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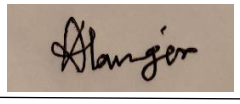

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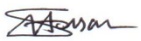

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Each group member proves to have equal participation in writing the thesis report by signing this document. Each group member is, therefore, accountable for the thesis' overall content.

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STUDENTERRAPPORT

MASTER'S THESIS

Chemical Handling in Tannery:

An Empirical Analysis of Chemical Management in Tanning Industry, Savar, Bangladesh

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Acronyms

Acronym	Meaning
BTA	Bangladesh Tanners Association
BSCIC	Bangladesh Small and Cottage Industries Corporation
BAB	Bangladesh Accreditation Board
BHSMA	Bangladesh Hide and Skin Merchants' Association
BLL	Bangladesh Labour Law
BLR	Bangladesh Labour Rules
CETP	Central Effluent Treatment Plant
COEL	Centre of Excellence for Leather Skill Bangladesh Limited
DIFE	Department of Inspection for Factories and Establishments
DW	Durbin-Watson
DoL	Department of Labour
DoE	Department of Environment
DG	Director General
EPB	Export Promotion Bureau
ECP	Environmental & Chemical policy
EIA	Environmental Impact Assessment
EMP	Environmental Management Plan
ETP	Effluent Treatment Plant
GDP	Gross domestic products
GHS	Globally Harmonized system
H&S	Health and Safety
ILO	International Labor Organization
ISO	International Organization for Standardization
IFC	International Finance Corporation
IUE	International Union of Environment Commission
ILET	Institute of Leather Engineering and Technology
IEE	Initial Environmental Examination
IULTCS	International Union of Leather Technologists and Chemists Societies
KMO	Kaiser–Meyer–Olkin
LWG	Leather Working Group
LFMEAB	Leather goods And Footwear Manufacturers & Exporters Association of Bangladesh
MSME	Micro, Small and Medium Enterprise
M&S	Marks & Spencer
MSDS	Material Safety Data Sheet
MANOVA	Multivariate Analysis of Variances
MRSL	Manufacturing Restricted Substances List
NAPE	National Association of Professional Environmentalists
NGO	Non-Government Organization
OSHA	Occupational Safety and Health Administration
OLS	Ordinary Least Square

Acronym	Meaning
PPE	Personal Protective Equipment
PETP	Personal Effluent Treatment Plant
PCA	Principal Component Analysis
PFD	Process Flow Diagram
RMG	Ready-Made Garments
SPSS	Statistical Package for the Social Sciences
SCP	Sustainable Consumption and Production
SOP	Standard Operating Procedure
SDS	Safety Data Sheet
SLF	Sustainable Leather Foundation
ToR	Terms of Reference
UNIDO	United Nations Industrial Development Organization
VIF	Variance Inflation Factor

Preface

The thesis report is written to fulfil the requirement of 30 ECTS master's thesis for two years master study program in "Risk and Safety Management" held at Aalborg University, Esbjerg, Denmark. This thesis paper has been prepared in the final semester of the master study program (February 2023 to June 2023). The study has been accomplished in collaboration of six different tanneries of BSCIC Tannery Industrial Estate, Hemayetpur, Savar, Dhaka, Bangladesh by interviewing 125 employees with the help of survey questionnaires that has been performed conducting in person survey procedure.

The report is prepared for the organizations and personnel who have interest and keen to work in chemical management of Bangladesh tanning industry, chemical safety, empirical analysis, Factor Analysis, regression analysis, and stakeholder analysis. This thesis paper comprises of six chapters and for referencing purposes APA style has been followed.

The authors would like to convey their heartfelt gratitude and thankful to the supervisor of this master thesis report Dewan Ahsan, PhD, Professor, University of Southern Denmark (SDU) and co-supervisor Anders Schmidt Kristensen, Associate Professor, Aalborg University (AAU), Esbjerg, Denmark. The authors also acknowledge and convey their gratitude to the respondents of survey for their cordial cooperation. The authors expressed their appreciations to SusLeather, DANIDA Project for their assistance for the successful completion of survey work. Gratitude to two Labour Inspectors from the Department of Inspection for Factories and Establishments (DIFE) deployed in BSCIC Tannery Industrial Estate, Hemayetpur, Savar, Dhaka for their cordial support in collaboration with factory management. Special gratitude also goes to Bangladesh Accreditation Board (BAB), Ministry of Industries, Bangladesh for their cordial support to achieve the Ethics Committee Certification of approval for the research.

Abstract

The tanning industry of Bangladesh has been facing an emerging threat to international leather market for not achieving third party compliance certification. Moreover, losing buyers, a mentionable decrease in workorders, and losing reputation in international leather domain are being considered a matter of concern for not being able to establish a safe chemical management system in Bangladesh tanning industry. Numerous factors are being thought liable for chemical management deviations. This thesis paper traced out the factors by performing qualitative and empirical data analysis. The qualitative data has been gathered from the secondary data sources and the quantitative analysis has been accomplished by conducting in person survey procedure among 125 employees from six different tanneries in BSCIC Tannery Industrial Estate, Hemayetpur, Savar, Dhaka, Bangladesh. The quantitative analysis has been performed using IBM SPSS statistical program v-29. Factor analysis has been conducted to extract the factors that contribute to chemical management deviations in tannery. The results depicted four key factors i.e., chemical related knowledge on storage and unloading, Employers attitude towards chemical effluent disposal and chemical dosing, factual complications to achieve third party certification, and chemical training and safety concern that are playing as key element for chemical management deviations in Bangladesh tanning industry. To tackle these obstacles, this thesis paper suggested some interventions in relation to chemical related Laws, Rules, Standards, Guidelines, Policies, and best practices that are being followed in global tanning industry. Moreover, opinion from chemical experts acquired by online survey have also been included to improve the chemical management deviations. On top of that suggestions were considered in regards to strengthen the different stakeholders for establishing a safe chemical management system in tanning industry of Bangladesh. To attain the sustainable improvement in chemical management system of Bangladesh tanning industry, a cumulative effort from government, employers, workers, and buyers and brands become an immense need.

Chapter 1

1.1 Introduction and Background of Tanning Industry in Bangladesh

1.1.1 Introduction

A wide range of chemicals for instance around 250 are used in different stages of leather production in tanning industry (UNIDO, Occupational Safety and Health Aspects of Leather Manufacture, 1999). The chemicals that are frequently used in leather processing are Sodium Chloride (NaCl), Soda Ash (Sodium Carbonate), Lime (Calcium Hydroxide), Sodium Sulphide, Sodium Hydroxide (Caustic soda), Formic Acid, Sulfuric Acid, Chromium Sulphate, Sodium Formate, Soda (NaHCO3), and Amino Resins. Figure 1 depicts list of chemicals that have been using in different stages of tanning process named as Beamhouse operation, Tanyard operation, and post tanning operation (Hüseyin Ata Karavana, 2011) (Dr. (Mrs.) Nalini Bhat, 2009) (A. B. M. Wahid Murad, 2016).

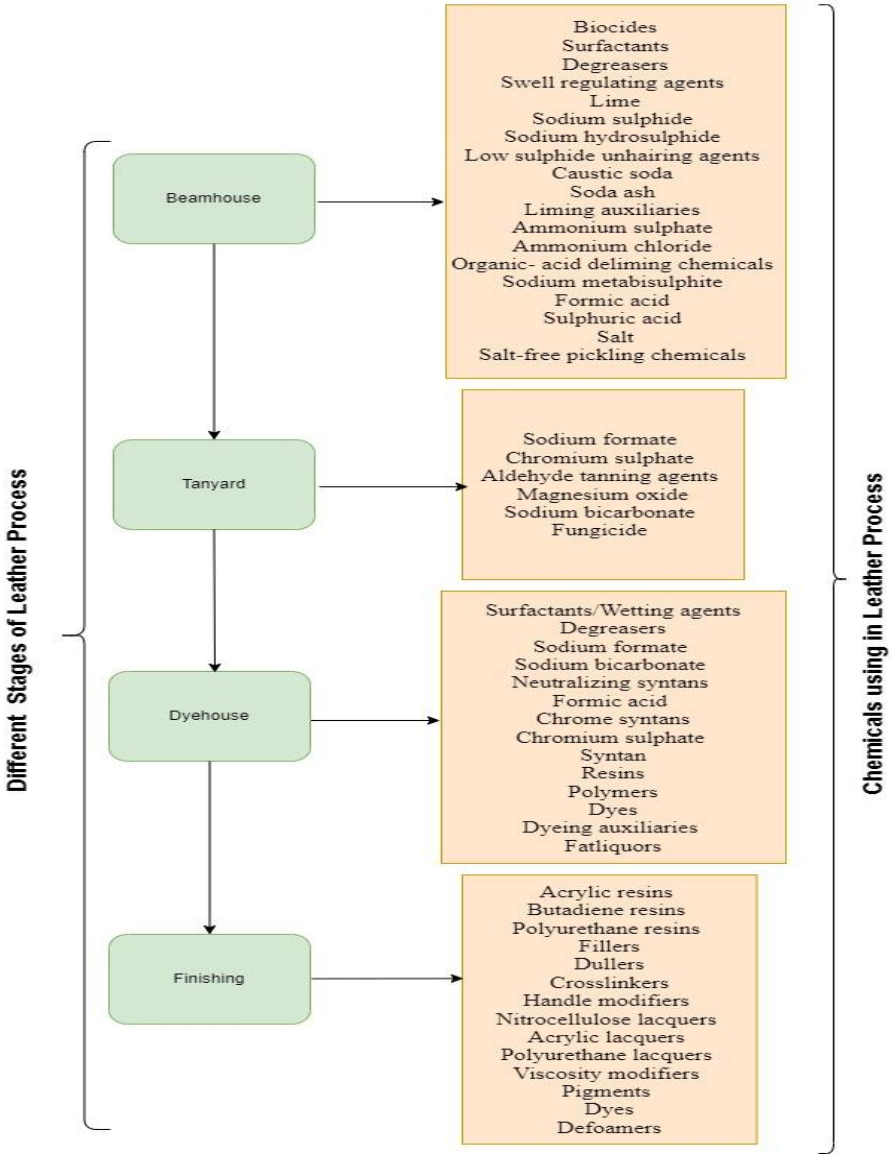


Figure 1: Chemicals used in different stages of leather process in tannery

(Fig. 1 source: (Hüseyin Ata Karavana, 2011) (Dr. (Mrs.) Nalini Bhat, 2009) (A. B. M. Wahid Murad, 2016)*)*

In tannery, employees need to handle chemicals while loading, unloading, storing, transferring, dosing, and disposing of chemical effluent. While dealing with chemicals in tannery, workers who directly confront to chemicals and workers who reside in surrounding area inside the tannery are exposed to adverse health effect in several ways for instance, inhalation, ingestion, absorption and eye contact due to chemical management deviations. Apart from the workers adverse health impact, chemical management deviation contributes to deteriorate the environment severely. Hence a safe chemical handling and management in tanning industry became an immense need to protect worker health and to promote occupational health and safety (UNIDO, Occupational Safety and Health Aspects of Leather Manufacturing, 2021) (Tanneries and leather products Sub-sectoral Environmental and Social Guidelines, 2009).

