other industrial zone in Bangladesh. From the ten most polluting industries, five polluting industries located in Chittagong were selected (i.e., tannery, pulp and paper, fertilizer, textile, and cement). These “red category” industries, as the Government of Bangladesh has classified them, are the most highly polluting industries [96].

5. Research Methods

Industrialization in the developing countries received relatively less attention from researcher on socio-environmental degradation from industrial activities. Research on this issue is still emerging. An exploratory research approach based on opinion survey of mid-to-senior managers has been taken for this study.

5.1. Choice of Methodology

This qualitative research based on the case study method is an exploratory project [97]. The unavailability of large-scale quantitative data led us to use the qualitative research method in order to understand what is happening, and to develop new theoretical understanding [98]. Moreover, Stuart et al. [99] argue that the qualitative study model is not only for understanding and preliminary theory development, it can also be used for refutation of, or extension to, existing concepts and models due to their rich observational capability. According to Thietart et al. [100] there are three types of explorative research: (i) Theoretical exploration; (ii) empirical exploration; and (iii) hybrid exploration. In our study, we have adopted the third approach. Hybrid exploration brings together both theories and observations. In this context, the researcher depends on the existing literature to make sense of data that can lead to the development of new concepts and models.

5.2. Data Collection and Analysis

Regarding data collection, for this qualitative research, two industrial units from each of the five major polluting industries were purposely selected as sample plants from the Chittagong industrial zone [101]. Five executives from the operations department of each industrial plant were selected as respondents. A total of fifty managers attended our interviews. The operations manager proposed all interviewees from the operations department as key informants.

We used the method of face-to-face interview using an interview guide. Since we did not want to influence the participants, we decided to proceed by asking open-ended questions [102]. Open-ended questions allow for the collection of data on an individual's or group's perspectives, feelings, opinions, values, attitudes, and beliefs about their personal experiences and social world, in addition to factual information [103]. To improve the understanding of the questionnaire and to be sure that our prospective respondents understand our questionnaire, we conducted a pilot test with five respondents, chosen randomly, and evaluated their responses to confirm whether they understood the questionnaire or not. The interview guide consists of open-ended questions. The interviews were conducted in periods ranging from 90 min to 120 min and took place during the months of November and December 2016. The employees were able to speak freely, making this method very efficient. During the interviews, we often crossed the pre-established boundary of our discussions and thus, we have assimilated other information about the industrial activities. The following Table 1 presents the descriptive statistics about the respondents.

Table 1. Respondents from sample industrial plants presented by category.

Name of Sample Industry	Number of Sample Industrial Plants	Number of Sample Respondents
Tannery Industry	02	(5/each plant × 2) = 10
Pulp and Paper Industry	02	(5 × 2) = 10
Fertilizer Industry	02	(5 × 2) = 10
Textile Industry	02	(5 × 2) = 10
Cement Industry	02	(5 × 2) = 10
Total	10	50

We have also collected documents of the organization where our respondents are affiliated. Moreover, we have consulted newspapers and other publicly available documents to find out related news, articles, and any other documents. Eisenhardt [104] highlighted the benefits of multiple methods of data collection to provide evidence of synergy and triangulation. It is accepted that qualitative research does not always lead in a clear manner to the conclusion [105]. We ensured the description and interpretation of data. We recorded the conversations and made transcriptions after each interview. This multi-method of data collection allowed us to better recap the data and allowed for triangulation among the data.

We have also followed the three stages of data analysis recommended by Creswell [106]. The three stages are (i) data combination according to the source of the data. This stage is helpful to check collected data and decide whether there is a need for additional data; (ii) making sense of data by highlighting the broader threads of the data and (iii) the coding process.

The interviews were transcribed into an MS Word verbatim and the content analysis was performed on the interview verbatim. The collected data were coded and aggregated into categories according to their similarities and differences [100].

We have also coded transcripts made of "other publicly available documents", using the same theme previously used for the interview verbatim, collected from the focal organization and other sources. We then drew relationships between the various categories to better understand the information we had collected using QDA Miner software (version 4.0.4). We have followed the process developed by Jones and Alony [107].

The purpose of the content analysis was to provide knowledge and understanding of the phenomenon [108]. For Hsieh and Shannon [109], a qualitative content analysis is a method of research for subjective interpretation of the content of text through a process of systematic classification of coding and identification of themes or patterns. The content analysis enabled us to establish embedded information through text analysis [110,111].

Direct personal interviews, with the help of prepared questions, were conducted using a five-point Likert-type scale to collect sample respondents' opinions about the environmental harm caused by their firms' operations. We have also used a semi-structured interview guide in order to get respondent's perceptions on the effects of their operations on human health, socio-economic factors, and the environment. We have presented descriptive statistics. Data analysis of the semi-structured interviews helped gain an in-depth understanding of the issues and develop several categories of issues that were embedded into the topic of our study.

