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Legal Compliance of Waste Management in Tannery Industrial Estate in Bangladesh:
An Assessment from Environmental Criminological Perspective

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Abstract
The establishment of Savar BSCIC Tannery Industrial Estate (Tannery Estate) as the only tannery industrial estate in the nation marked a significant breakthrough for the leather industry in Bangladesh. However, the lack of effective waste management regulations, utilization of substandard technology, and inadequate facilities for treating industrial wastes are causing the environmental problems in this area to worsen gradually. The capacity of this industry to efficiently amass, process, dispose of, or recycle wastes is substantially limited. This study examines the nature of waste generated and the strategies employed for waste management in this tannery industrial estate. It also evaluates the current situation regarding waste management, specifically from a legal perspective. This was accomplished through the examination of the impacts of waste on human health and the surrounding ecosystem. Data was collected using qualitative techniques, which involved conducting focus group discussions (FGD) and in-depth interviews, as well as employing direct observation methods. The study demonstrates how the existing failures of proper waste management infringe upon established human rights and environmental laws from local and global standards. It also presents a number of recommendations that differ from the current waste management standards in Bangladesh's BSCIC tannery industrial estate.

Keywords
Waste management, Environmental criminology, Environmental laws, Tannery Estate, Occupational Hazards

INTRODUCTION

Leather and its associated industries are among the oldest foreign currency-earning industries to intensify Bangladesh's national economy. Bangladesh's leather industry has evolved into the country's second-largest source of foreign exchange, exporting 10 percent of the global market for leather, just behind the RMG sector (Hashem et al., 2015). According to the Export Promotion Bureau, Bangladesh shipped leather and leather products worth $941.67 million in the FY 2020-2021, which is about 2.43 percent of the country's total export earnings ($38.758 billion). However, this industry is one of the highest-contaminant industries in the world that utilizes more than 250 types of chemicals. It is accountable for severe environmental hazards by releasing untreated liquid effluents and solid wastes straight into the surrounding, low-lying areas, which include a high amount of heavy metals such as Cr, Cu, As, Cd, Fe, Hg, Mn, Ni, Pb, and Zn (Kamruzzaman, 2022). That can cause temporary effects such as dizziness, headache, irritation of eyes, skin or lungs, allergic reactions, poisoning of the liver, kidney or nervous system or collapse due to lack of oxygen (Misra & Pandey, 2005). Used untreated wastewater released from tannery industries contains a large amount of Cr (VI) (Emmanuel, 2004)). Moreover, almost all (more than 99.99%) of Cr (VI) is beyond the admissible limit of WHO, FAO, EPA, and other countries' utmost discharging and existing limits. Cr (VI) has diverse health effects, including acute toxicity, mutagenic, carcinogenic, and high blood pressure.

Though there are admiringly sophisticated technologies to treat these liquid particles of waste at the current time, there is no opportunity to manage solid wastes from leather manufacturing procedures in Savar Tannery Industrial Estate. The solid waste produced during the tanning of hides and skins (trimmings, fleshings, shavings, etc.) is simply dumped along the rim of the streets or in an open, uninhabited space. The part of the waste that is not accumulated or used ultimately dries up or drains off to the nearby Dhaleswari River during the rainy season (Basak et al., 2020). As a result, the Department of Environment (DOE) did not renew environmental clearance licenses for the function of the estate in 2021 (The Daily Star, 2022).

Whether due to lack of capacity or caprice, it is clearly understood that the process in which tannery industrial estate is carrying out its work is having a very bad impact on the environment and human health at the same time. According to Ahsan et al. (2014), the main reason behind severe industrial waste-related problems is the lack of proper application of the existing laws and regulations (Islam et al., 2017). Wilson et al. (2007) identified the need for more research-based knowledge to strengthen waste management policies.

There are more than 200 area-specified laws that deal with environmental issues in Bangladesh so far. They focus largely on soil use, space above soil and water, toxic waste, sound, noxious chemicals, unyielding waste, forest preservation, flora and fauna protection, mineral resources, industry, ecological well-being and hygiene etc. (Sarker, 2016). For the protection of the environment, some basic principles of international environmental law need to be incorporated into the domestic legal system in the interest of better protection of the environment. Nevertheless, the crucial point is that countries around the world are very reluctant to incorporate these principles directly into their national legal system (Ashraful, 2014).

More specifically, the main objective of the study is to assess the legal compliance of industrial waste management norms in Tannery Industrial Estate. The specific objectives of the study are; to identify the nature of toxic industrial waste in the Tannery industry; to identify the laws and regulations violated by the traditional industrial waste management practices in the Tannery industry; to analyze the weaknesses in the implementation of existing environmental laws in the Tannery industry; and to develop a set of recommendations toward effective management of toxic industrial wastes in Tannery Industry in Bangladesh.

However, this study tries to show the sources of irregularities regarding the traditional legal system considering the nature of wastes produced in the tannery industrial estate of Bangladesh. Moreover, its findings in tackling this impendent situation might play a groundbreaking role in the further development of the tannery industry from the legal point of view.

MATERIALS AND METHODS

The selected field of study was the Savar BSCIC Tannery Industrial Estate in Dhaka. This study employed a qualitative research methodology. The primary data-gathering approach employed in this study was the direct observation method. Over a span of 10 days, the researcher conducted a firsthand observation, diligently concentrating on particular aspects outlined in a checklist. Not a single question was posed to anyone in the field at this stage. Additional approaches employed for data collecting were Focus Group Discussion (FGD) and In-depth interviews.

Data was mostly collected from individuals who were exposed to health risks associated with tannery industrial wastes and duty officers. The primary data collection involved the use of a semi-structured questionnaire and a systematically developed FGD guideline that included pertinent open-ended questions. A total of four focus group discussions (FGDs), ten in-depth interviews, and two telephone interviews were conducted in the study area. The FGD had a total of 28 participants, who were separated into four distinct groups.