On top of that, a safe chemical management is one of the 17 prerequisite criteria to get third party certification named LWG (Leather Working Group) certification which is thought as mandatory to gain access to international leather market for example access to the leather market of Europe, the US and some developed Asian countries (Mirdha, 2019). Moreover, LWG certificate is mandatory requirement for foreign buyers such as Adidas, Clarks, Ikea, Nike, Marks and spencer, New balance and Timberland, as well as key leather manufacturing companies from across the globe (Islam K. M., 2022).

The present situation of chemical handling and management in Bangladesh tanning industry depicts that worker adverse health effect scenario is being deteriorated gradually. Huge number of workers are being suffered in different adverse health issues for example, severe respiratory problem, skin related disease, and cardiovascular complexity (M M Rahman, 2022). In respect to LWG certification, the current status of Bangladesh tanning industry become worse day by day for not being compliance with chemical management which is one of the most vital requirements for being certified. For this reason, the consequence come out with losing buyers, workorders and reputation in international leather market. Hence, the sustainability of Bangladesh tanning industry is being confronted to a big challenge in international leather domain (Islam K. M., 2022).

So, considering the above-mentioned issues, the necessity of a safe chemical management in tannery sector is very crucial. But the tanning industry of Bangladesh is still far behind to build up a safe chemical management due to some dormant and obvious reasons in chemical unloading, storing, transferring, dosing and disposing of tannery internal wastage that are accelerating the deviations in chemical management.

This thesis work will investigate and focus about the causes of deviations in chemical management and will come to an end with some possible interventions against chemical management deviation in the tanning industry of Bangladesh.

1.1.2 Background of Bangladesh Tanning Industry

Tanning industry is considered as a dominant export-oriented sector in Bangladesh as it contributes significantly to our national economy (Shilpy Basak, 2020). It is thought as the second largest sector to the national economy after the ready-made garments (RMG) of Bangladesh in respect to export earnings (Leather industry in Bangladesh, 2023) (Chakma, 2023).

The first tannery in Bangladesh inaugurated in Narayangonj in 1940, later it was relocated to Hazaribagh in Dhaka district. Around 155 tanneries have been shifted from Hazaribagh to the Tannery Industrial

Estate in Hemayetpur, Savar, Dhaka in 2017 in an area of 8,09,371 square meters (Leather industry in Bangladesh, 2023) (Dr Abdur Razzaque, 2019).

According to the Export Promotion Bureau (EPB), being the second largest export earning sector of Bangladesh, it contributes a mentionable portion of country's national GDP. Three main products of tannery sector; leather, leather products and leather footwear have been contributed around 12.5%, 27% and 60% consecutively of the country's total export from leather sector in the fiscal year 2020-2021 (Abul Kashem, 2022) (Khan, 2023).

The tanning industry is opined as a crucial sector of Bangladesh economy as per the ministry of commerce and sectoral entrepreneurs. The sector plays a key role to the national employment scenario as about six hundred thousand people are directly engaged to the leather and leather products related works and almost three hundred thousand employees are indirectly involved with this sector. The contribution of tanning industry to Bangladesh economy is huge. This sector contributes around 4% of total exports in the country and contributed 0.5% to the national Gross Domestic Products (GDP) (Abul Kashem, 2022) (Khan, 2023). The tannery sector has been contributing constantly to Bangladesh national economy for the last few decades. The national Gross Domestic Product (GDP) is highly enriched with a mentionable export earnings which is around 3 billion USD ((BIDA), February 2021).

Moreover, the tanning industry of Bangladesh is also a major employer of semi-skilled or unskilled workers. This sector possesses 240 tanneries, 3,500 MSMEs, 2500 footwear making units, and 90 large firms. Around 8380 million is earned as salary and wages benefit by the employees involved in tanning industry (Hira Paul, 2013).

China holds the leading position in the world in respect to export of leather goods with an export rate of around 30.3% of the global value in the year 2020 (see figure 2). Italy and France are considered as the representative of Europe traditional tanning industry. Italy contributed 17.8% of the total global export value while France has been considered as third position in the world leather exporting market with a total global value of 14.8%. Some Asian country for instance, Vietnam and India grab a mentionable amount of the total global export value with 6.4% and 2.6% respectively and the rest of leather and leather products exporting countries contributes 27.5% of the global export value (Abul Kashem, 2022) (BizVibe, 2023).

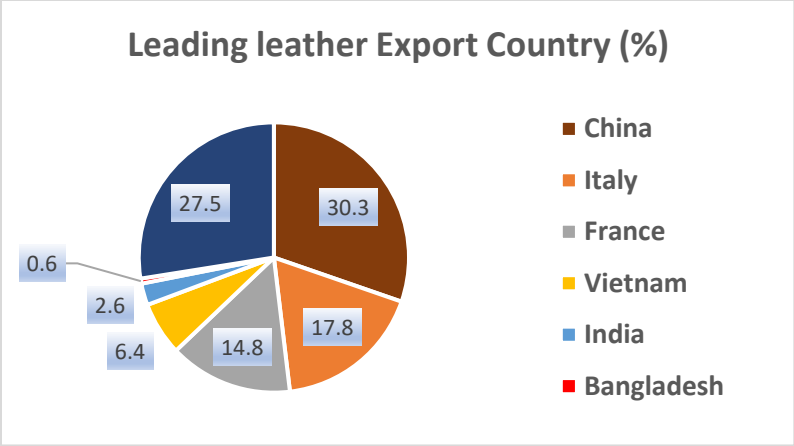


Figure 2: Leading leather export countries all over the world

(Source: (Abul Kashem, 2022) (BizVibe, 2023))

Bangladesh is contributing around 0.6% of the global exporting leather and leather goods (see figure 2) around 53 countries such as China, France, the USA, Germany, Italy, South Korea, Netherlands and Vietnam. Companies that are deeply rely on Bangladesh leather include Nike, Puma, CK, H&M, Hugo Boss, Armani, Timberland and many more (Rakib, 2020).

As per the statement of Bangladesh Export Promotion Bureau (EPB) the ratio of leather and leather products export is being increased constantly since 2010. It also says that in the fiscal year 2012-2013 there is a significant amount of money has been earned by exporting leather and leather products which is around US$ 1120 million. The EPB added that in the fiscal year 2016-2017 this sector scored the highest amount of exporting with a figure of US$ 1230 million which was a record in the history of tanning sector (Abul Kashem, 2022) (Islam K. W., 2022).

Figure 3: Statistics of leather and leather products export for Bangladesh

(Fig.3 source: (Abul Kashem, 2022) (BizVibe, 2023))

But after the golden period, the figure of exporting leather and leather products were being declined dramatically in three consecutive years. The EPB claimed that the export of leather and leather products have been decreasing since the fiscal year 2017-2018 and continues to decline in a constant rate till 2019-2020 which remains around US$ 800 million (see figure 3). But in 2020-2021, the export volume was increased to around US$941.67 million comparing to the previous fiscal year which is almost 18% higher than the fiscal year 2019-2020 (Abul Kashem, 2022) (Islam K. W., 2022)

From the above figure (see figure 3) it obvious that after shifting the tannery industry (from 2017) to its newly place, the situation of export earnings from this sector was seen as deteriorating condition. The constant declining phase is considered as natural as the sector was in transition period. The matter that raised the concern is not getting a quick recovery from the declining period as it was expected to. One of the major factors of concern is the chemical management deviations and the adverse health effect of chemicals to workers, environment and aquatic inhabitants. Due to the unorganized chemical management which is not being compliant with the international buyer's requirement, the buyers are still not paying their full concentration for placing mentionable workorders in the tanning industry of Bangladesh (Abul Kashem, 2022).

Moreover, for not being compliant with the third-party certification such as LWG certification on chemical management issue, the workorders from the buyers are being declining significantly. According to the statement of the president of Bangladesh Tanners Association (BTA)- "Leather Working Group's certificates are important in attracting foreign buyers. If factories are not fully compliant, it is not possible to get this certificate. And to get foreign buyers and higher prices for products, it is a must".

He claimed that the tannery sector gets a lower price of its products from the buyers due to the poor compliance issues. The price will be increase if the factory meets the criteria for being compliant. According to the BTA president the foreign buyers emphasize on the third-party certification like Leather Working Group (LWG) Certification as it is well known globally for representing the brand requirement to the leather industry. It should be mentioned that in Bangladesh only three leather factories achieved the LWG certification and the rest of the tannery are still away from being certified for the noncompliance issues. Not being LWG certified is considered as a big challenge for the growth of export in tannery sector. To increase the export rate in the global market, compliance is thought as the key challenge in this sector (Abul Kashem, 2022) (assomac, 2023).

Even though, the objective of the relocation of tanning industry to Savar was to protect the environment pollution and provide a safeguard to workers' health from the negative impact of chemicals, the expected result is not being obvious yet as the tannery industry is not in the phase of fully complaint and the actions taken by the owners for being complaint is seen in negligible condition. To protect tanning industry from losing its buyers and to build up a sound tanning industry in respect to compliance issue, a safe chemical management system become a time-demanding issue for the tannery sector of Bangladesh (Dr Abdur Razzaque, 2019).

1.2 Problem Formulation

A safe chemical handling and management procedure in tanning industry become an increasingly challenging issue in Bangladesh as tannery sector is still far behind to meet the requirements of international buyers due to unsafe chemical management. For Bangladesh tanning industry, to attain reputation, grabbing notable workorder, to protect workers from adverse health effect of chemicals and to achieve a sustainable position in the international leather market, a third-party audit certification for instance, LWG certification is a vital requirement. A proper chemical management is being considered as one of the most prerequisite criteria that need to be accomplished for acquiring the third-party certification.

Hence, for Bangladesh tanning industry, to identify the factors that are playing a role of hindrance to safe chemical management become an immense need. Also, some interventions are required to be initiated for creating a safe chemical management system based on standards, guidelines, and best practices that are being followed worldwide in leather processing industry.

1.3 Aim of the Thesis

To scrutinize the existing chemical management system in Bangladesh tanning industry for identifying the factors that are creating obstacles in the way of a safe chemical management culture, and to provide solutions against these factors based on the chemical management standards, guidelines and best practices that are followed in leather industries globally.

1.4 Research Questions

1) To find out standards, guidelines and best practices that are being followed for the management of chemicals in tanning industry throughout the world.

2) To illustrate the current status of chemical handling and management procedure in Bangladesh tannery sector.

3) To identify the factors that triggers the deviations in proper chemical management in tanning industry of Bangladesh.

4) To provide some interventions for establishing a safe chemical management system in Bangladesh tanning industry focusing international standards, guidelines, and best practices.