5.3. *Validity and Reliability of the Qualitative Study*

In conducting a qualitative study, meeting the requirement of reliability can be a challenging issue because interview because respondents could change their views over time. Therefore, it is an inherent challenge to find the same results with similar research over different periods of time in different kinds of organizations in terms of context, objectives, and processes. An interview guide was used for semi-structured interview and interviews were recorded, and transcribed into verbatim with utmost care. To ensure validity and reliability of this research, we used multiple sources of data (verbatim and documents from publicly available sources) [97]. We have three trained coders who coded verbatim prepared from collected data from several sources. We have then compared the two coder's coding by an author of this study. The process shows that in more than 80.5% cases, there were similarities of codes developed by the two coders. They were provided adequate training on coding and research topics, which have facilitated development of a better understanding of the coding process reflected by approximately 81% similar coding. We have also gave instructions to coders to keep aside the text where they do have doubt or find difficult in coding during the first round of coding and go back to coding those parts once completed the first round of coding. This process has contributed to improving the validity of the coding process. We have assessed reliability informally during the coder training and kept assessing during the actual coding. We then cross-checked the results and lastly, we compared them to existing literature. The respondents were offered copies of the results to thank them for their participation. Moreover, we generated and saved a database of the data collected and its findings (protocol description, questionnaire, verbatim, and online documents).

Yin [112] stated that reliability is used to minimize errors and bias in a study. It is impossible to achieve internal validity without reliability. Stronger internal validity increases reliability, making it essential to focus on this type of validity. However, according to Merriam [113], some factors can ensure the results are reliable; one is triangulation. Our approach is based on the use of multiple methods (focus groups, interviews, and content analysis) and publicly available documents. Our methods of data collection and analysis increase reliability and internal validity. Another strategy mentioned by Merriam [113] is the position of the interviewer, by which the researcher should provide a clear explanation of the theory and assumptions behind the case study, the position of the researcher to the study group, and the social environment in which the data were collected. All these issues were carefully respected. Finally, the process of verification has been undertaken, that is, the researcher explains in detail how the data were collected. In general, the reliability target is to reduce the risk of errors in the proposed research project. These criteria have been met throughout this research project.

6. Results

Our qualitative data analysis helped us to develop our understanding on polluting industries and their effect on physical environment.

6.1. Environmental Harm of Tanning Operations

Table 2 Presents the Score of affected factors related to health hazards, natural environment, and socio-economic aspects due to effluents of tanning industry.

Table 2. Effects of the tanning industry on human health, the environment, and socio-economic factors.

Human Health Factors	Score	Environmental Factors	Score	Socio-Economic Factors	Score
Skin disease	4.0	Acid rain	1.0	Livelihood	3.3
Respiratory illness	3.6	Greenhouse effect	1.3	Livestock	1.2
Children respiratory disease	1.4	Water-logging	2.1	Forest resources	1.1
Brain and nervous system effect	3.5	Effect of toxicity	0.0	Water resources	3.6
Diarrhea and stomach related disease	1.3	BOD * load	2.7	Export market	1.0
Waterborne disease	1.2	COD ** load	2.4	Quality of life	3.5
Effect of poisonous gas	1.3	Salinity of water	2.0	Grazing land	3.4
Bad smell	3.4	Soil erosion	2.8	Productivity of land	3.5
Effect of toxicity	3.8	Depletion of aquatic life	2.1	Discoloring and eroding buildings	2.6
		Decrease in fertility of land	3.0		
		Underground water pollution	2.0		
		Surface water pollution	3.8		

BOD * = Biological Oxygen Demand, COD ** = Chemical Oxygen Demand.

Health Hazards: Table 2 shows the health hazards caused by tanning operations; the most harmful health hazard is 'skin disease'. Most of the respondents report that human skin is significantly (score, 4.0) affected by tannery industrial plant operations. The other major health hazards are 'effect of toxicity', 'respiratory illnesses', 'brain and nervous system effect', and 'bad smell'. Respondents report that hydrogen sulfide is a highly poisonous gas that affects the nervous system and that chromium is toxic to human health as well as a potential skin sensitizer. In tanning operations, carbon dioxide is produced from sodium carbonate, and the inhalation of excess carbon dioxide may cause senselessness.

Environmental Hazards: Table 2 also shows the environmental hazards of operations of tannery industrial plants; here, the most environmentally harmful factor is surface water pollution. Most of the respondents report that surface water is polluted due to the toxic effluents discharged from tanning operations (score, 3.8). The other affected factors are decrease in fertility of land, depletion of aquatic life, Biological Oxygen Demand (BOD) load, Chemical Oxygen Demand (COD) load, water logging, underground water pollution, and salinity of water. Reportedly, tannery waste contains BOD: water having high BOD is harmful to aquatic life. In addition, seepage (leakage) of untreated tannery effluents results in underground water pollution.

Socio-Economic Hazards: Table 2 also shows the socio-economic hazards of tanning operations. Most of the respondents report that the depletion of water resources (score, 3.6) is high among other socio-economic hazards. Other factors i.e., quality of life, livelihood, productivity of land, grazing land, and the discoloring and eroding of buildings are also significantly affected by tanning operations. Reportedly, untreated tannery waste that pollutes water and is high in P_h can result in the reduction of soil productivity.