Various secondary data sources, including books, journals, newspapers, articles, print media, electronic media, and social media, were utilized systematically and analyzed thematically. 0However, the primary sources of secondary data were renowned publications like Springer, SAGE, Google Scholar, Scopus, Web of Science, JSTOR, and numerous more.

A checklist was devised, and essential descriptive field notes, as well as photographs and videos, were captured on-site to gather data. The sample size in this investigation was indeterminate. Thus, this study included two non-probability sampling methods for selecting the participants. The sampling method employed a hybrid approach, utilizing both judgment and snowball techniques.

The data analysis was conducted thematically. The primary data were evaluated using the fundamental subject matter of focus group discussions (FGD) and interviews. During the observation method, essential observations were recorded on a checklist. Subsequently, the data is summarized and categorized into distinct codes and themes in order to arrive at the findings.

Profile of Study Area: Savar BSCIC Tannery Industrial Estate

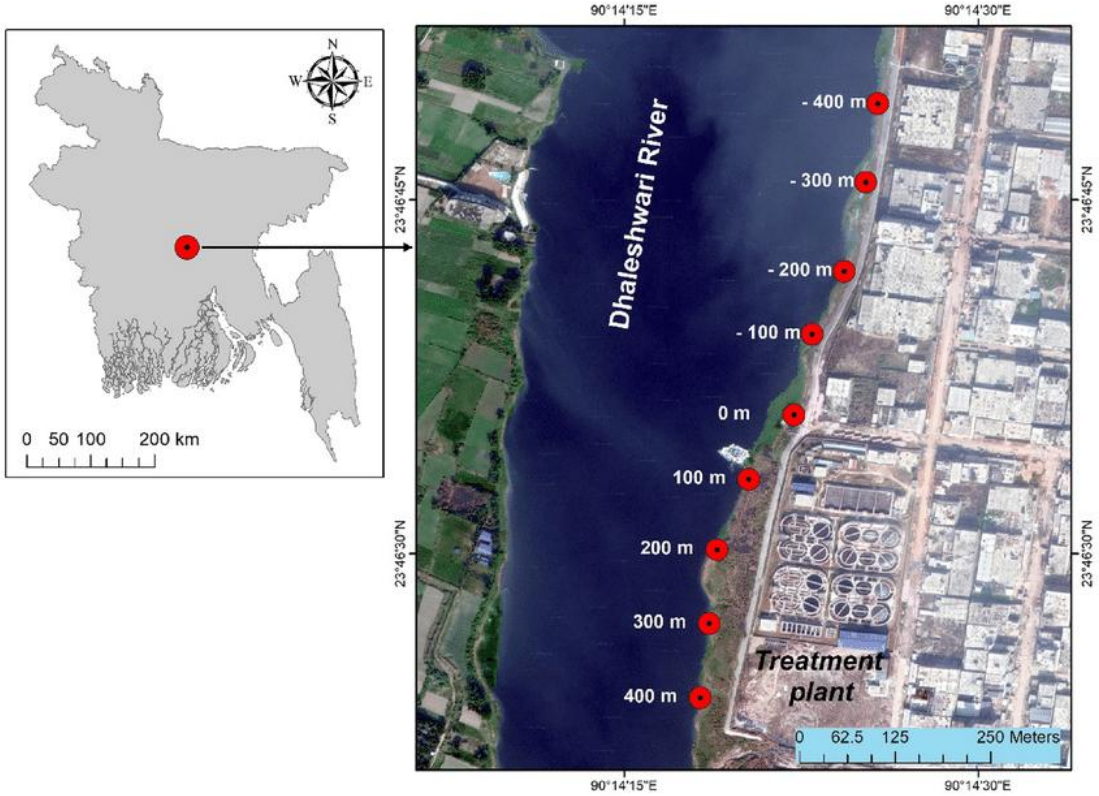

Fig. 1 Map of Savar BSCIC Tannery Industrial Estate

Table 1 A short profile of Savar BSCIC Tannery Industrial Estate

Savar BSCIC Tannery Industrial Estate	
Year of Establishment	2003
Location	Hemayetpur, Savar
Area	200 acres
Cost of the Project	107871.00 lac Taka
Total Number of Plots	195
Number of Running Tanneries	155
Number of Workers	Around 1 lac
Number of EPS	3
Capacity of Liquid Waste Management	25,000 cubic meters per day
Production Types	Wet blue leather, Crust and complete leather, Finished leather, Split leather and rawhide.

According to UNIDO (United Nations Industrial Development Organization), the weight of raw material processed in Savar BSCIC Tannery Industrial Estate was estimated at 85,000 t/year. The peak load during the Qurbani period (75 days) was estimated at 450 t/day, and the load during the rest of the year (225 days) at about 230 t/day (Basak et al., 2020b).

Infrastructural developments like internal roads, drains and culverts, street lights, electricity and water supply, and so on make the project more decorated. The setup of an administrative building, police fari, fire service unit, and pump driver quarter have made the project look more furnished. A Common Effluent Treatment Plant (CETP) and waste Dumping Yard have also been developed at the project site.

RESULTS AND DISCUSSIONS

This section of the paper discusses the major findings of the study. The empirical data are analyzed according to the study objectives with a legal assessment. The results are assessed based on national and international legal standards of waste management and existing practices.

Nature of wastes produced and waste management practices in Tannery Estate

Roughly 6.5 million tons of wet-salted hides/skins are prepared worldwide every year. For every ton of raw material, around 600 kg of solid waste is rendered in the form of trimmings, fleshings, chrome shavings, and buffing dust (Clare, 2021). Furthermore, among them, the portion of assembled solid wastes is approximately 4 million (Ahammed Bin Azam & Saha, 2021). In Bangladesh, tanneries create around 20000 m^3 of liquid waste and 232 tonnes of solid waste per day. During the time of processing, a considerable portion of solids, including liquefied and suspended organic subjects, degrade wastewater possessing chemicals that are vastly accountable for environmental pollution (Hossain & Abedin, 2019).