Chapter 2: Research Methodology

First, the authors accomplished a qualitative risk analysis on chemical management deviations in the tanning industry of Bangladesh based on some secondary data sources for instance, studying different articles, journals and publications, on-site inspection, gathering experience from Labour Inspectors from the Department of Inspection for Factories and Establishments (DIFE) under the ministry of Labour and Employment, Bangladesh. Later on, to validate the outcome of qualitative risk analysis, the authors conducted a quantitative analysis. This empirical analysis has been commenced with survey to employees of different factories in tanning industry in Bangladesh. The survey procedure was conducted in two different level. The first level of survey was performed to different factories' workers and employees to find out the deviations in chemical management. The second level of survey was done by sending a google questionnaire to the chemical experts for the improvement of chemical management deviation in tanning industry. In empirical analysis the data has been analyzed using the IBM SPSS (Statistical Package for the Social Sciences) 29 package. A stakeholder analysis has been done to illustrate the roles and responsivities of different stakeholder involved in chemical management in the tanning industry of Bangladesh.

2.1 Risk Analysis Procedure

Risk analysis deals with hazard and risk. Hazard can be defined as any sources associated with risk that has a potential consequence of harm where risk might be known as the multiplication of the probability of a hazardous event that might happen and the severity of the consequences raised from the event (Terje Aven, 2009). In this thesis work a risk analysis was performed on chemical management deviations in Bangladesh tanning industry. The analysis shows what are the triggering factors that create a deviation for a safe chemical management in tanning industry of Bangladesh. Several deviation factors have been illustrated in different stages of chemical management in tannery. Two different risk analysis tools were utilized to find out the core reason behind the chemical management deviation. Fish Bone analysis also known as cause-and-effect analysis has been used to trace out the root cause for the deviation in chemical management. Later, a bowtie analysis was performed to identify the causes and consequences as well as mitigation barriers of chemical management deviation in tanning industry of Bangladesh.

2.2 Study Location

The research area is located in BSCIC Tannery Industrial Estate, Hemayetpur, Savar, Dhaka, Bangladesh (see figure 4). The tanning industry in Bangladesh has been relocated to this new place in 2017 from its previous location Hazaribag, Dhaka. Around 155 tanneries have been shifted in an area of around 8,09,371 square meters.

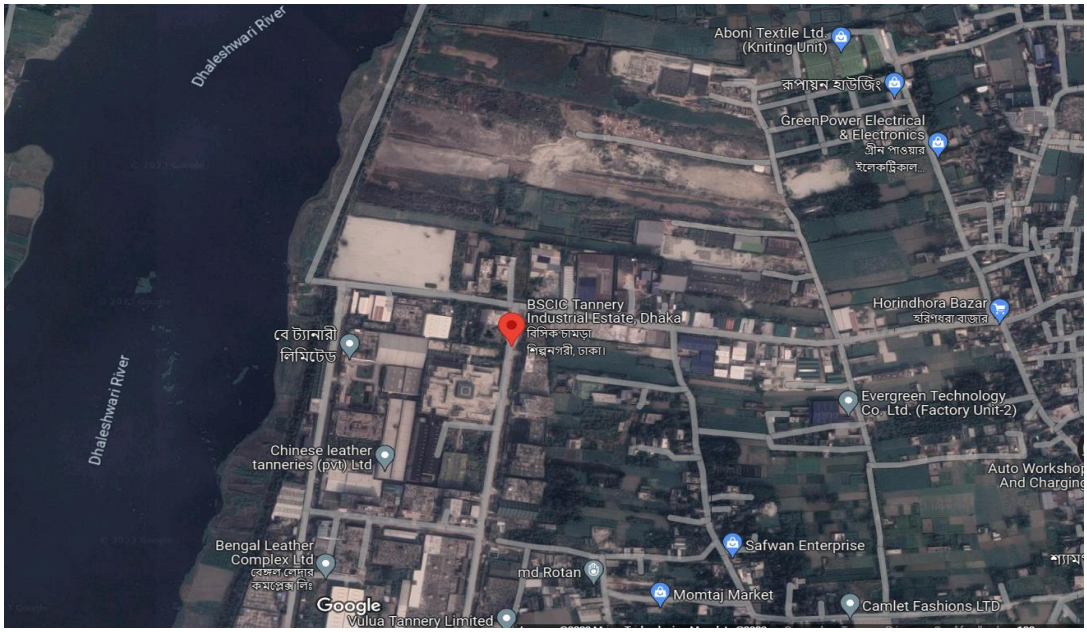


Figure 4: Location of BSCIC Tannery Industrial Estate, Dhaka, Bangladesh

(Source (Google Maps, 2023))

2.3 Data Collection Procedure

2.3.1 Survey Instruments

Two set of questionnaires have been prepared as an elements of survey procedure. First, a set of questionnaires was prepared for workers and management of tanning industry. The structure of the questionnaires is in the form of Likert scale where a scale of 1 to 5 has been considered. In the Likert scale 1 refers to strongly disagree, 2 for disagree, 3 for undecided or neutral, 4 for agree and 5 stands for strongly agree. Preliminary, 80 questions (see appendix I) were included in the questionnaire which later reduced to 50 (see appendix II) after the piloting and validation process held in some tanneries. The questionnaires have been prepared considering five different stages of chemical handling i.e.; Unloading, Storing, Transferring, Dosing and Disposing in tanning industry. For the improvement of existing chemical management system in Bangladesh tanning industry, the authors prepared other set of Likert scale online based questionnaires in google form (see appendix IV) that were sent to different scholar who have a better knowhow on chemical related fields. The result of the questionnaires was gathered by online and utilized as a suggestion in recommendation section of chemical management deviations. Both of the Likert scale questionnaires set were prepared in local language (Bengali) as the most of the target respondents were local workers, then these have also been rendered into English for research purposes (see appendix III and appendix V).

2.3.2 Sample Selection and Interview

The survey has been conducted from 5 February 2023 to 4 March 2023 (See table 1). Initially five factories have been chosen for research, later on the number of factories has been increased to six. The factories were selected by stratified sampling method based on number of workers and the size of factories. The total number of workers in six factories around 600.

Table 1: Schedule of factory visit

Factory Location	Factory	Number of Workers	Date
BSCIC Tannery Industrial Estate, Hemayetpur, Savar, Dhaka, Bangladesh	Factory 1	44	From 05-02-2023 to 09-02-2023
	Factory 2	133	From 11-02-2023 to 14-02-2023
	Factory 3	155	From 15-02-2023 to 19-02-2023
	Factory 4	140	From 20-02-2023 to 25-02-2023
	Factory 5	45	From 26-02-2023 to 28-02-2023
	Factory 6	60	From 01-03-2023 to 04-03-2023

Prior to the survey procedure, the authors conducted a pilot survey to the three factories of 15 employees. Among them 12 were workers and three were from management. The piloting procedure has been performed to check the level of relevance of the questionnaires and to gather knowledge if there need any modification in questionnaires. After the completion of piloting process, the result reveals that some questionnaires were incomprehensible to the workers, some were redundant in nature. So, the authors shorten the questionnaire from 80 questions to 50 questions. Total number of workers and employees have been randomly selected for survey were around 150. But due to the time limitation 125 respondents have been finalized. Among them 102 were workers and 23 were from factory management. The respondents have been selected based on their demographic characteristics for instance, Age, Gender, Education, Experience and Training. This method was selected considering the variations in every individual perception on chemical management safety as the responds of the questions varies based on their demographic characteristics. The survey was conducted in person (Face to Face interview) as the most of the workers in this sector are not possess enough knowledge about this type of questionnaires and majority of them did not finish their secondary level of education. The survey for management was also taken face to face as they feel comfortable to have an open discussion with authors. The other set of questionnaires which was prepared in google form were sent to email of the respondents as some of them were tough to reach for being stayed in different locations.

While conducting the survey, the authors informed both the workers and employees about the purposes of this survey and was committed not to disclose the factory name and the respondent's name. Based on this condition the factory management has signed the consent paper of conducting survey.

2.4 Developing Questionnaires

The questionnaires for tannery workers and management have been developed by acquiring input from different chemical standards, Policy, Guidelines, and best practices throughout the world specially in leather dominating countries for instance China, Italy, France, Vietnam, India, Bangladesh, Brazil, USA, South Korea, Pakistan, Turkey, Egypt and Uganda.

The standards, guidelines, and best practices that were followed to prepare the survey questionnaire are the United Nations Industrial Development Organization (UNIDO) report on Occupational Safety and Health Aspects of Leather Manufacturing (UNIDO, Occupational Safety and Health Aspects of Leather Manufacturing, 2021), International Labor Organization (ILO) checklist for chemicals, Occupational Safety and Health Administration (OSHA) standards on Safety Datasheet, OSHA Standards on Labelling and Pictogram, OSHA Standards on hazard communication (OSHA, 2012) (OSHA, 2013) (OSHA, 2013), ECOLEBAN project for tanning industry in Bangladesh guided by SWITCH-ASIA program prepared best practices named " Guidelines on best Sustainable Consumption and Production (SCP) practices for the

leather sector in Bangladesh" (ECOLEBAN), Leather Working Group (LWG) audit Checklist: clause-16 for chemical management (LWG, 2021), ISO 11014 (MSDS) (ISO, 2009), Checklist on chemical safety prepared by West Virginia University named as Environmental Health and Chemical Safety (West Virginia University, 2023), Checklist developed by iAuditor for chemical safety (iAuditor by SafetyCulture,, 2023), Checklist based on best available techniques in the leather industry prepared by Environmental Research of the Federal Ministry of the Environment, Nature Conservation and Nuclear Safety, Germany (Dr. Norbert Reintjes, 2012); checklist prepared by M&S a renowned audit organization named as ECP Minimum Standards Factory Self-Audit: Tanneries (M&S, 2021), National Profile of Chemicals Management in China (CCCA, 2014); Environmental, Health, and Safety Guidelines for Tanning and Leather Finishing prepared by International Finance Corporation (IFC) (IFC, 2007), Fast Retailing Chemical Management Guideline, National Association of Professional Environmentalists (NAPE) best practices named as Safe Use Of Chemicals in The Tannery Industry In Uganda (NAPE, 2019), IUE 11 – Occupational Health and Safety in the use of Chemicals in Tanneries developed by International Union of Leather Technologist and Chemist Societies (IULTCS) (IULTCS, 2018), Factory Inspection Checklist developed by Department of Inspection for Factories and Establishments (DIFE), Bangladesh based on Bangladesh Labour Law 2006 and Bangladesh Labour Rules 2015 (DIFE, 2023).

For the purposes of gathering opinion of chemical experts to overcome the chemical management deviations and to improve chemical management system in tannery, the other set of questionnaires has been developed based on the questionnaire prepared for workers and management previously and posed to the different personnel involved with chemical related academic field and engaged with chemical dealing workplace.