The findings show that managers of polluting industry informally acknowledge the consequences of their activities. One of the managers from tannery plant mentioned, "Lack of enough space and drainage system of the tanneries were responsible for environmental pollution and health problems of the tannery workers and residents in Hazaribagh area". He also added, "Absence of enforcement of

labor law and low level of literacy and awareness among the factory workers are partially responsible for this problem”.

6.2. Environmental Harm of Pulp Operations

Table 3 presents the scores of impacted factors related to human health, the natural environment, and socio-economic aspects due to effluents generated by pulp and paper industries.

Table 3. Effects of the pulp industry on health, environmental, and socio-economic factors.

Human Health Factors	Score	Environmental Factors	Score	Socio-Economic Factors	Score
Skin disease	3.8	Acid rain	1.2	Livelihood	2.4
Respiratory illness	2.6	Greenhouse effect	2.2	Livestock	1.6
Children respiratory disease	2.4	Water-logging	1.0	Forest resource	2.8
Brain and nervous system effect	1.2	Effect of toxicity	3.2	Water resource	3.0
Diarrhea and stomach related disease	1.3	BOD load	3.1	Export market	1.0
Water-borne disease	1.2	COD load	2.6	Quality of life	2.5
Effect of poisonous gas	1.2	Salinity of water	1.0	Grazing land	2.1
Bad smell	2.5	Soil erosion	2.8	Productivity of land	2.3
Effect of toxicity	1.4	Depletion of aquatic life	1.3	Discoloring and eroding building	1.2
		Decrease in fertility of land	1.2		
		Underground water pollution	3.6		
		Surface water pollution	3.3		

Health Hazards: Table 3 shows the health hazards of pulp operations, with the most harmful effect of pulp pollution being to human skin. Most of the respondents claim that human skin is affected (score, 3.8) most by pulp operations while other health hazards are respiratory illness, bad smell, effect of poisonous gas, and children respiratory disease. Respondents also comment that toxic and obnoxious chemicals such as chlorine, acid, and dust from Linc Kline emitted from pulp operations are greatly responsible for air pollution that causes substantial damage to human health.

Environmental Hazards: Table 3 shows the environmental hazards of pulp operations, with surface water pollution highly damaging. Respondents report that surface water is severely polluted (score, 3.6) due to pulp operations. The other environmental hazards are destruction of aquatic life, effects of toxicity, BOD load, soil erosion, and greenhouse effect. Reportedly, the natural environment is being polluted because pulp and paper waste contains a high amount of suspended solids, high BOD and COD ratio, and alkaline that are directly discharged into the river. It is noted here that no treatment plant was found during the time of the field visit.

Socio-Economic Hazards: Table 3 shows ‘water resource depletion’ is the greatest socio-economic hazard of pulp operations. Most of the respondents reported that the water resource of the Karnaphuly River is seriously depleted (score, 3.0) by effluents that are generated from pulp operations. Other affected factors are ‘forest resource depletion’, ‘quality of life’, ‘livelihood’, and ‘productivity of land’. Respondents also reported that highly toxic waste materials are discharged during the time of chemical recovery. It is reported that a huge amount of bamboo is used as a raw material in pulp operations, which causes the depletion of forest resources.

One of the operation managers from the paper and pulp plant said “We use different kind of chemicals in our production process and when we discharge water, it contains solids, dissolved organic matter like lignin, cholates, chlorine, and metal compounds”. These chemicals contribute to the pollution of water and soil.

6.3. Environmental Harm of Fertilizer Operations

Table 4 presents score of impacted factors related to health hazards, natural environment, and socio-economic aspects due to effluents of fertilizer industry.

Table 4. Effect of the fertilizer industry on health, environmental, and socio-economic factors.

Human Health Factors	Score	Environmental Factors	Score	Socio-Economic Factors	Score
Skin disease	1.4	Acid rain	1.2	Livelihood	2.1
Respiratory illness	3.6	Greenhouse effect	2.2	Livestock	2.5
Children respiratory disease	2.4	Water-logging	1.2	Forest resources	1.2
Brain and nervous system effect	1.2	Effect of toxicity	2.1	Water resources	3.2
Diarrhea and stomach related disease	1.2	BOD load	1.2	Export market	1.2
Water-borne disease	1.3	COD load	1.2	Quality of life	2.5
Effect of poisonous gas	1.2	Salinity of water	1.3	Grazing land	2.5
Bad smell	2.5	Soil erosion	1.4	Productivity of land	2.2
Effect of toxicity	1.0	Depletion of aquatic life	2.3	Discoloring and eroding buildings	1.0
Irritation of the mucous membranes of nose, throat, eyes.	3.5	Decrease in fertility of land	1.3	Extraction of ground water	2.6
		Underground water pollution	2.8		
		Surface water pollution	2.4		

Health Hazards: Table 4 reveals that the most harmful result of operations is ‘respiratory illness’. Most of the respondents view that respiratory illness is caused by effluent-generated pollution from the fertilizer industry (score, 3.6). Among the other affected factors, such as ‘irritation to the mucous membranes (nose, throat, and eyes)’, ‘bad smell’, ‘children respiratory disease’, ‘skin disease’, etc. The major pollutant from fertilizer operations is ammonia, which creates a bad smell and places those who come into contact with it at great health risk from nitrate pollution.