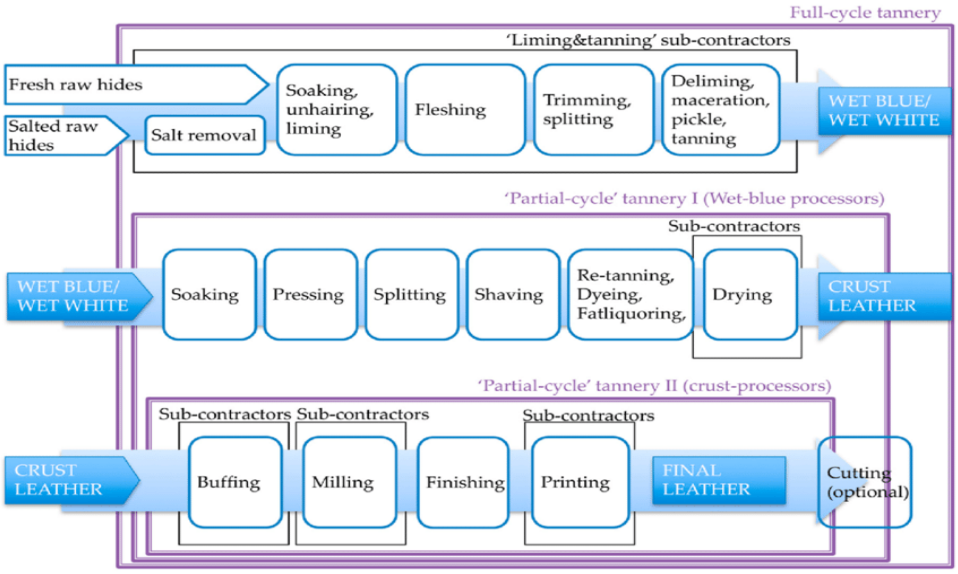

Fig. 2 The leather production process and the firms performing each activity
Source: De Marchi & Di Maria, 2019

Diverse types of pollution transpire during the tanning process. On a bigger scale, we can categorize them into three divisions. They are Liquid Waste, Solid Waste, and Gaseous Waste.

Fig. 3 Types of Wastes

Liquid waste management

About 60 m^3 of water is required to process one ton of hides and skins (Hashem et al., 2015). The wastewater contains hazardous chemicals, leached proteins, and degradation products of hides and skins. In most cases, liquid wastes contain about 45–65% (w/w) moistness, 30%(w/w) of organic essences, and 2.5%(w/w) Cr (III) blends. A lot of chemical substances such as lime, sulfide, ammonia, various salts, acids, and dyes are used at an increased grade to process the rawhide and produce serviceable leather (Fela et al., 2011). In a study, Laila et al. classified wastewater discharged from six local industries in Bangladesh with a heightened amount of pollution hurdle and revealed a mean outcome concerning TDS 3450mg/L; TSS 1650 mg/L; BOD 540mg/L; COD 1450 mg/L.

Standard treatment methods for liquid waste

Tannery wastewater is treated by different physicochemical and organic strategies and by a blend of both. Physical and chemical cycles are utilized much of the time to treat debased zones, yet frequently do not annihilate outer substances (Reed et al., 1999). According to Madda (2017), there are five stages of tannery effluent treatment strategies: (1) Preliminary Treatment, (2) Physical-chemical Treatment (primary), (3) Biological Treatment (secondary), (4) Advanced Treatment (tertiary), and (5) Sludge handling and disposal.

Mohammed (2017) has also suggested multiple liquid waste treatment methods in his study on tannery waste management opportunities and limitations. Suggested wastewater treatment methods are (1) Aerobic bacterial systems, (2) Macrophyte systems, (3) Microalgal systems, and (4) Anaerobic digestion.

Methods used in Savar BSCIC Tannery Industrial Estate

One of the engineers of DTIEWTPCL explained how liquid wastes are treated in the Savar BSCIC Tannery Industrial estate.

> *"Management of waste following the standards is basically the main job of CETP. In the tannery industry, some chemicals are used to process the leather, especially for the fat and hairs that are present in the skin. For that, around 25 to 30 types of chemicals are used. The effluents that are produced from there are very harmful. Among them, two types of effluents are our main concern. One of them is Chrome liquor. In the wet blue sector, the skin is treated with chrome. The reason behind this is that if the skin is treated with chrome, it will last longer. After that, it is taken to the finishing part. The part that is treated with chrome produces chrome liquor. Here, we have 3 EPS and around 140 industries are running. Moreover, they are divided into these 3 EPS. EPS means effluent pumping station. Each station consists of 40-60 factories. Effluents come in two flows. One of them is chrome liquor. In the effluent pumping*

station, we have CCR. There, we separate the chrome sludge from chrome liquor. After separating them, we keep them in the closed dumping yard. Furthermore, the rest of the water is processed in the CETP (KII).

There are three distinct steps involved: 1. Physical Treatment, 2. Chemical treatment, and 3. Biological Treatment. The implementation of physical treatment[1] began in the industry. Additionally, certain components are completed within the jurisdiction of the authority, like control of critical components, including a screening chamber, equalization tank, clariflocculator, aeration tank, secondary clarifier, sand filters, carbon filter, and more.

An automated screen is employed to transfer the collected effluent into the receiving sump, providing a highly efficient method for reducing suspended particles, biological oxygen demand (BOD), and chemical oxygen demand (COD). The effluent is thereafter sent into a grit chamber and accumulated in two equalization tanks equipped with submerged ejector aerators. Subsequently, the aerator draws in air from the surrounding atmosphere and delivers it to the bottom of the tank. This enhances the measurement of biochemical oxygen demand (BOD) and chemical oxygen demand (COD) in the following treatment units.

At this point of the process of chemical treatment[2] commences. The effluent and the ejector aerators are homogeneous. The sulfides present in the raw effluent are oxidized by their action, hence promoting the bacterial corrosion caused by oxygen. Equilibrium is crucial in this context.