2.5 Data Analysis

All computations and analysis have been conducted using the IBM SPSS statistical program package (version 29). The respondents' answers were performed by descriptive statistics. The demographic characteristics also have been studied using descriptive statistics. Standard parametric statistical procedures were assumed appropriate for ordinal variables in the form of Likert-type scales (George F Patrick, 1997) (R.B.M. Huirne, 1997). A factor analysis was executed to reduce the number of variables into some factors. The eigenvalue has been used to select how many factors need to be kept and how many factor need to be eliminated. Eigenvalue greater than one has been considered for the factors that should be kept and eigenvalue less than one has been ignored and hence the factors with eigenvalue less than one has been removed. Varimax rotation method (orthogonal rotation method) was used that shows the correlation coefficient between factors and their respective variables. Kaiser–Meyer–Olkin (KMO) and Bartlett's test has been done for the measurement of sampling adequacy and for checking the factorability of the correlation matrix. The KMO value greater than 0.70 indicated that patterns of correlations were comparatively compact and factor analysis was very accurate. In factor analysis, factor loadings greater than 0.30 are considered significant factors. Loading of more than 0.40 is considered more important while loading greater than 0.50 is considered very significant (Handan Akcaoz, 2009). These guidelines are considerable when the sample size is more than 50. The authors considered a factor loading greater than 0.40 as a crucial factor (Josehp F. Hair JR, 2006).

2.6 Stakeholder Analysis

The importance of stakeholder analysis is to identify the relationship among different stakeholders in respect to their roles and responsibilities. In this thesis work, the function and relation of different

stakeholders has been discussed elaboratively involved in chemical management issue in tanning industry of Bangladesh. There are basically three types of stakeholder's theories: descriptive, instrumental and, normative (DONALDSON, 1995). In this thesis work, considering the consistency, the authors have chosen the normative theory of stakeholder analysis which discussed about three attributes: power, legitimacy and urgency of different stakeholders (Ronald K. Mitchell, 1997).

Chapter 3: Results

This chapter focuses the results from the risk analysis, survey data analysis and stakeholder analysis of chemical management deviation in tanning industry of Bangladesh.

3.1 Risk Analysis

This section presents the risk analysis which commence with identifying the hazards and describing how hazard raise in different stages of chemical management in Bangladesh tanning industry. Then two different risk analysis tools i.e.; fishbone diagram analysis and bowtie analysis have been performed to find out the main causes of chemical management deviation as well as consequences.

3.1.1 Chemical Management Deviation and Hazard Identification

Chemical management deviation in tanning industry occurs while- unloading, storing, transferring, dosing and disposal of chemical (UNIDO, Occupational Safety and Health Aspects of Leather Manufacturing, 2021).

Deviation while unloading chemicals

Chemical deviations in the time of unloading occur in several ways. For example, in the case of chemical containers lids not being tightly sealed the possibility of deviation become increase. If there is a leakage found on the containers and packaging, the chemical may spread out and the deviation become more obvious. On the other hand, if the chemical substances not being held in their original containers, the probability of deviation become higher. If the supervisor not available while unloading and the employees engaged with unloading are not well trained, there might a greater probability chemical deviation (iAuditor by SafetyCulture,, 2023).

Deviation while storing chemicals

While storing chemicals deviations occur in different ways for instance, absence of inventory of all chemicals, unavailability of MSDS for stored chemical, storage of chemicals in the working area, and absence of layout of chemical storage. The deviations become more obvious by no categorization of hazardous chemicals such as corrosive, flammable, toxic, explosive, and keeping incompatible chemicals side by side or alphabetically. The lack of monitoring in chemical storage, keeping chemicals in direct contact of sunlight or heat, bad housekeeping of the chemicals, no segregation of chemicals used in different stages of tanning process, random placement of chemical containers, and by accessing of unauthorized personnel to the restricted area of highly toxic chemical storage are others potential deviation in chemical storing (UNIDO, Occupational Safety and Health Aspects of Leather Manufacturing, 2021) (iAuditor by SafetyCulture,, 2023) (IULTCS, 2018) (West Virginia University, 2023).

Figure 5: Chemical containers are randomly stored

(Source: Images taken by authors from visited factories)

Deviation while transferring chemicals

Deviation may occur during transferring chemicals from containers. The possible chemical deviation that arises in the time of transferring of chemicals include- no proper labelling and color coding of chemical containers, absence of safety signage, container's lids are not connected properly and taps are not closed tightly. Also, other matters of concern for chemical deviation in tannery are insufficient knowledge of the workers who are associated with chemical transferring, using same measuring cups for taking different chemicals, and not using trolleys and pallet trucks while carrying chemicals (UNIDO, Occupational Safety and Health Aspects of Leather Manufacturing, 2021) (IULTCS, 2018).

Figure 6: Chemical carrying carelessly

(Source: Images taken by authors from visited factories)

Deviation while dosing chemicals

While dosing chemicals, the deviations may arise in the time of pouring chemicals directly into the pit or drum and by applying inappropriate chemical dosing method. The deviation in chemical during dosing might occur in different ways. For instance, mixing chemicals randomly that is not following the actual proportionate of the chemicals the deviation become raise. While pouring or measuring the chemicals, if appropriate care is not taken then the chemical deviation occurs by spillage. Chemicals should not be poured in the drum directly rather follow the aid of some engineering control measures such as building an extra funnel with drum so that chemical are not directly poured into the drum. In the case of directly pouring chemical to drums, the chemical gets spills and the deviation occurs. If appropriate tools for example, scoops and other measuring cups are not being used during the dosing the chemical deviation may raise. The automatic dosing system can mitigate the deviation, in the case of absence of automatic chemical dosing, the deviation of chemical become an obvious issue. In absence of chemical supervisor while dosing, the chemical deviation might occur (UNIDO, Occupational Safety and Health Aspects of Leather Manufacturing, 2021) (IULTCS, 2018)

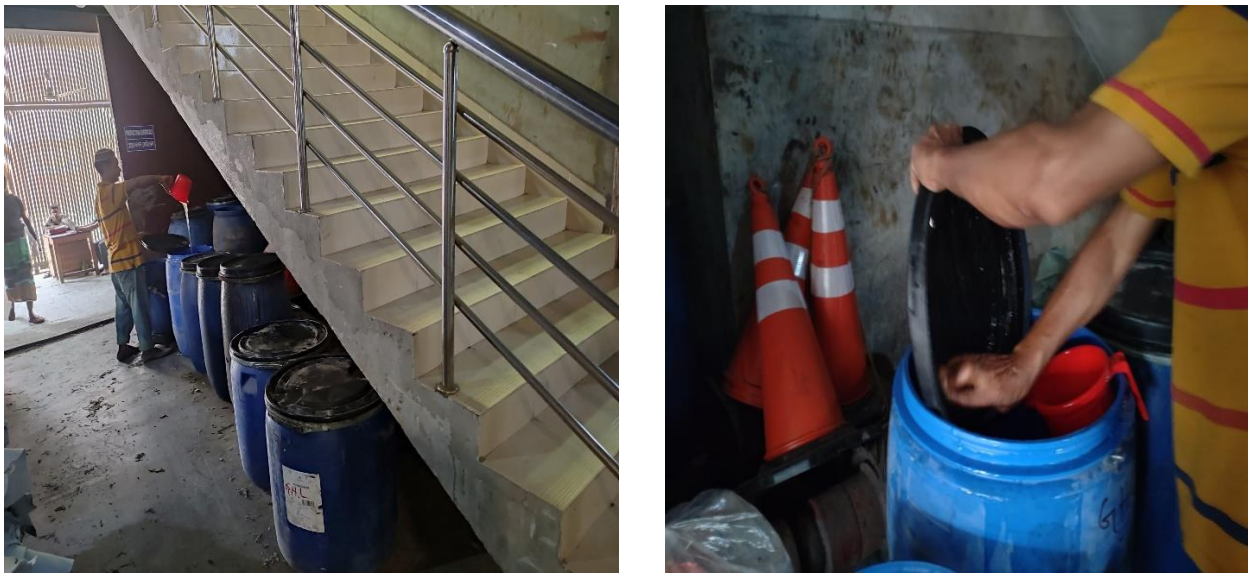


Figure 7: Indiscriminate mixture of chemicals

(Source: Images taken by authors from visited factories)

Deviation while disposing chemicals

While disposing the chemical empty containers and other effluent the chemical deviation become a matter of concern. If the empty containers are kept in the storage and working area for long time, the chemical deviation might be occurred. If there is not any segregated place assigned for storing the empty containers then chemical deviation become an evident matter. In the case of storing different chemical effluents in the same container, the probability of being wrong with chemical empty containers get higher and higher. If the empty container is not being provided to the supplier for refilling purposes and the empty container are used for general work, then the chemical deviations issue become a matter of more concern. In any case the empty chemical containers cannot be used for daily usage for instance, uses of keeping drinking water and other daily household work, the chemical deviation can be avoided. Otherwise

there remains an issue of immense danger due to the use of empty chemical container that are used for storing drinking water and preserving food products. When the chemical disposal is been thrown outside the factory directly then chemical deviation might be occurred. If the waste water not being treated by effluent treatment plant, the probability of exposing chemical deviation become more. If the existing regulations are not being followed while disposing the chemicals then chemical deviation occurs (UNIDO, Occupational Safety and Health Aspects of Leather Manufacturing, 2021) (ECOLEBAN) (IULTCS, 2018) (iAuditor by SafetyCulture,, 2023).

Figure 8: Empty containers taken by workers and untreated chemical disposal

(Source: Images taken by authors from visited factories)

3.1.2 Risk Analysis of Chemical Management Deviation in Tanning Industry of Bangladesh

Two different tools of risk analysis have been utilized for finding out the key elements that contributes the chemical management deviation in tanning industry. First a fishbone diagram also known as Ishikawa diagram has been performed to identify and describe about the core elements that cause chemical management deviations in tanning industry of Bangladesh. The motto of fishbone diagram analysis is; to find out the causes of an event and to classify them into several groups. The fishbone diagram analysis has been used to perform a qualitative analysis of chemical management deviation. The right end of the fishbone diagram is denoted by head of the fish which indicates the ultimate effect, in this case, chemical management deviation in tanning industry and the bones of the spine are known as the causes of deviations. While analyzing with fishbone diagram, usually 4M categories are followed. 4M represents, Man for example people, Methods for instance, work procedures including rules and regulations, Materials represents raw materials, Machinery includes technical equipment, Milieu denotes environment related issues for instance, internal or external environment, time, safety culture and location which is named as others in this diagram (RAUSAND, 2011). Then a bowtie method has been used to illustrate the causes of deviations and implementation of existing preventive barriers against the deviations and to describe the consequences that might be raised from chemical deviation in tannery sector as well as putting some reactive or recovering measures to mitigate or minimize the consequences raised from different causes of deviations. The left side of the Bowtie diagram analysis illustrates about different causes of deviations along with assigning some proactive interventions to prevent the causes so that the event might not be occurred. The middle of the Bowtie represents the specific event- in this case

chemical management deviations. And the right portion of Bowtie method demonstrates different reactive barriers that have been taken to reduce the impact of the event after the event being taken place and finally ends with some obvious consequence that came out as final consequence from the specific event (RAUSAND, 2011).