Environmental Hazards: Table 4 shows that the most harmful result of fertilizer operations is surface water pollution. Most of the respondents report that surface water is polluted due to effluent-generated pollution from the fertilizer industry (score, 2.8). The other affected factors are ‘aquatic life’, ‘fertility of land’, ‘greenhouse effect’, ‘effect of toxicity’, etc. Reportedly, free ammonia is toxic to the fish of the river while acids and alkalis destroy the aquatic life of the river; carbon dioxide causes the greenhouse effect.

Socio-Economic Hazards: Table 4 also shows that the most harmful result of fertilizer operations is ‘depletion of water resource’ (score, 3.2). The other affected factors are extraction of ground water, live-stock, quality of life, grazing land, and livelihood. Reportedly, water resources of the Karnaphuly River have depleted gradually due to untreated effluents of sample industrial installations. Respondents report that sulfur dioxide and sulfuric acid steams that are generated from fertilizer operations cause the corrosion of materials. Moreover, wastewater-containing harmful chemicals have harmful effects on livestock, quality of life, and grazing land of the locality.

The manager of the fertilizer plant mentioned, “Role of fertilizer for agricultural production and self-sufficiency is enormous. However, it has side effects”. However, fertilizer contains various chemicals and minerals such as nitrogen, potassium, sulfur, calcium, magnesium, and so on, which deplete the quality of the soil, contaminate the water body, create arsenic that leaches into the groundwater, and so on. He also added “Clean technology and adequate public supports for compliance of environmental regulations are needed”.

6.4. Environmental Harm of Textile Operations

Table 5 presents the scores of factors related to health hazards, the natural environment, and socio-economic aspects due to effluents of the textile industries.

Table 5. Effects of the textile industry on health, the environment, and socio-economic factors.

Human Health Factors	Score	Environmental Factors	Score	Socio-Economic Factors	Score
Skin disease	3.8	Acid rain	1.0	Livelihood	1.7
Respiratory illness	3.4	Greenhouse effect	1.5	Livestock	1.3
Children respiratory disease	1.7	Water-logging	1.0	Forest resources	1.0
Brain and nervous system effect	2.5	Effect of toxicity	2.6	Water resources	2.8
Diarrhea and stomach related disease	1.1	BOD load	2.5	Export market	2.7
Water-borne disease	1.0	COD load	2.0	Quality of life	2.3
Effect of poisonous gas	1.2	Salinity of water	1.2	Grazing land	1.5
Bad smell	1.3	Soil erosion	1.1	Productivity of land	2.0
Effect of toxicity	2.1	Depletion of aquatic life	2.6	Discoloring and eroding buildings	1.2
		Decrease in fertility of land	2.1		
		Underground water pollution	1.2		
		Surface water pollution	3.1		

Health Hazards: Table 5 shows that ‘skin disease’ is the most harmful result of textile operations. Most of the respondents reported that human skin is affected significantly (score, 3.6) by the effluents from textile operations. The other health hazards are respiratory illness, respiratory disease in children, and the effects of toxicity. Respondents report that a hypochlorite solution is used in the bleaching process of textile operations which is responsible for skin and eye irritants. Dyeing materials in textile operations, where workers use harmful mixtures of abrasive, alkali and bleaching agents, are skin irritants.

Environmental Hazards: Table 5 shows that the natural environment-related factors are affected by the effluent-generated pollution from textile operations, with ‘surface water pollution’ being the most harmful. Most of the respondents opine that surface water is significantly (score, 3.1) affected by the textile operations. The other affected factors are destruction of aquatic life, effect of toxicity BOD, and a decrease in fertility of the land. Reportedly, the textile effluents, generally gray in color, have high BOD, high total dissolved solids, high total alkalinity, high amount of suspended solids, high pH, and different color solids. It is reported that the alkalinity and toxic substances affect aquatic life.

Socio-Economic Hazards: Table 5 shows that ‘water resource depletion’ represents the most serious effluent-generated pollution problem in textile operations. The other affected factors are export market, quality of life, productivity of land, and livelihood. Reportedly, the increased pH of textile effluents harms soil productivity, and increases the deposition of acidic textile wastes, which adversely affects resources of economic value of river water and agriculture.

The manager of the textile plant mentioned “Textile industry consume huge amount of water and many chemicals in its long production process. It generates wastes such as liquid, gaseous, and solid wastes that contribute to pollution and other human health related issues”.

6.5. Environmental Harm of Cement Plant Operations

Table 6 presents the scores of factors relating to health hazards, the natural environment, and socio-economic aspects due to effluents of the cement industry.