Next, the aerator draws in air from the surrounding atmosphere and delivers it to the bottom of the tank. This enhances the measurement of biochemical oxygen demand (BOD) and chemical oxygen demand (COD) in the following treatment units. The effluent and the ejector aerators are homogeneous. The sulfides present in the raw effluent are oxidized by their action, hence promoting the bacterial corrosion caused by oxygen. Equilibrium is crucial in this context and possesses four equalization tanks.

The homogeneity of the discharged waste generated by this procedure enhances the uniformity of effectiveness in subsequent treatment. This process results in the acquisition of a homogenized character during the flow. Next, they combine the substances. Upon application of the chemical, the solids are subsequently deposited in the primary sedimentation tank (PST). The chemical sludges are subsequently transported to a specialized location for further processing by the use of pumping. The water is filtered and ready for the next stage, which is biological treatment.

Biological treatment[3] involves using microorganisms like bacteria or fungi to break down and change organic substances in waste or polluted areas. The process includes using bacteria for treatment, completing denitrification, transferring obtained sludge to a secondary sedimentation tank, and returning a portion of it to restore bacterial balance. The bacterial concentration is 5000 milligrams per liter.

The B series, which is the secondary biological treatment, begins after the completion of the A series. This is somewhat distinct. Bacterial therapy is also employed here. This stage comprises an additional four steps. Subsequently, the disinfected water treated with chlorine dioxide is disposed of in the river. We adhere to all the regulations stipulated by the ECR (Environment Conservation Rule, 1997).

Observations and assessment

A certain amount of dissimilarities were found in the researchers' direct observation. Because there was a confident statement from the chief engineer of DTIEWTPCL that said,

'There is no chance of dumping the liquid waste into the river directly.'

It has been observed that a significant amount of chemical waste is being released into the river water, either directly or indirectly. In 2017, the high court summoned the Chinese and Bangladeshi representatives of effluent treatment plants, specifically Shut Tannery (2021). The calculated daily capacity for liquid waste treatment is 25000 m3. The tannery generates an excess of 40000 m^3 of liquid waste (Savar Tannery Estate, 2022).

Solid waste management

During the initial pre-tanning stage, all attached flesh, fatty tissue, rough edges, and contaminants are extracted from the animal skin. The primary sources of solid waste in tanneries arise from the removal of excess parts and tissues from raw hides and skins, as well as the process of dividing and thinning tanned hides and skin material (Basak, 2020).

As various stages of leather manufacturing continues, many forms of waste are produced. Examples of materials include powdered salt, salt obtained from solar evaporation ponds, sheep hair used for adhesive purposes, lime sludge primarily derived from cattle, unprocessed animal trimmings, fleshing waste, wet trimmings or shaving waste, chrome shaving waste, dried animal trimmings, various types of garbage, and different sludges from the Common Effluent Treatment Plant (CETP) (Alamgir and Debnath, 2017).

The haphazard disposal of solid wastes from tanneries poses significant risks to the environment, ecosystem, and public health.

Standard treatment for solid waste

Conventional solid waste management options include (1) waste minimization at source, (2) recycling and reuse, (3) transformation, and (4) properly designed and maintained sanitary landfills, can be used to tackle the problems associated with tannery solid wastes (Shams et al., 2017). However, for a developing or underdeveloped country, lower-cost landfilling is usually a more practical waste disposal option than incineration (Solid Waste Management in Asia, 1999).

Methods used in Savar BSCIC Tannery Industrial Estate

The key informant interview with one of the Engineer of DTIEWTPCL, stated that

> *"We lack a solid waste management system. We try to ensure the best possible we can. But the thing we can not ensure is TDS (Total Dissolved Solid), which is salt. That is not available in our treatment process. For some other necessary treatment processes, including TDS, we are trying to hire an expert consultant" (KII).*

Further added,

> *"For now, we suggest the factory owners minimize the waste at the source. Because CETP does not have the capacity to manage this solid waste properly".*

In response to the question regarding the method they follow for managing solid wastes, he added that;

> *"We follow the landfilling method for the solid wastes right now."*

Observations and assessment

From the direct observation of this study, it is found that most of the solid wastes are dumped at the backside of the project site on the bank of the Dhaleswari River. The produced solid wastes are directly transported to the dumping zone and disposed of. The method of landfilling and burning is used to dispose of the waste. No sign of approach regarding the country's 3R policy was seen on the project site, which clearly violates section 3 of the National Environmental Policy, 2018. It is clearly stated in this section that 'no waste shall be discharged into a river, canal or any water body before purification.'

Gaseous waste management

The gaseous wastes are generated in the environment mainly due to anthropogenic activities. The gaseous wastes include carbon dioxide (CO_2), methane (CH_4), chlorofluorocarbon (CFC), oxides of nitrogen (NO_x), carbon monoxide (CO), oxides of sulphur (SO_x) etc.

The other particles incorporate unsaturated fats like butyric acid, valeric corrosive, and caproic acids, solvents, polishes, formalin, and a portion of the synthetic substances utilized in completing tasks. Smells in tanneries heighten from unhygienic practices on the skin and conceal handling and deferred removal of fluid and solid wastes (Nimmi, 2018).

Standard treatment of gaseous waste

Gaseous waste comes in various structures; however, one of the most well-known approaches to treating it is wet scrubbing (Akeredolu, 1984). A wet scrubber is a gadget using a fluid intended to isolate particulate matter of vaporous pollutants from a gas stream by at least one system, like inertial impaction, interference, dissemination, ingestion, buildup, and so forth. Assuming waste gas streams circular segment combustibles, flares can likewise be utilized for Treatment (Stone et al, 1992).

Methods used in Savar BSCIC Tannery Industrial Estate

No specific methods were mentioned to be used in treating the gaseous waste. But the chief engineer stated that,

> *"We could not develop any standard strategy for treating gaseous wastes yet. However, we try to work and supervise in a manner that the production of the gaseous substances gets decreased."*

Waste Transportation

A checklist was developed and utilized to assess the overall condition of the tannery industrial estate's waste transportation system. Here, all the violations of laws that are taking place in the project site are noted by direct observation of the researcher.