3.1.3 Fishbone Diagram Analysis of Chemical Management Deviation

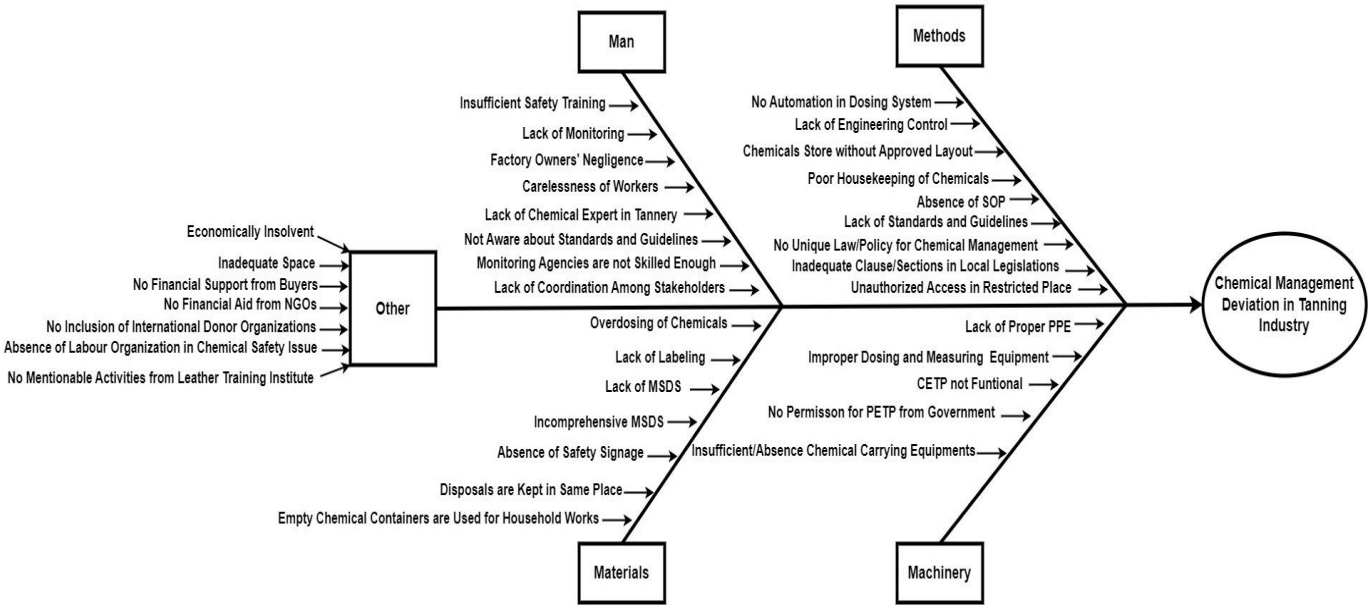


Figure 9: Fishbone diagram analysis of chemical management deviation in tanning industry of Bangladesh

(Modified from Source: (RAUSAND, 2011)*)*

In the fishbone diagram analysis (see figure 9), the chemical management deviation factors have been clearly identified. The analysis has done by segregating the deviation into five different segments. These segments are regarding deviation caused in Methods or Process, deviation occurred by people or human being, discrepancies caused by Machinery or equipment, by materials fault or deficiency and other reasons. In method or process portion, it is obvious that the deviations are related to numerous things. For example, no automation has been applied while dosing chemical, no engineering control method has been taken out while pouring the chemical in drums. Chemicals have been stored without the approval and approved layout from the competent authority, Poor housekeeping has been identified in the storage, absence of standard operating procedure (SOP), absence of unique law or policies on chemical management, local legislation does not cover all the requirements of chemical management and allowing unauthorize person in the restricted area. In the case of Machinery or Equipment, several factors triggered the deviations. These factors include- lack of proper Personal Protective Equipment (PPE), utilization of improper measuring and dosing equipment, Central Effluent Treatment Plant (CETP) not being functional, no approval for Personal Effluent Treatment Plant (PETP) and absence or insufficient number of chemicals carrying equipment inside the tannery. These factors cumulatively influenced the chemical management deviation in Bangladesh tanning industry. While considering Man or people related aspect, some obvious violations have been observed in the tannery. The violations comprise with providing insufficient training

to employees, weak chemical management monitoring system, negligence of tannery owners in respect to promote chemical safety. Sometimes the carelessness of workers has been observed a major violation while dealing with chemicals. The most obvious fact in tanning industry of Bangladesh has been seen as lack of chemical expert. The workers are not cautious on chemical related law, rules, policies, and guidelines. The monitoring agencies are not equipped enough with skilled manpower and equipment. No coordination among different stakeholders have been observed in tanning industry of Bangladesh in respect to establishing a compliance scenario, especially in chemical management.

Materials related deviations include- Overdosing of chemicals, lack of Material Safety Data Sheet (MSDS) also the Safety Data Sheet (SDS) found incomprehensible to workers that is it was not translated to local language. Absence of safety signage has been found in most of the factories that accelerate the deviation hugely while handling chemical. The empty chemical container has been taken out and were used for storing drinking water which appears as a matter of great concern. Different types of disposals have been found in the same container. These above-mentioned materials related discrepancies boost up the chemical management deviation in Bangladesh tanning industry.

The others issues that contribute chemical management deviations in Bangladesh tanning industry are- inadequate space, no financial support from buyers, international agencies, government and other stakeholders.

In the fishbone diagram analysis, it is evident that which causes are the key players for chemical management deviation in Bangladesh tanning industry. The following section will focus on causes, preventive barriers, event occurred, mitigating measures and the consequences in a Bowtie method analysis.

3.1.4 Bowtie Analysis of Chemical Management Deviation

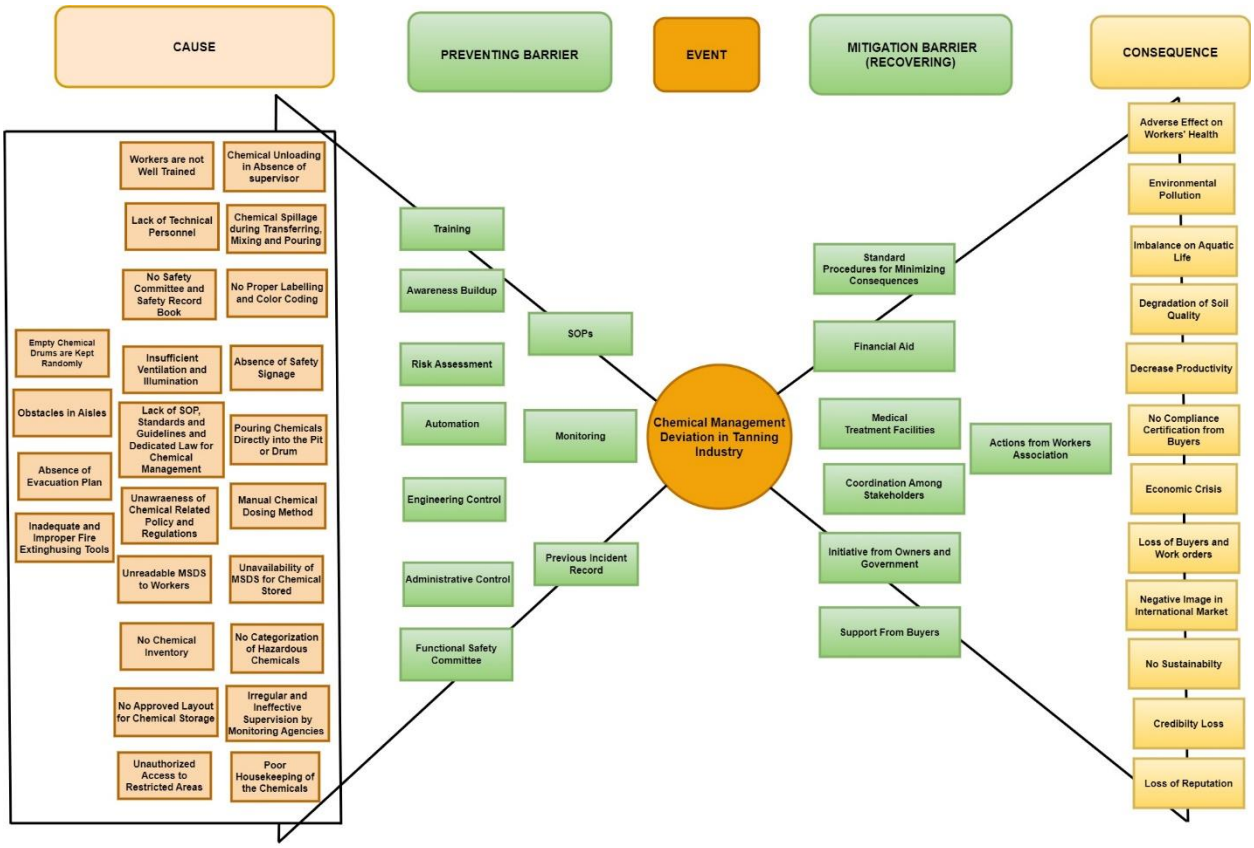


Figure 10: Bow-tie analysis of chemical management deviation in tanning industry of Bangladesh

The Bowtie analysis has been analyzed and discussed in the above figure (figure 10). From the Bowtie, it become obvious which factors are contributing to deviations in chemical management in Bangladesh tanning industry. The diagram depicts an overall chemical management deviation factor in tannery. The deviating factor comprises with some management negligence issues, workers unawareness, and some legislation or regulation deficiencies. If we have a look on the factors in the left side of Bowtie method, it can be seen that empty chemical containers are kept randomly inside the tannery, The aisles are found blocked or obstacles have been found in the egress line to the exit. Also, a lot factors that accelerate the chemical deviations in tannery have already been discussed in the fishbone diagram analysis. So, to avoid the iteration of deviating factors, focuses are now given to the consequences of the chemical management deviations issues. It should be mentioned here that in the left side of Bowtie method, some preventive measures have been shown. These measures include- providing adequate training to workers for raising the chemical safety related awareness between them. A risk assessment can be thought as a crucial proactive action against chemical deviations. Putting some legislative initiative for instance, formation of safety committee in the factory (if applicable) and make it functional according to Bangladesh labour law and rules might be worked as a solid proactive measure. Availability of standard operating procedure (SOP) and activities according to SOP must be practiced to avoid chemical deviation. Factory management proactive initiative for instance, taking some administrative control measures and implementing

engineering control in different stages of chemical handling can help enormously to tackle chemical deviation in the tannery.

If eyes are kept on the right side of the Bowtie, it clearly shows that some mitigating barriers have been implemented to minimize the consequence as less as possible to recover the adverse situation. The mitigating steps that are seen are- providing instant medical treatment facilities, assisting the enterprises with financial support from the government and from buyers. Trade union or workers union can be involved with taking initiatives so that the consequences can be minimized. The government and other stakeholders need to be worked actively and collaboratively to mitigate the impact of chemical management deviation.