Health Hazards: Table 6 shows the health hazards of cement plant operations, with the most harmful result of pollution being respiratory disease. Most of the respondents reported that the human

respiratory system is significantly affected (score, 2.8) by cement plant operations. Respiratory disease in children, skin disease, diarrhea and stomach-related disease, and waterborne disease also factor greatly among the health hazards to humans. Respondents also report that the respiratory system, in particular, is seriously affected due to dust from cement plant operations. Reportedly, the respiratory system of children is highly affected when exposed to dust, and human skin is severely affected due to dust particles from cement plant operations.

Table 6. Effects of the cement industry on health, environmental, and socio-economic factors.

Human Health Factors	Score	Environmental Factors	Score	Environmental Factors	Score
Skin disease	2.3	Acid rain	1.5	Livelihood	1.0
Respiratory illness	2.8	Greenhouse effect	2.4	Livestock	2.1
Children respiratory disease	2.4	Water- logging	1.0	Forest resources	2.1
Brain and nervous system effect	1.0	Effect of toxicity	1.0	Water resources	2.2
Diarrhea and stomach related disease	2.2	BOD load	1.2	Export market	1.0
Water-borne disease	2.1	COD load	1.3	Quality of life	2.8
Effect of poisonous gas	1.2	Salinity of water	1.0	Grazing land	2.2
Bad smell	1.2	Soil erosion	1.2	Productivity of land	1.2
Effect of toxicity	1.0	Depletion of aquatic life	1.0	Discoloring and eroding buildings	2.2
		Decrease in fertility of land	2.2		
		Underground water pollution	1.2		
		Surface water pollution	2.1		

Environmental Hazards: Table 6 shows the greenhouse effects from cement plant operations (score, 2.4). Most of the respondents view the greenhouse effects as being due to undesirable emissions from cement plant operations. The other environmental hazards are decrease in fertility of land, surface water pollution, and acid rain; while reportedly, the surface water becomes polluted and fertility of land decreased largely due to dust particles that settle on the surface.

Socio-Economic Hazards: Table 6 shows that the most harmful result of cement plant operations is ‘deterioration of quality of life’. Most of the respondents view that quality of life has deteriorated significantly (score, 2.8) due to cement plant operations. The other affected factors due to the emissions of particles are grazing land, water resource, discoloring and eroding of buildings, forest resources, and livestock. Moreover, neighboring animals that consume toxic substances found in the plants and grasses experience various physical disorders.

One of the operation managers from the cement plant says, “In our production, we use lots of raw materials and energy as well as discharge emissions into the air”. Emissions in the air contribute to air pollution and cause various diseases.

6.6. Comparison of Health Hazards from Polluting Tannery, Pulp & Paper, Fertilizer, Textile, and Cement Industries

The following Figure 2 presents a comparison of the levels of various health hazards due to polluting industries from Tannery, Pulp & Paper, Fertilizer, Textile and Cement sectors.

Figure 2 shows a comparative analysis of health hazards among tanning, pulp & paper, fertilizer, textile, and cement industries. Human skin is severely affected by the harm of tannery, pulp, and textile operations. Why is human health seriously affected by these firms’ operations? According to researchers [114–117], the discharge of chromium from the tanning operations is what is responsible for the health hazards. Figure 2 shows that respiratory illness also rates very highly as a health hazard in the case of tanning, fertilizer, and textile operations, while the effects to the brain and nervous system

is also very high the case of tanning operations. On the other hand, diarrhea and stomach-related diseases, and waterborne disease, due to the effects of poisonous gases, are relatively less affected. There are significant health hazards caused by tanning operations in other areas of Bangladesh as well; for example, approximately 12,000 laborers in the tannery industries of Hazaribagh (Dhaka) have been suffering from more than one disease [65]. These laborers in Hazaribagh (Dhaka) also depend on the Buriganga River for their water in their day-to-day life as they are members of a low income group. It has been revealed [85,118,119] that the untreated wastes of Hazaribagh (Dhaka) tannery industries are discharged into the Buriganga River which is putting the river's ecosystem into peril [85,118,119]. The World Health Organization (WHO) estimates that 80 percent of all diseases in the world are water-related [80]. Figure 2 also shows that irritation to the mucous membranes of the nose, throat, and eyes ranks highly as a health hazard due to fertilizer operations. What are the harmful pollutants of fertilizer industries that are most responsible for human health hazards? A study [83] reveals that breathing urea dust and gaseous ammonia that is generated from fertilizer operations is responsible for various health problems in workers in Bangladesh. It is clearly evident from this discussion that polluting industries discharge untreated harmful effluents that are mostly responsible for health hazards resulting in a huge social cost to Bangladesh.