Table 2 Assessment of Waste Transportation according to legal provisions

Criteria	Checklist	Yes	No	N/A	Legal Compliance in Waste Transportation
Waste containers	1. Containers are sealed, without funnels		√		If there are multiple containers of hazardous waste in a Satellite Accumulation Area (SAA), each container must be labeled in accordance with rule 262.34 (c) of U.S. Environmental Protection Agency.
	2. Are wastes stored in compatible containers?		√		According to section 2 of Environmental Health & Safety Services, one should only store waste in clean containers that are free of residue. And use containers that are compatible with the waste materials. EPA recommends that a container cover by properly secured with snap rings tightly bolted, bungholes capped, and, where appropriate, pressure-vacuum relief valves to maintain the container's internal pressure to avoid explosion (National Waste Management Strategy, 2008).
	3. Containers labeled with the words Hazardous Waste		√		All chemical waste must be properly labeled as soon waste is added to a container (CSUSB, 2019).
	4. Constituents of the waste described on the container label		√		Section(b) of part 273 from Standards for Universal Waste Management declares, a container (or multiple container package unit), tank, transport vehicle or vessel in which recalled universal waste pesticides as described in 40 CFR 273.3(a)(1) are contained must be labeled or marked clearly.
	5. Waste containers are in good condition.		√		If a container holding hazardous waste is not in good condition or if it begins to leak, the generator must transfer the waste from this container to a container that is in good condition, over-pack the container, or manage the waste in some other way that prevents a potential for a release or contamination (Louis, 2004).
	6. Secondary containment used for waste stored near sink or floor drain?		√		Secondary containment is highly recommended when moving chemicals through buildings or outdoors. It is also recommended for most hazardous waste containers, particularly those stored near sinks, drains, or on the floor (Clare, 2021) .
	7. Fixed extinguisher system present?		√		According to chapter 6 of Bangladesh Labor Law Partner, fixed extinguisher system must be installed. (Labor Law Partner, 2016)
	8. Are containers tightly closed?		√		Containers must be tightly closed to ensure no further contamination is done.(Bangladesh Standards and Guideline for Sludge Management, 2016)
	9. Are incompatible wastes properly segregated?		√		According to Bangladesh Banks Environmental and Social Risk Management, Hazardous wastes should always be segregated from non-hazardous wastes.
	10. If required, is an eyewash station accessible and ready for use?	√			
Waste Storage	11. Are all waste containers stored inside the waste storage area?		√		MLI Environment, an international organization on hazardous materials management, Keep containers in a secure, supervised work area where they can be monitored.
	12. Is the total volume of wastes stored below the facility's generator status?		√		According to section 9 (1) of the Bangladesh Environment Protection Act (1995), where the discharge of an environmental pollutant in excess of the limit prescribed by rule occurs or is likely to occur as a result of any accident or any other unforeseen act or event, the person responsible for such discharge or in charge of the place where such discharge occurs shall be bound to prevent or abate the environmental pollution occurred (Bangladesh Environmental_Conservation_Act, 1995).
Vehicles	13. Are the vehicle producing any harmful smoke?	√			According to section 6 (1) of Bangladesh Environment Protection Act (1995), there shall not be driven any vehicle producing smoke which is injurious to health or harmful to the environment.
	14. Are the wastes covered when transported?		√		Article 3.17.16 of national environment policy (2018) states, waste must be covered when transported.

Impact on Environment

Due to the discharge of untreated effluents, industrial wastes are considered primary sources of pollutants with immense capacity to pollute the soil and water. More than 250 chemicals are being used in this process, and further, a mixture of complex toxic substances, such as polychlorinated biphenyl, chromium, sulfides, nitrates, etc., gets discharged as waste (Patel et al., 2021). That creates a significant impact on the environment.

Table 3 Assessment of environmental impact according to legal provisions

Themes	Environmental Issues	Major Issues Assessed	Yes/ No	Legal Compliances
1. Pollution Control	(1) Air Quality	(a) Do air pollutants, such as sulfur oxides (SOx), nitrogen oxides (NOx), soot and dust, and dioxins emitted from various sources, such as incinerators and vehicles used for waste collection and transportation, comply with the country's emission standards and ambient air quality standards?	No	A maximum penalty of 10 years imprisonment or fine or both for violating the law governing air pollution according to The National Air Quality Management Plan. (Bangladesh Clean Air Bill, 2019) According to section 6 (1) of the Bangladesh Environment Protection Act, 1995, there shall not be any vehicle producing smoke that is injurious to health or harmful to the environment. 6.(1) A vehicle emitting smoke or gas injurious to health or environment shall not be operated (Environment Conservation Act, 1995). Violation of sub-section (1) of section 6 In case of first offence, a fine not exceeding taka 5 (five) thousand and an imprisonment not exceeding 1 year or a fine not exceeding taka 10 (ten) thousand or both.
		(b)Does the air cause any inhalation problem?	Yes	(1) Any person damaged or apprehending to be damaged on account of environmental pollution or deterioration of the environment may, in such manner as may be prescribed by rules, apply to the Director General for remedying against the damage or apprehended damage (Section-8, The Environment Act, 1995).
	(2)Water Quality	(a)Are the nearby water reservoirs getting affected by the waste?	Yes	*To save the water reservoirs, no dumping ground should be made near a water resource.* (Section 3.4.7 of National Environmental Policy, 2018). Section 3(2) of the Bangladesh water Act states the *"right to potable water, use of water for hygiene and sanitation will be considered shall be treated as a universal right*." Bangladesh constitution states *"The state shall endeavor to protect and improve the environment and to preserve and safeguard the natural resources, bio-diversity, wetland, forests and wildlife for the present and future citizens"* (Article 18A).
		(b)Is the water getting odorous?	Yes	The Environment Conservation Rules, 1997 Schedule 1(C), industrial units likely to produce sound, smoke, odor beyond permissible limit shall not be acceptable in commercial areas.
		(c)Is fish and other livestock getting affected?	Yes	According to section 18 of (Bangladesh Water Act, 2013), *In the declared water-stressed area priority usages would be in the order being drinking water > domestic usage > irrigation > fish culture > bio-diversity > wildlife > in-stream flow > industry >salinity control > power generation > recreation.*
		(d) Is the water drinkable?	No	*All the human has right to water and sanitation* (UNR 64/292, 2010). Section 3(2) of the Bangladesh Water Act,2013, states the *"...right to potable water, use of water for hygiene and sanitation will be considered shall be treated as a universal right*."
		(e) Are adequate measures taken to prevent contamination of surface water and groundwater by these effluents and leachates?	No	Article 30.(II) Water Pollution Control Act, Chaina, *the dumping of garbage, nightsoil, sludge, acidic or basic liquid waste, construction waste or other pollutants in water bodies or within a designated distance from their shorelines.*
		(f)Are the waste discharged into the river before purification?	Yes	*No waste shall be discharged into a river, canal or any water body before purification* (Bangladesh Water Act, s-3.3.3)