Even though, huge mitigating measures have been taken from different sources to recover the adverse outcomes still there remain some consequences from chemical management deviations. The consequences are given at the top most right side of the Bowtie which include- adverse health effect on workers, deteriorating the quality of environment and creation of imbalance to the aquatic life. Apart from this, some other negative impact of chemical management deviations is seen. These deviations comprise with not being certified as international standard, losing international buyers, reducing the productivity, decreasing the product price, reputation and credibility loss to international market, distract from attracting new buyers and finally fear of holding a sustainable position in global leather market.

To validate the qualitative analysis, emphasize will be given on quantitative analysis in the later part of this chapter.

3.2 Survey Data Analysis

This section focuses the results from the statistical analysis that has been described in earlier chapter based on theoretical assumptions. The chemical deviations status, demographic characteristics, four factors that have been extracted, and the relationship between demographic characteristics are given in the following literature of this section. The findings from online survey have also been presents in this segment.

3.2.1 Demographic Characteristics of Respondents

Following table 2 presents the demographic characteristics of respondents (workers and management).

Table 2: Demographic characteristics of respondents (workers and management)

Characteristics		**Frequency/Number (N)**	**Percentage (%)**
Employee Type	Management	23	18.4
	Worker	102	81.6
Gender	Male	124	99.2
	Female	1	0.8
Age	18-24 Years	33	26.4
	25-35 Years	46	36.8
	36-50 Years	42	33.6
	51-60 Years	3	2.4
	Above 60 Years	1	0.8
Education Level	i-v	52	41.6
	vi-x	26	20.8
	xi-xii	25	20
	Graduate	22	17.6
Experience (Current Factory)	0-2 Years	58	46.4
	3-5 Years	29	23.2
	6-10 Years	33	26.4
	Above 10 Years	5	4
Previous Experience	Tannery	73	58.4
	Others	52	41.6
Chemical Management Training	Yes	60	48
	No	65	52

Total 125 employees have interviewed in six different tanning industries. Among 125 employees 23 were chosen from the management group and 102 have been selected from workers who were involved in different stages of chemical handling in tannery including chemical unloading, chemical storing, chemical transferring(from store to workingplace), chemical mixing or dosing, and chemical disposing. Regarding the gender issues of these employees, interestingly the authors found that the largest proportionate of the interviewee were male which accounts for almost above 99% of the total respondants and only a single interviewee was female who is from the management side. The education level have been segregated into four clusters where i-v of education level was in cluster 1 , vi-x belongs to cluster 2, xi-xii

is considered into cluster 3, and those who completed graduation level of education were in cluster 4. It was observed that a major portion of the respondant have finished their primary level of education(cluster 1) which was 52 in numbers that is 41.6% of the total interviewee and considered as the highest proportion of the accumulated respondants. The lowest proportion of the interviewee were found in group 4 meaning that they have finished their graduation which was only 17.6% of the total employees. In respect to education level, the second largest group of interviewee were from the cluster 2 that refers to the employees who have completed their secondary level of education (vi-ix) and the proportion of this group is 20.8% of the accumulated employees which were 26 in numbers. The employees who have finished their higher secondary level of education was in cluster 3 (xi-xii) who were 25 in numbers and 20% of the total proportion of the interviewees.

The age of the interviewees have been sorted into five different segment, for instance segment 1 to 5 where age between 18-24 years kept into segment 1, age between 25-35 years were considered into segment 2, those who are in the age of between 36-50 years have been placed in segment 3. In segment 4 the employees who were in the age in between 51-60 were kept. Above 60 years of age employees have been kept in segment 5 of age.

Analyzing the age of the employees, the survey identified that the number of middle age (between 25-35 years) employees have been working in the tanning industry of Bangladesh preserved the highest proportion of the total employees which is 46 in numbers and 38.6% in proportion. The second largest group of employees have been found from the age in between 36-50 years that was 33.6% of the total respondants and in numbers it is 42. Comparatively the older age generation are less recruited or they showed less interest to work in tanning industry of Bangladesh as their proportion is almost negligable to count which was 2.4% and 0.8% for the age group of 51-60 years and above 60 years respectively.

Based on the experience in current factory, the employees have been catagorized into four groups where experience from zero to two years is kept in group 1, experience three to five years are placed in group 2, employees who have the experience from six to ten years in their present workplace are in category 3, and experience more than ten years in the running tannery are in category 4.

The results of the survey depicts that if the years of experience in their running job have been taken into account, then almost half of the interviewees are fall in the category 1 that is they have been working in the current tannery since for two years. The proportion of this group of employees is found 46.4% which is 58 in numbers out of 125 interviewees. It is obvious from the result that employees who have been working in the running tannery from six to ten years are about 26.4% of the total employees which is 33 in numbers from 125 interviewees. The results shows that only 4% of the total respondants have an experience more than ten years in the running tannery and they are 5 in numbers. This group is the lowest comparing to others who have been working in the current factory. Employees who have been continuing their job in the current workplace for three to five years are 29 in numbers out of 125 which accounts for 23.2% of the total proportion of employees in whom the survey has been conducted.

Among 125 respondents the major proportion of employees have their previous experience in tannery which were 73 in numbers and 58.4% in proportion. The rest employees have an experience in some other working domain which is 41.6% and their number is 52 from 125 selected candidates who were participated in the survey procedure.

The results also reveals that the number of employees who did not get any training in chemical management are higher in numbers in the comparison with those who were attended chemical management training. It shows that out of 125 respondents 65 employees replied about not having any traning in chemical management where 60 respondents have acknowledged that they have participated in chemical management training provided by their employers.

3.2.2 Mean and Standard Deviation of Responses

Table 3 depicts the mean value and the standard deviation of the responses acquired from the workers and management who have participated in the survey questionnaires.

Table 3: Mean and standard deviation of the responses

Cases/Items No.	Cases/Items	N	Mean	Std. Deviation
Q1	Chemical containers lids are tightly sealed	125	2.74	1.497
Q2	Packaging and containers are free from leakage	125	2.63	1.359
Q3	Chemical substances are held in their original containers	125	2.53	1.395
Q4	Employees are trained about chemical unloading	125	2.64	1.439
Q5	Unloading is done in presence of chemical supervisor	125	2.53	1.317
Q6	Maintain chemical inventory	125	2.71	1.469
Q7	Chemicals are stored according to layout	125	**1.93**	0.785
Q8	Chemicals are grouped according to their hazard category (corrosives, flammables, etc.)	125	2.51	1.336
Q9	Secondary containment or trays are used to contain leaks or spills of chemicals	125	4.29	0.455
Q12	Proper fume hood installed	125	2.60	1.295
Q13	Adequate light and ventilation system available	125	2.55	1.228
Q14	Availability of access prohibiting signage and unauthorized access restriction	125	2.70	1.309
Q15	Presence of MSDS of each chemical drum	125	2.53	1.305
Q16	SDS is easily readable to employees and workers	125	2.57	1.285
Q17	Chemical spillage is cleaned up or reported immediately to the supervisor	125	2.70	1.270
Q18	Enough washing and cleaning facilities available	125	2.60	1.251
Q19	Availability of appropriate fire extinguisher	125	2.58	1.151

Cases/Items No.	Cases/Items	N	Mean	Std. Deviation
Q20	Proper fire suppression and protection system	125	2.58	1.186
Q21	No obstacles in aisles	125	2.56	1.160
Q22	Regular checking of electric lines	125	**2.49**	1.222
Q23	Proper evacuation plan and drill regularly	125	**2.48**	1.229
Q24	Availability of first-aid facilities	125	**2.37**	1.202
Q25	Adequate training on chemical hazards and management	125	**2.38**	1.162
Q26	Provide appropriate PPE and using properly	125	**2.34**	1.212
Q27	Employees are Familiar with chemical related legislations, standards and guidelines	125	**2.37**	1.208
Q28	Keep records of accidents and incidents	125	**2.34**	1.239
Q29	While transferring acids, hand piston pumps are used	125	**2.46**	1.388
Q31	Chemicals are being carried in closed containers	125	2.50	1.401
Q32	For using of spill kits training is provide	125	**2.44**	1.370
Q33	Availability of automatic dosing systems	125	2.62	1.348
Q34	During chemical dosing appropriate tools for instance: scoops, spatulas and measuring cups are used	125	2.53	1.377
Q35	While pouring chemicals to drums or pits engineering controls such as mounting a fixed funnel or IBC tank with drum axle are applied	125	**2.46**	1.299
Q36	Wearing proper PPE (respiratory masks, safety googles, gloves, boots)	125	**2.42**	1.226
Q37	Presence of chemical supervisor is ensured during chemical dosing	125	2.54	1.298
Q38	Empty chemical containers are stored in a designated area	125	**2.38**	1.305
Q39	Before disposing containers are washed	125	**2.35**	1.259
Q40	Chemical wastewater is sent to Effluent Treatment Plant (ETP)	125	**2.39**	1.237
Q41	Availability of dedicated sink for liquid chemical waste	125	**2.47**	1.299

Cases/Items No.	Cases/Items	N	Mean	Std. Deviation
Q43	A chemical management system has been followed in the factory and responsible individual available for chemical management	125	**1.77**	0.794
Q44	The management system or procedure clearly stated about the name, position and qualification of the responsible individual for chemical management	125	**1.80**	0.842
Q45	The experience of the responsible individual for chemical management are clearly indicated	125	**1.82**	0.899
Q46	The educational qualification of the responsible person for chemical management is met. (Graduate from chemistry-oriented discipline)	125	**1.82**	0.899
Q47	The procedures to be followed during normal working conditions are clearly stated	125	**1.90**	0.841
Q48	The procedures to be followed during emergency events (such as significant spillages) are clearly stated	125	**1.83**	0.896
Q49	The factory maintains a register (e.g., spreadsheet) that records the compliance against client MRSL requirements	125	**1.82**	0.908
Q50	The actual proportion of the factory's incoming chemicals (by mass) is obtained from companies that have been documented compliance to MRSL	125	**1.82**	0.892
Q10R	Chemicals in container over 1L, are stored on shelves above 1.5m in height	125	4.10	0.296
Q11R	Chemicals are stored in heat and direct sunlight"	125	4.05	0.215
Q30R	Chemicals are being carried manually"	125	**1.82**	0.597

The questionnaire were prepared in positive nature except three question (Q10R,Q11R,Q30R) that were reverse type question. The result of survey questionnaire has depicted that the mean value of 25 responses were less than 2.5 (see table 3) which can be illustrated that a larger portions of the respondents replied negetively to the questionnaire posed to them. The responses received from the questionnaire indicate that there is reamin an obvious chemical management deviation in the tanning industry of Bangladesh. If look is given to the standard deviation of the responses, it is obvious that most of the responses has a standard deviation ranges from 0.5 to 1.5 that indicate a strong correlation of the variables as the variables are around the central of the normal distribution curve.