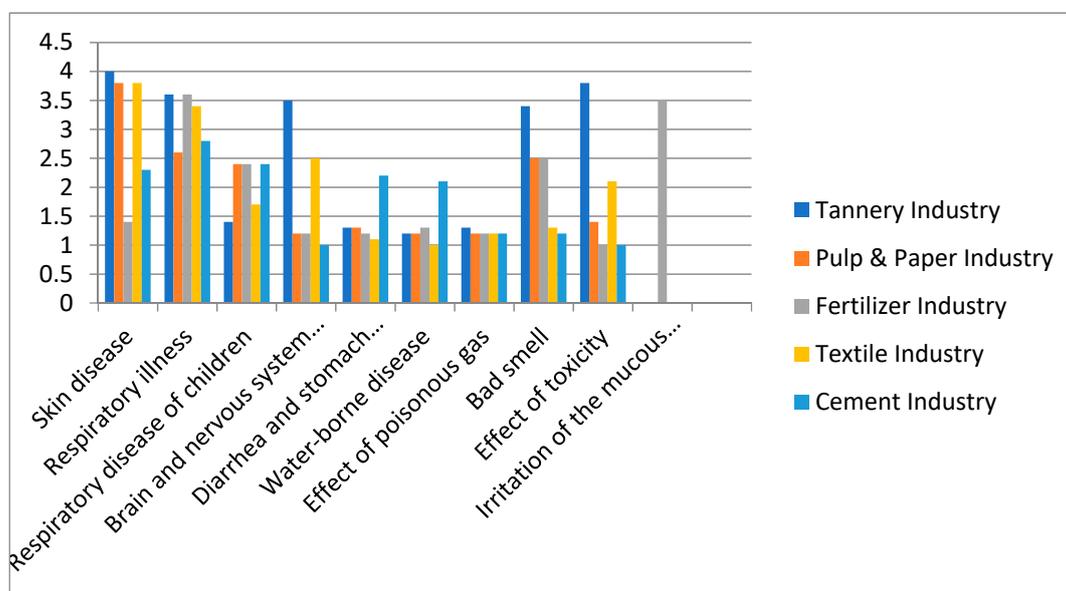


Figure 2. Comparison of health hazards due to the polluting industries such as tannery, pulp & paper, fertilizer, textile, and cement.

6.7. Comparison of Environmental Hazards from Polluting Tannery, Pulp & Paper, Fertilizer, Textile, and Cement Industries

Figure 3 presents a comparison of the levels of environmental hazards due to polluting industries from Tannery, Pulp & Paper, Fertilizer, Textile, and Cement sectors.

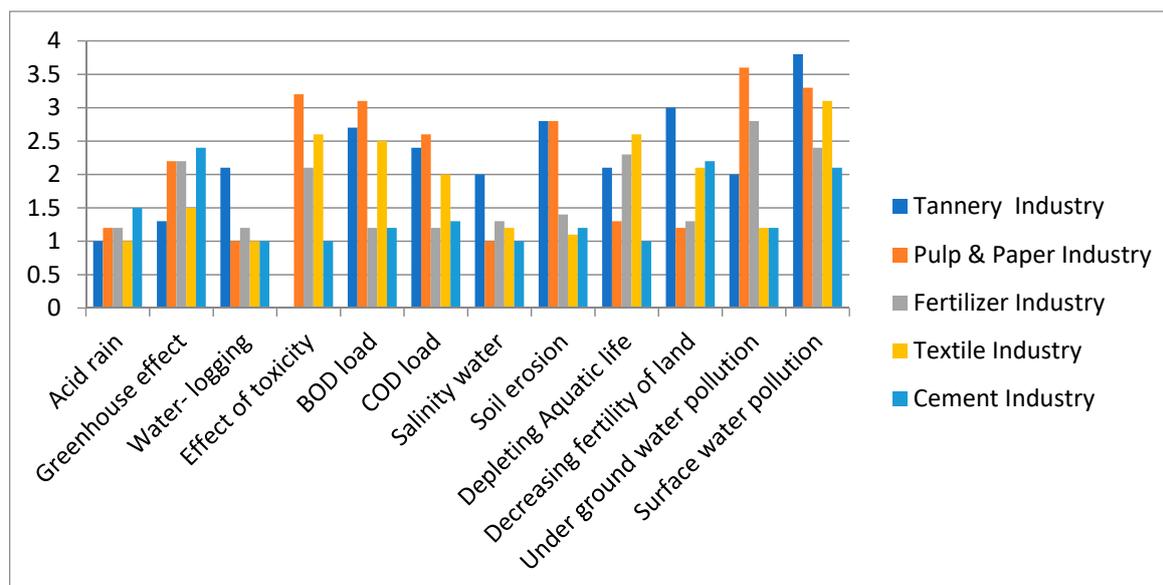


Figure 3. Comparison of environmental hazards due to the polluting tannery, pulp & paper, fertilizer, textile, and cement industries.