	(3) Wastes	(a)Are the wastes properly treated and disposed of in accordance with the country's regulations?	No	3.15.1 of the Waste Control Act, *Identified polluting industries should take necessary measures and clean development mechanism should be applied.* 3.15.9 of the same convention, a *waste permit and consent order should be developed and maintained to develop waste disposal and purification.*
		(b) Are hazardous and dangerous wastes properly segregated from other wastes, stabilized, treated, and disposed of in accordance with the country' s standards?	No	
		(c) Is there any discharge of excessive environmental pollutants?	Yes	(9) Where, due to an accident or other unforeseen incident, the discharge of any environmental pollutant occurs or is likely to occur in excess of the limit prescribed by the rules, the person responsible and the person in charge of the place of occurrence shall take measures to control or mitigate the environmental pollution. (Environment Conservation Act, 1995)
	(4)Soil Contamination	(a) Are adequate measures taken to prevent contamination of soil and groundwater by leachates from the waste disposal sites?	No	
	(5) Noise and Vibration	(a) Do noise and vibrations generated by the facility operations (especially incinerators, waste segregation and crushing facilities), and vehicle traffic for waste collection and transportation comply with the country's standards?		The Environment Conservation Rules, 1997 Schedule 1(C), Industrial units likely to produce sound, smoke, odor beyond permissible limit shall not be acceptable in commercial areas. According to Environmental Clearance Certificate, 3.15, In order to control noise pollution, vehicles & equipment shall be maintained regularly; working during sensitive hours and locating machinery close to sensitive receptor shall be avoided. According to section 14(1) of Sound Pollution control act (2006), if for running a factory or using the machineries of the factory creates such kind of sound which exceeds the standard level of sound. In that case, for reducing the effect of sound pollution on people working in that factory, necessary legal steps will be taken against the owner or the person in charge.
	(6) Odor	(a) Are adequate odor control measures taken?		Section 3.8 (5) of National Waste Management Strategy, *The frequency of the service should not encourage illegal dumping or cause a nuisance in terms of odours and volumes of waste being stored.*
	(7) Heat	(a) Is there any heat pollution?	Yes	According to article 3.23 of National Environment Act, *Waste heat must be recovered and every type of heat pollution should be controlled.*
2. Natural Environment	(1) Protected Areas	(a) Is the project site located in protected areas designated by the country' s laws or international treaties and conventions?	No	
	(2) Ecosystem	(a) Does the project site encompass primeval forests or ecologically valuable habitats? (e.g., coral reefs, mangroves, or tidal flats)	No	If it appears to the Director General that any particular activity is causing damage to the ecosystem he may take action (Section-7, The Environment Act, 1995)
		(b) If significant ecological impacts are anticipated, are adequate protection measures taken to reduce the impacts on the ecosystem?	No	(1) If the Government is satisfied that an area is in an environmentally critical situation government may, by notification in the official 1 Gazette, declare such area as an ecologically critical area (Environment Conservation Act, 1995).
		(e) Any fixed place for dead birds or other animals?	No	Section 3.12.35 of environment conservation act says, for dead birds and other animals, fixed place and incinerator should be made.
	(3) Management of Abandoned Sites	Is a sustainable management framework for the abandoned sites established?	No	Article 20" Inventory of Closed Waste Facilities" states, it shall be ensured that an inventory of closed waste facilities, including abandoned waste facilities, located on their territory which cause serious negative environmental impacts or have the potential of becoming in the

				medium or short term a serious threat to human health or the environment is drawn up and periodically updated.(EU “Mine Waste Directive”)
3.Social Environment	(1) Living and Livelihood	(a) Is there a possibility that the project will adversely affect the living conditions of inhabitants?	Yes	
		(b)Is there any residence in the tannery area?	Yes	Article 3.15.4 of the Environment conservation act states, subjective industrial zones should be built with strategic environmental assessment. Establishing industries in the residential areas should be prohibited.
		(c) Is there a possibility that waste transportation will adversely affect the regional traffic?	No	
		(d) Is there a possibility that pathologic insects or other disease vectors will breed as a result of the project?	Yes	According to section 5.(1) of Destructive Insects and Pests Act, 1914, The Government may make rules for the detention, inspection, disinfection or destruction of any insect or class of insects or of any article or class of articles in respect of which a notification has been issued under section 33 or of any article which may have been in contact or proximity thereto, and for regulating the powers and duties of the officers whom it may appoint in this behalf.
	(2) Resettlement	(a) Is involuntary resettlement caused by project implementation?	No	
	(3) Heritage	(a) Is there a possibility that the project will damage the local archeological, historical, cultural, and religious heritage?	No	
	(4) Landscape	(a) Is there a possibility that the project will adversely affect the local landscape?	Yes	According to the section 434 of Penal code, 1860, whoever commits mischief by destroying or moving any land-mark fixed by the authority of a public servant, or by any act which renders such land-mark less useful as such, shall be punished with imprisonment of either description for a term which may extend to one year, or with fine, or with both.
	(5) Ethnic Minorities and Indigenous Peoples	(a) Are all of the rights of ethnic minorities and indigenous peoples in relation to land and resources respected?	No	Everyone, without any discrimination, has the right to equal pay and respect for equal work (article 23,UDHR).
	(6)Working Conditions	(a) Is the project proponent violating any laws and ordinances associated with the working conditions of the country?	Yes	No woman shall work in any establishment during the eight weeks immediately following the day of her delivery. (section 45 (2), Bangladesh Labour Act,2006)
		(b) Is there any child labor?	Yes	No child shall be employed or permitted to work in any occupation or establishment. (section 34, Bangladesh Labour Act,2006)