3.2.3 Factor Analysis

Factor analysis (FA) was accomplished to find out the factors that explained the most of the variables of survey questionnaire. The Principal Component Analysis (PCA) has been performed on the 50 questions along with varimax rotation. From the KMO and Bartlett's Test for sampling adequacy, the KMO value is found 0.869 (see figure 11) which is satisfactory for factor analysis. The Kaiser-Meyer-Olkin (KMO) measures sampling adequacy, and it should be more than 0.50 to perform factor analysis (FA) (Darren George, 2006) (Dr. L. Sudershan Reddy, 2019). The p-value also meets the criteria for factor analysis as it is less than 0.005 (Darren George, 2006) (Dr. L. Sudershan Reddy, 2019). Both prerequisites (KMO and Bartlett's test) for FA was found fair enough for proceeding further analysis.

KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.869
Bartlett's Test of Sphericity	Approx. Chi-Square	8220.266
	df	1176
	Sig.	.000

Figure 11: KMO and Bartlett's test

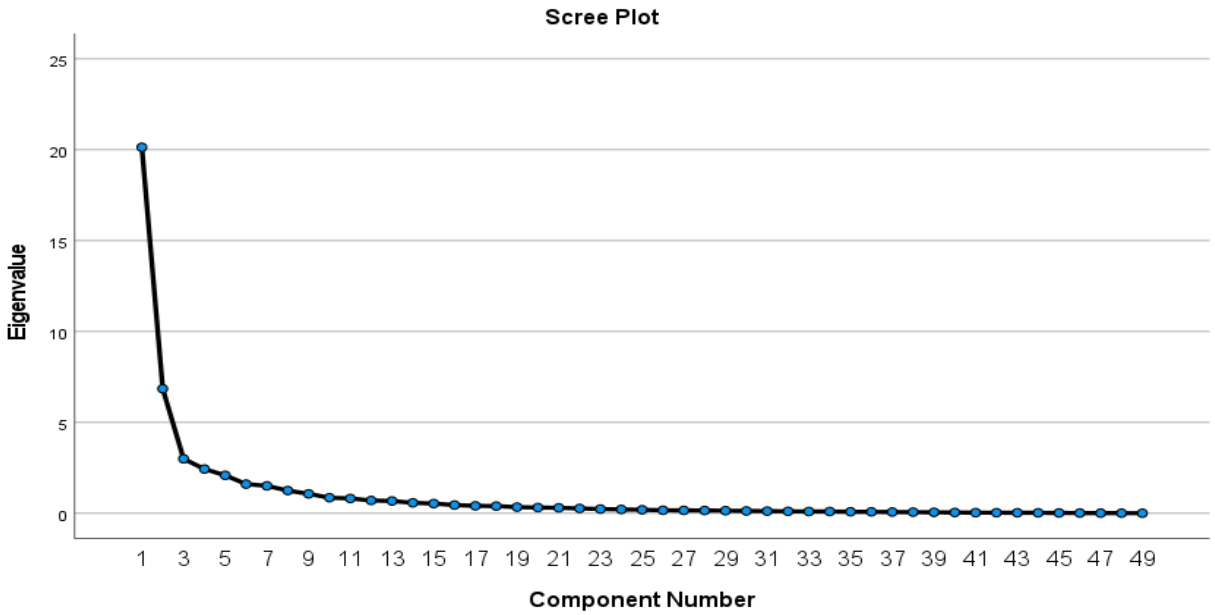


Figure 12: Scree Plot for factor analysis

From the scree plot (see figure 12) four factors have been chosen with Eigenvalue greater than one. Even though, from the Principal Component Analysis (PCA) 9 factors have been found with Eigenvalue greater than one (See Table 4), 9 factors could have been taken for calculation and further analysis. But as some of the factors has only one variable, so these factors were excluded from calculation. Hence, in PCA the authors have chosen 4 factors that describe the most of the variables (Pallant, 2007). The total variance explained by these four factors is 66.159%.

Table 4: Total variance explained

Total Variance Explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	20.134	41.091	41.091	20.134	41.091	41.091	10.390	21.204	21.204
2	6.852	13.984	55.075	6.852	13.984	55.075	8.820	17.999	39.203
3	2.997	6.117	61.192	2.997	6.117	61.192	6.807	13.892	53.095
4	2.434	4.968	66.159	2.434	4.968	66.159	6.402	13.065	66.159
5	2.089	4.262	70.422						
6	1.605	3.276	73.697						
7	1.510	3.081	76.778						
8	1.250	2.551	79.330						
9	1.070	2.183	81.513						
10	.858	1.752	83.265						
11	.816	1.664	84.929						
12	.706	1.441	86.370						
13	.677	1.382	87.751						
14	.577	1.177	88.928						
15	.534	1.091	90.019						
16	.454	.926	90.945						
17	.411	.838	91.784						
18	.396	.808	92.592						
19	.340	.693	93.285						
20	.316	.644	93.930						
21	.301	.615	94.544						
22	.267	.545	95.090						
23	.234	.478	95.568						
24	.213	.434	96.002						
25	.194	.396	96.398						
26	.167	.340	96.738						
27	.161	.329	97.068						
28	.155	.315	97.383						
29	.144	.295	97.678						
30	.129	.263	97.941						
31	.120	.244	98.185						
32	.109	.222	98.407						
33	.099	.203	98.609						
34	.098	.200	98.809						
35	.086	.176	98.986						
36	.082	.167	99.152						
37	.070	.142	99.295						
38	.063	.128	99.423						
39	.054	.111	99.534						
40	.045	.092	99.625						
41	.036	.073	99.698						
42	.033	.068	99.767						
43	.030	.061	99.828						
44	.026	.053	99.881						
45	.020	.040	99.921						
46	.015	.030	99.951						
47	.010	.021	99.972						
48	.009	.017	99.990						
49	.005	.010	100.000						

Extraction Method: Principal Component Analysis.

Table 5: Varimax rotated factor loading for chemical management

Cases/Items No.	Cases/Items	Communalities	Component			
			1	2	3	4
Q1	Chemical containers lids are tightly sealed	0.685	**0.781**	0.221	0.099	0.132
Q2	Packaging and containers are free from leakage	0.61	**0.730**	0.234	0.126	0.037
Q3	Chemical substances are held in their original containers	0.68	**0.779**	0.201	0.155	0.092
Q4	Employees are trained about chemical unloading	0.70	**0.778**	0.262	0.086	0.132
Q5	Unloading is done in presence of chemical supervisor	0.73	**0.793**	0.250	0.190	0.049
Q6	Maintain chemical inventory	0.73	**0.795**	0.277	-0.010	0.141
Q7	Chemicals are stored according to layout	0.31	**0.439**	0.206	0.150	-0.224
Q8	Chemicals are grouped according to their hazard category (corrosives, flammables, etc.)	0.70	**0.732**	0.396	-0.024	0.077
Q9	Secondary containment or trays are used to contain leaks or spills of chemicals	0.26	0.212	0.230	0.129	-0.375
Q12	Proper fume hood installed	0.60	**0.669**	0.231	0.072	0.313
Q13	Adequate light and ventilation system available	0.63	**0.664**	0.273	-0.016	0.339
Q14	Availability of access prohibiting signage and unauthorized access restriction	0.72	**0.780**	0.244	0.007	0.216
Q15	Presence of MSDS of each chemical drum	0.69	**0.692**	0.272	-0.113	0.347
Q16	SDS is easily readable to employees and workers	0.72	**0.701**	0.266	-0.061	0.397
Q17	Chemical spillage is cleaned up or reported immediately to the supervisor	0.69	**0.693**	0.148	-0.079	**0.422**
Q18	Enough washing and cleaning facilities available	0.64	**0.577**	0.292	-0.003	**0.470**
Q19	Availability of appropriate fire extinguisher	0.70	**0.529**	0.330	-0.134	**0.540**
Q20	Proper fire suppression and protection system	0.65	0.380	**0.431**	-0.155	**0.540**

Cases/Items No.	Cases/Items	Communalities	Component			
			1	2	3	4
Q21	No obstacles in aisles	0.62	0.380	0.322	-0.102	**0.597**
Q22	Regular checking of electric lines	0.68	0.316	0.387	-0.074	**0.653**
Q23	Proper evacuation plan and drill regularly	0.70	0.373	0.341	0.133	**0.656**
Q24	Availability of first-aid facilities	0.71	0.350	0.357	0.041	**0.674**
Q25	Adequate training on chemical hazards and management	0.73	0.247	**0.424**	-0.001	**0.701**
Q26	Provide appropriate PPE and using properly	0.74	0.205	**0.532**	0.044	**0.642**
Q27	Employees are Familiar with chemical related legislations, standards and guidelines	0.73	0.247	**0.530**	0.009	**0.621**
Q28	Keep records of accidents and incidents	0.70	0.211	**0.488**	0.100	**0.639**
Q29	While transferring acids, hand piston pumps are used	0.54	0.283	0.377	0.057	**0.561**
Q31	Chemicals are being carried in closed containers	0.62	0.367	**0.557**	0.105	**0.403**
Q32	For using of spill kits training is provide	0.64	0.295	**0.670**	-0.012	0.320
Q33	Availability of automatic dosing systems	0.62	**0.458**	**0.578**	0.050	0.270
Q34	During chemical dosing appropriate tools for instance: scoops, spatulas and measuring cups are used	0.67	0.389	**0.642**	0.111	0.303
Q35	While pouring chemicals to drums or pits engineering controls such as mounting a fixed funnel or IBC tank with drum axle are applied	0.76	**0.469**	**0.719**	-0.003	0.131
Q36	Wearing proper PPE (respiratory masks, safety googles, gloves, boots)	0.72	0.393	**0.746**	-0.097	0.052
Q37	Presence of chemical supervisor is ensured during chemical dosing	0.73	**0.419**	**0.732**	-0.112	0.087
Q38	Empty chemical containers are stored in a designated area	0.81	0.247	**0.854**	-0.035	0.143

Cases/Items No.	Cases/Items	Communalities	Component			
			1	2	3	4
Q39	Before disposing containers are washed	0.83	0.255	**0.863**	-0.017	0.153
Q40	Chemical wastewater is sent to Effluent Treatment Plant (ETP)	0.77	0.329	**0.786**	0.033	0.201
Q41	Availability of dedicated sink for liquid chemical waste	0.72	0.332	**0.769**	0.092	0.115
Q43	A chemical management system has been followed in the factory and responsible individual available for chemical management	0.12	0.064	-0.164	0.294	0.069
Q44	The management system or procedure clearly stated about the name, position and qualification of the responsible individual for chemical management	0.90	0.011	-0.009	**0.950**	-0.021
Q45	The experience of the responsible individual for chemical management are clearly indicated	0.96	0.016	0.017	**0.978**	-0.050
Q46	The educational qualification of the responsible person for chemical management is met. (Graduate from chemistry-oriented discipline)	0.97	0.000	0.017	**0.983**	-0.031
Q47	The procedures to be followed during normal working conditions are clearly stated	0.77	0.087	0.077	**0.866**	0.047
Q48	The procedures to be followed during emergency events (such as significant spillages) are clearly stated	0.94	0.061	0.053	**0.965**	-0.031
Q49	The factory maintains a register (e.g., spreadsheet) that records the compliance against client MRSL requirements	0.93	0.078	0.063	**0.958**	-0.037

Cases/Items No.	Cases/Items	Communalities	Component			
			1	2	3	4
Q50	The actual proportion of the factory's incoming chemicals (by mass) is obtained from companies that have been documented compliance to MRSL	0.96	0.020	0.022	**0.979**	-0.035
Q10R	Chemicals in container over 1L, are stored on shelves above 1.5m in height	0.22	0.007	-0.084	0.010	**0.457**
Q11R	Chemicals are stored in heat and direct sunlight"	0.14	0.039	-0.093	0.131	0.336
Q30R	Chemicals are being carried manually"	0.06	-0.015	-0.067	0.081	-0.216
Extraction Method: Principal Component Analysis.						