Figure 3 shows the high level of surface water pollution due to effluents of tannery, pulp & paper, and textile industries in Chittagong. Gain [69] reports that the tannery industries in Chittagong discharge about 150,000 L of effluents every day which is mostly responsible for the surface water pollution of the Karnafuly River. Further, a Chittagong Hill Tract pulp and paper mill dumps tons of chemical waste into the Karnafuly River every day causing surface water pollution [120]. What is the most harmful element from tannery effluents that is responsible for surface water pollution in Bangladesh? The chromium in tannery effluents is greatly responsible for surface water pollution. For example, the maximum concentration of chromium in the Buriganga River near the effluents discharge point is approximately 6 micrograms per liter, but the Department of Environment (DoE) has fixed the standard at 0.01 micrograms per liter concentration of chromium for the river's ecosystem [69]. It is clearly evident that DoE cannot and does not enforce regulations effectively in order to prevent industrial pollution, a clear example of institutional failure on the part of government agencies. Figure 3 also shows a high level of underground water pollution, effect of toxicity, and BOD load due to untreated effluents from the pulp & paper industry. Figure 3 also shows that the decreasing fertility of land is high due to effluents from textile industries. What are the harmful elements of textile pollutants that are responsible for environmental hazards? Studies [121–123] indicate that textile effluents contain toxic substances, such as chromium, chlorine, and fungicides, resulting in serious impacts on the environment. From the above discussion, it is clear that natural environment related factors are affected significantly due to industrial pollution that is responsible for the environmental degradation in Bangladesh.

6.8. Comparison of Socio-Economic Hazards from Polluting Tannery, Pulp & Paper, Fertilizer, Textile, and Cement Industries

The following Figure 4 presents a comparison of level of socio-economic hazards due to polluting industries from Tannery, Pulp & Paper, Fertilizer, Textile and Cement sectors.

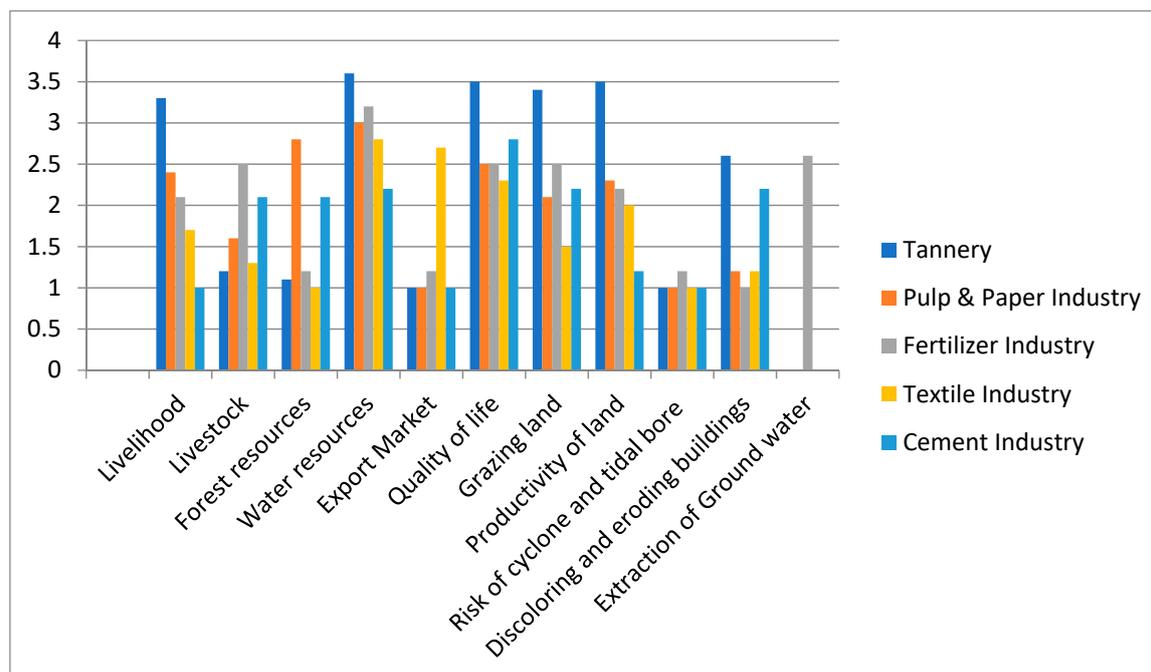


Figure 4. Comparison of socio-economic impacts due to the polluting tannery, pulp & paper, fertilizer, textile, and cement industries.

Figure 4 shows that the depletion of water resources is high because of generated pollution from tannery, pulp & paper, and fertilizer industries. Islam's [76] study discloses that free ammonia from the fertilizer industry is toxic to fish at concentrations of approximately 1.5 milligrams per liter, which is also responsible for the depletion of the dissolved oxygen level in water. Effluent discharges from the Chittagong Urea Fertilizer Factory (CUFL) have seriously affected the 'hilsa' fish stock in the Bay of Bengal Ocean [124]. Nearly 100 cattle, mostly buffalo, have died from toxic gas poisoning, following a leakage at Chittagong Urea Fertilizer Limited (CUFL) [125]. Figure 4 also shows that quality of life has deteriorated, productivity of land has decreased, and livelihood has significantly altered due to pollutants from tannery industries. Islam and Miah [95] report that many fishermen of Rangunia, Raozan, Boalkhali, and Anowara Upazila in Chittagong have become unemployed, as the quantity of fish has decreased in the Karnaphuly River because of water pollution. Tons of chemical waste is dumped into the Karnaphuly River every day from Karnaphuly Paper Mills (KPM) at Chandraghona in Chittagong (Hill Tract), polluting the river water and resulting in huge environmental impacts [120,126].