Impact on Safety and Health

The *Occupational Safety and Health Act (1970)* entitles all employees to three fundamental rights: the about health and safety matters, the right to participate in decisions that could affect their health and safety and the right to refuse work that could affect their health and safety and that of others.

One of the main goals of this study was to determine the prevalence and patterns of health problems of tannery workers and to find out the factors associated with those health problems. The study has assessed five separate indicators for this section. They are- The work environment, health and safety program, Disease, Sanitation and Treatment.

Working Environment

Legal standards

Article 8 (1) of the Working Environment (Air Pollution, Noise and Vibration) Convention declares that the competent authority shall establish criteria for determining the hazards of exposure to air pollution, noise and vibration in the working environment and, where appropriate, shall specify exposure limits on the basis of these criteria.

Field Level Practice

From a health standpoint, there are several grievances arising from the owners' disregard for the well-being of their workers. Additionally, the study reveals that the work environment within the plants is exceedingly substandard, with no established guidelines for assessing the risks associated with exposure.

Workload and Health

Legal standards

Everyone has the right to rest and leisure, including reasonable limitation of working hours and periodic holidays with pay (article 24, UDHR). According to section 100 of the the Bangladesh Labour Act 2006, No adult worker shall ordinarily work or be required to work in an establishment for more than 8 (eight) hours in a day.

Section 54 of the Bangladesh Labour Act 2006 states that effective arrangements shall be taken in every establishment for the disposal of wastes and effluents due to the manufacturing process carried out therein. Also, section 39 (3) of the same Act states that no adolescent shall be allowed to clean, lubricate or adjust any machinery of any establishment. At the same time, it is in motion or to work between moving parts or between the fixed and moving parts of such machinery.

Field Level Practice

The majority of participants believe that the level of stress they experience at their workplace is mostly responsible for their health issues. Furthermore, the observation revealed that the workers are exceeding the standard 8-hour workday. This constitutes a violation of both domestic and international legal norms.

Dealing with the waste has always been a point of concern among the workers. However, the group discussions concluded that workers in the wet blue sector who deal with raw materials face more issues than others.

Air Ventilation System and Waste Odor

Legal standards

Article 8 of the Hygiene Convention (1964) denotes that all premises used by workers shall have sufficient and suitable ventilation, natural or artificial or both, supplying fresh or purified air. According to section 52 (1) of the Bangladesh Labour Act, arrangements for adequate ventilation shall be made to secure and maintain the circulation of fresh air in every workroom of every establishment.

Field level practice

Surprisingly, almost all the participants said they face no such complexity in dealing with waste odor, though the air ventilation system is not sufficient. From the direct observation, it was also noticed that no legal standards are being maintained in terms of ventilation and odor control.

Waste disposal and hygiene

Legal standards

Section 54 (Bangladesh Labour Act) says effective arrangements shall be taken in every establishment for the disposal of wastes and effluents due to the manufacturing process carried out therein. Section 12 (Factories Act, 1965) states that the floor of every workroom shall be cleaned at least once every week by washing, using disinfectant where necessary or by some other effective method.

Field level practice

The group discussion resulted in finding no workers having minimum knowledge and concerns about maintaining hygiene in their workplace. And most of them are pretty much sure that wastes are not being disposed of properly.

Health and Safety program

Legal standards

Article 14 of the Occupational Safety and Health Convention, 1981 states that measures shall be taken for safety with a view to promoting in a manner appropriate to national conditions and practice of all workers. Any violation of the laws

and regulations of the Occupational Safety and Health Convention demands the enforcement system to provide adequate penalties (OSHC, 1981). No worker shall be employed unless he has been given adequate instruction or training properly(C152 - OSHC, 1979).

Field-level practice

No health and safety program is conducted following the national and international guidelines. A clear reflection of this was also seen inside the factory during the observation method. Thus it is a clear violation of the legal standards.

Safety precautions

Legal standards

Article 17 (Hygiene Convention, 1964) states that workers shall be protected by appropriate and practicable measures against substances, processes and techniques that are obnoxious, unhealthy or, toxic or for any reason harmful. Section 1(a) of Article 4 of the Occupational Safety and Health Convention (1979) says that providing and maintaining workplaces, equipment and methods of work that are safe and without risk of injury to health for the workers is essential. Also, section 33 states that suitable precautions shall be taken to protect workers.

Field level Practice

Most of the participants from the group discussions said that they do not follow any safety precautions for hazardous works and waste management.

> *"Accidents are very common in this industry. However, we are not accustomed to using any safety instruments. Also, we are not equipped with all of them(Participant, FGD)."*

Guidelines to follow

Legal standards

Article 4 (1) of the Occupational Safety and Health Convention (1979) suggests that workers should be provided with any personal protective equipment and protective clothing and any life-saving appliances reasonably required where adequate protection against risks of accident or injury to health cannot be provided by other means. Article 6.1 (c) of the convention mentions a strict guideline where workers should report forthwith to their immediate supervisor any situation which they have reason to believe could present a risk.

Field level practice

Majority of participants from FGD agreed that they do not have any specific guidelines from their factories. Nevertheless, as observed, most factories in recent times try to keep the inner part of their factory clean. However, no international guidelines are seen to be followed in the factories.

Occupational Hazards and Disease

Legal standards

Article 39 of the Occupational Safety and Health Convention states that to assist in the prevention of occupational accidents and diseases, measures shall be taken to ensure that they are reported to the competent authority and, where necessary, investigated.