7. Discussion

To reiterate, the objectives of this study were (i) to examine the extent to which human health is affected by firms' operations due to their inadequate compliance with environmental standard in an industrial zone in Chittagong, Bangladesh; (ii) to examine the extent to which the natural environment is affected by firms' operations in an industrial zone at Chittagong, Bangladesh; and (iii) to examine the extent to which socio-economic factors are affected by firms' operations in an industrial zone in Chittagong, Bangladesh. Results of this study indicate that industrial firms generate effluents during the time of operations have enormous impacts on human health, the natural environment, and socio-economic aspects. As a result, these socio-ecological problems ultimately create huge social costs in Bangladesh. The literature review indicates that institutional pressures at the inter-organizational level or inter-firm level influences firms to adopt environmental management practices [44]. Regulative institutional pressure at the inter-firm level is not working adequately to influence industrial firms to adopt environmental management practices. Some managers

mentioned that more public support for compliance and clean technologies is needed to comply with the environmental regulations. Our study uncovers huge environmental harm due to the firms' operations and lack of environmental management practices. It is noted here that approximately 200 environmental regulations in Bangladesh [75] are routinely ignored/broken due to lack of enforcement [62]. Further, normative (or social) institutional pressure (i.e., standard operating procedures and occupational safety or environmental management) is not effective enough in influencing firms to adopt standard operating procedures as most of Bangladesh's industries are not equipped with treatment facilities [8,66,67]. Furthermore, cognitive or cultural institutional pressure is not effective enough in influencing industrial firms to accommodate to everyday social reality. However, there are some examples of cognitive pressure from community stakeholders under the leadership of local civil society's initiatives in preventing pollution that have proved successful in various areas of Bangladesh [74]. The literature review also indicates that institutional pressures (e.g., regulative, normative, and cognitive) may influence environmental alignment [35,36]; however, our study does not find authentic information about environmental alignment among industrial firms to reduce environmental harms from their operations through adopting pollution preventive practices or central effluent treatment initiatives in industrial zones. This study also finds that the executives of top-level management of industrial firms are aware of the environmental harm of firms' operations in Bangladesh; however, they are not reactive towards environmental responsiveness. Sharma & Vredenburg [22] argue that "the managers of the reactive companies did not associate environmental responsiveness with any capability or learning processes". Further, the Bangladesh government has committed to the international community for conservation and protection of its natural environment by signing treaties and protocols [69,70]; however, the Government's commitment does not work adequately as results of this study indicate huge environmental harm at the hands of industrial firms operations in Bangladesh. This study supports the findings that reveal that corporate environmentalism in developing countries is largely nonexistent [127–129] or, if present, is confined to only a few large organizations [129].

8. Conclusions

This study responds to the call to conduct research on socio-ecological degradation emanating from certain polluting industries while inadequately using environmental guidelines. The study revealed socio-ecological consequences of noncompliance of manufacturing firms in developing countries and contributed to the literature on business operations and the natural environment [130]. Our research also responds to the call to advance research on organizational sustainability holistically [45,46,51,130–132]. Our research found that the environmentally damaging impacts of industrial operations are caused by unsustainable practices at the organizational level from a developing country perspective. Lack of consciousness and an institutional void allow polluting industries to exist. This study also contributes to different relevant audiences by providing authentic information to the policy-makers of developed and developing countries about environmental harm due to firms' operations. Thus, policy-makers can formulate strategies and policies for sustainable industrial development in order to implement them in an effective manner for developing countries. In addition, administrative decision-making of government and owners of industries is often hindered because of the non-availability of authentic information regarding environmental harm of firms' operations. The findings of this study can provide reliable information to the government officials and owners of polluting industries so that they can show their responsiveness towards environmental harm of firms' operations. These findings focus on the reality of a developing country; findings that are relevant to the academic community by providing illumination for further research. This study covers five industries from the top-ten polluting industries. A further study covering the other five polluting industries of other districts in Bangladesh would also be valuable. In addition, more research is needed on how environmental harm of firms' operational aspects in a developing country context is different from developed countries.

Qualitative research is ultimately both a process and a product in which the researcher is deeply and unavoidably implicated [133]. The findings from a qualitative study are therefore a subjective construction in which the knowledge, beliefs, and activities of the researcher's play a significant role and findings are "unique social interactions" and, for this reason, qualitative research can never be truly 'generalizable'. To increase the generalizability of the findings, future research could record and compare the experiences and cases of industrial pollution, environmental degradation, and health care. In order to improve the intercoder reliability (ICR), one or more tests among the Scott's (p), Cohen's kappa (k), and Krippendorff's alpha (a) can be used in the future.

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