Field level Practice

Almost half of the participants from FGDs think that the factory environment and the work they do are not responsible for their getting sick. But the rest of the group directly blamed the type of work they did for their sickness.

> *"I can feel that I have a serious problem with hearing. This problem with hearing has developed since I started working in this factory as a Gunman. Also, I have developed severe headaches and body aches (Participant, FGD)."*

Diversified opinions on the negative impact of tannery waste on the participants' illnesses were found in the group discussion. The impact of the waste differs a great deal based on the type of work they do. For example, in the chemical department, the type of waste they deal with is totally different from the type of waste the people in the machinery department handle. However, irrespective of the sector they work in, most of the participants had similar types of symptoms. Among them, problems like inhalation problems, asthma, severe headaches, common colds, digestion problems, migraine problems, body aches, high blood pressure, diabetes, ulcers, anemia, loss of appetite, allergy, skin diseases, and gastric problems were the most common ones.

Hygiene and Sanitation

International legal standards

According to section 120 of the Occupational Health and Safety Convention, sufficient and suitable washing facilities and sanitary conveniences shall be provided and properly maintained. Article 15 of the Hygiene Convention also states that suitable facilities for changing, leaving and drying clothing that is not worn at work shall be provided and properly maintained.

According to section 20(2) of the Factories Act, the government may prescribe the number of latrines and urinals to be provided in any factory in proportion to the number of male and female workers.

Field-level practice

There were several contradictory opinions about the factory's sanitation in the group discussions. During the observation, it was also noticed in the factory's washrooms that there was no soap or detergent to wash hands. No hand shower is available, only some pots for washing their selves.

Treatment and First Aid

Legal standards

Article 19 of the Hygiene Convention (1964) declares that every industry to maintain its own dispensary or first-aid post. Article 4, Occupational Safety and Health Hazard, states that providing and maintaining suitable and adequate first-aid and rescue facilities should be a factory's prior concern.

Field-level practice

The majority of interviewees expressed the view that they do not receive any assistance from their employers for medical treatment, even if they fall ill while on duty. Numerous instances exist where individuals fall ill during their employment and are neglected by the governing bodies. The majority of participants believe that they should be granted additional amenities for their healthcare treatment.

RECOMMENDATIONS

From the researchers' observation, participants' responses and overall findings of the study, a variety of limitations and loopholes were found regarding the tannery's waste management process, workers' health and safety, along with the environmental protection approaches.

Technical experts in waste management recommend that proper responses from the owners in time to manage the waste can solve many problems that become major at a later stage. *The factory must follow the* guidelines of waste management properly to make it easier for the CETP to ensure environmental safety through proper waste management. Particularly, four major issues are crucial to ensure proper management of industrial waste according to law: (1) Proper cooperation from the factory owners; (2) Consciousness of the workers; (3) Recycling; and (4) Appointing expert consultants and (5) Regular monitoring by the inspection Department.

Regarding workers' health, one of the key informants, a physician, recommended that unawareness, massive workload, absence of health rights, and abuse of drugs are the main reasons for the workers' suffering. Another Key Informant, an administrative officer of the Tannery Workers Association, recommended that insurance of workers' rights and efficient and safe waste transportation be ensured. Further, it is claimed that the factory contractors are more oppressive towards the workers than the owners. Therefore, demands come to abolish the contracting system of waste management or at least prioritize regulating the contractor and contracting system to comply with the standards and rules of waste management.

The representatives of the workers' associations focused on providing and ensuring the use of safety equipment at work. He stated that;

> *"The workers handle a lot of toxic wastes. But as they do not have any safety equipment, they fall into danger. So necessary safety equipment must be ensured".*

Based on the information obtained from firsthand observation, focus group discussions, interviews, and several secondary studies, this study also presents numerous recommendations.

The industry should prioritize and ensure (1) upgradation of waste management procedure; (2) proper solid and gaseous waste management system; (3) Proper national guidelines; (4) the 3R Model should be applied; (5) Production by-products and recycling.

In relation to the protection of the environment, the industry should be proactive in ensuring proper surveillance, strict application of laws, proper heat and odor management, and increasing the capacity of CETP, which might help protect the environment.

The protection of workers' health is another priority issue the study observed. We recommend (1)conducting regular health campaigns, (2) providing safety training, (3) ensuring a decent work environment, (4) maintaining protocol of occupational safety and health, (5) respecting human rights and business responsibilities. These can be some of the basic recommendations for effective planning of proper waste management in the tannery industrial estate.

CONCLUSION

The Tannery Industry is a significant economic contributor to the national economy of Bangladesh. Nevertheless, the state of tannery waste and its management in Bangladesh has emerged as a prominent environmental and occupational health concern. Although the government has established a concrete framework and regulations for waste management, the failure to effectively implement them has resulted in a worsening trash problem exacerbated by the growing population. The study found significant violations of national and international standards from the legal point of view.
Furthermore, the uncontrolled discharge of leachate, which combines biomedical and urban waste, together with the presence of toxins in the waste, indicates the increasing health hazards faced by the workers (Ashikuzzaman & Howlader,

2019). Consequently, this leads to the development of various illnesses that have the potential to endanger the lives of the workers

In Bangladesh, legislations are implemented using a top-down manner, similar to development planning. Government officials and legislative bodies enforce laws upon individuals. Due to the absence of public ownership of such legislation, individuals tend to exhibit apathy toward compliance, leading to issues arising throughout the enforcement process (Mohammad, 2020).

Instead of employing a top-down method, it is advisable to adopt a bottom-up approach. The government, in conjunction with the appropriate authorities, must prioritize efforts to maximize the potential of this business fully.
Together with the unwillingness of the employers, the unconsciousness of the workers also contributes to the improper management of waste and poses a health impact on the workers. Government authorities need to be more concerned about the proper implementation of domestic laws and follow the commitment to achieve the sustainable development goal with a just transition.

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