In the varimax rotation (see table 5), considering factor loading greater than 0.4 (Pallant, 2007) (Dr. L. Sudershan Reddy, 2019), it has been observed that factor 1 comprises with fifteen variables, factor 2 accounts for eleven variables, factor 3 includes with seven variables and factor four has twelve variables.

After the successful completion of factor analysis, this thesis study identified 4 factors with 45 variables that explains the chemical management deviations in Bangladesh tanning industry. For each factor the Cronbach Alpha found quite high that is almost around 1 which indicates the strong reliability among the variables (Joseph A. Gliem, 2003). As the naming of the factors is quite subjective, and it varies from researcher to researcher. The name of the four factors have been given below (See table 6).

Table 6: Reliability statistics of factor

Factor Number	Factor Name	Cronbach's Alpha	Number of Items/Cases
1	Factor 1: **Chemical storage and unloading knowledge**	0.955	15
2	Factor 2: **Employers' attitude on chemical effluent disposal and dosing**	0.958	11
3	Factor 3: **Certification requirements and factual complications**	0.986	7
4	Factor 4: **Chemical training and safety concern**	0.946	12

From the reliability statistics (see table 6) the Cronbach's Alpha for factor 1 is 0.955 and total variables are 15 under factor 1 whereas the Cronbach's Alpha for factor 2 found 0.958 and the numbers of variables in factor 2 are 11. On the other hand, the Cronbach's Alpha for factor 3 is seen 0.986 and the variables under factor 3 is 7 where the value of Cronbach's Alpha for factor 4 is found 0.946 and the variables in factor 4 is 12.

Table 7: Variables under factor 1 with factor loading

Cases/Items	Factor Loading
Factor 1: Chemical storage and unloading knowledge; Eigenvalue 20.134; Variance Explained 41.091%; Cumulative 41.091%; Cronbach Alfa 0.955	
Q6. Chemical inventory is maintained	0.795
Q5. Unloading is done in presence of chemical supervisor	0.793
Q1. Chemical containers lids are tightly sealed while unloading from vehicle	0.781
Q14. Availability of access prohibiting signage and unauthorized access restriction	0.780
Q3. Chemical substances are held in their original containers	0.779
Q4. Employees are trained about chemical unloading	0.778
Q8. Chemicals are grouped according to their hazard category (corrosives, flammables, etc.)	0.732
Q2. Packaging and containers are free from leakage	0.730
Q16. SDS is easily readable to employees	0.701
Q17. Chemical spillage is cleaned up or reported immediately to the supervisor	0.693
Q15. Presence of MSDS of each chemical	0.692
Q12. Proper fume hood installed	0.669
Q13. Adequate light and ventilation system available	0.664
Q18. Enough washing and cleaning facilities	0.577
Q7. Chemicals are stored according to layout	0.439

Table 8: Variables under factor 2 with factor loading

Cases/Items	Factor Loading
Factor 2: Employers' attitude on chemical effluent disposal and dosing; Eigenvalue 6.852; Variance Explained 13.984%; Cumulative 55.075%; Cronbach Alfa 0.958	
Q39. Before disposing containers are washed	0.863
Q38. Empty chemical containers are stored in a designated area	0.854
Q40. Chemical waste water is sent to Effluent Treatment Plant (ETP)	0.786
Q41. Availability of dedicated sink for liquid chemical waste	0.769
Q36. Wearing proper PPE (respiratory masks, safety googles, gloves, boots)	0.746
Q37. Presence of chemical supervisor is ensured during chemical dosing	0.732
Q35. While pouring chemicals to drums or pits engineering controls such as mounting a fixed funnel or IBC tank with drum axle are applied	0.719
Q32. For using of spill kits training is provided	0.670
Q34. During chemical dosing appropriate tools for instance: scoops, spatulas and measuring cups are used	0.642
Q33. Availability of automatic dosing systems	0.578
Q31. Chemicals are being carried in closed containers	0.557

Table 9: Variables under factor 3 with factor loading

Cases/Items	Factor Loading
Factor 3: Certification requirements and factual complications; Eigenvalue 2.997; Variance Explained 6.117%; Cumulative 61.192%; Cronbach Alfa 0.986	
Q46. The educational qualification of the responsible person for chemical management is met (Graduate from chemistry-oriented discipline)	0.983
Q50. The actual proportion of the factory's incoming chemicals (by mass) is obtained from companies that have been documented compliance to MRSL	0.979
Q45. The experience of the responsible individual for chemical management are clearly indicated	0.978
Q48. The procedures to be followed during emergency events (such as significant spillages) are clearly stated.	0.965
Q49. The factory maintains a register (e.g., spreadsheet) that records the compliance against client MRSL requirements.	0.958
Q44. The management system or procedure clearly stated about the name, position and qualification of the responsible individual for chemical management	0.950
Q47. The procedures to be followed during normal working conditions are clearly stated	0.866

Table 10: Variables under factor 4 with factor loading

Cases/Items	Factor Loading
Factor 4: Chemical training and safety concern; Eigenvalue 2.434; Variance Explained 4.968%; Cumulative 66.159%; Cronbach Alfa 0.946	
Q25. Adequate training on chemical hazards and management	0.701
Q24. Availability of first-aid facilities	0.674
Q23. Proper evacuation plan and drill regularly	0.656
Q22. Regular checking of electric lines	0.653
Q26. Provide appropriate PPE and using properly	0.642
Q28. Keep records of accidents and incidents	0.639
Q27. Employees are Familiar with chemical related legislations, standards and guidelines	0.621
Q21. No obstacles in aisles	0.597
Q29. While transferring acids, hand piston pumps are used	0.561
Q19. Availability of appropriate fire extinguisher	0.540
Q20. Proper fire suppression and protection system	0.540
Q10. Chemicals in container over 1L, are stored on shelves above 1.5m in height	0.457

3.2.4 Factor 1: Chemical Storage and Unloading Knowledge

Factor 1 is named as **Chemical storage and unloading knowledge** which Eigenvalue is 20.134 and the variance explained by factor 1 is 41.091% with Cumulative variance 41.091% and the value of Cronbach Alfa 0.955 (See table 7). Factor 1 consists of 15 questions or variables. These questions have been divided into two portions, for example storage and unloading knowledge on chemicals. In factor 1, Q3, Q6, Q7, Q8, Q12, Q13, Q14, Q15, Q16, Q17, and Q18 are related to chemical storage. Q6 which is about chemical inventory management in the storage. Q14 depicts about the prohibition of unauthorized access and about prohibition signage in restricted place. Q3 describes about preserving chemical substance in its original container. Q8 is about segregation of chemicals according to their hazard type. Q12 describes about installation of proper fume hood in the chemical storage. Q16 states translation of safety datasheet in local language so that workers can read and understand it. Q17 tells about reporting of chemical spillage to supervisor. Q15 provides information about availability of MSDS for each chemical. Q13 describe about adequate light and proper ventilation system in the chemical storage. Q18 says about the washing and cleaning facility in the chemical storage and Q7 talks about the presence of layout in chemical storage. On the other hand, 4 questions are kept in chemical unloading knowledge. Q5 tells about the presence of chemical supervisor while unloading the chemical. Q1 is about checking of chemical containers lid

whether it is tightly sealed or not. Q4 describe about the training of workers about chemical unloading. Q2 tells the status of chemical containers if it is free from leakage.

3.2.5 Factor 2: Employers' Attitude on Chemical Effluent Disposal and Dosing

Factor 2 is named as **Employers' attitude on chemical effluent disposal and dosing** with an Eigenvalue 6.852 where variance explained 13.984% with cumulative variance explained 55.075% and the Cronbach Alfa 0.958 (See table 8). Factor 2 consists of 11 questions or variables where some questions are regarding chemical effluent disposal and some are on chemical dosing. Four questions; Q38, Q39, Q40, Q41 are about disposal of chemical effluent. Q39 tells about the washing of containers before disposing. Q38 is about whether empty chemical containers are kept in a designated area or not. Q40 depicts on sending the waste water into the ETP (Effluent Treatment Plant). Q41 says the availability of dedicated sink for disposing liquid chemical wastage. Q31, Q32, Q33, Q34, Q35, Q36 and Q37 are regarding chemical dosing. Q36 tells about wearing the proper PPE while chemical dosing. Q37 is about the presence of chemical supervisor while chemical dosing. Q35 describes about implementation of engineering control while pouring chemical into drums or pits. Q32 depicts that whether workers are provided training for using spill kits or not. Q34 describe about using appropriate tools while chemical dosing. Q33 reveals the availability of automatic dosing system and Q31 says about the carrying of chemical in a close container.

3.2.6 Factor 3: Certification Requirements and Factual Complications

Factor 3 that is named as **Certification requirements and factual complications** has an Eigenvalue 2.997 and variance explained by factor 3 is 6.117% with cumulative variance 61.192%; Cronbach Alfa 0.986 (See table 9). Factor 3 consists of 7 questions or variables. Q46 tells about the educational qualification of the responsible person for chemical management. Q50 describes whether the actual proportion of the factory's incoming chemicals (by mass) is obtained from companies that have been documented compliance to MRSL. Q45 is about providing indication about the experience of the responsible individual for chemical management. Q48 says what procedures need to be followed during emergency events. Q49 tells about the maintaining of register (e.g., spreadsheet) that records the compliance against client MRSL requirements. Q44 depicts whether the management system or procedure clearly stated about the name, position and qualification of the responsible individual for chemical management or not. Q47 tells about the procedures to be followed during normal working conditions.

3.2.7 Factor 4: Chemical Training and Safety Concern

Factor 4 is named as **Chemical training and safety concern** with an Eigenvalue 2.434. The variance explained by factor 4 is 4.968% with a cumulative variance explained 66.159% and the value of Cronbach Alfa 0.946 (See table 10). Factor 3 consists of 12 questions or variables and they have been divided into two segments, i.e., training and safety concern. Q10, Q23, Q25, Q26, Q27, Q29 are in the training segment. Q25 tells whether adequate training on chemical hazards and management were provide or not Q23 describes about the practice of regular drill and availability of proper evacuation plan. Q26 tells whether appropriate PPE being provided or not and used properly or not. Q27 demonstrates whether employees are familiar with chemical related legislations, standards and guidelines or not. Q29 is about uses of hand piston pump while transferring acids and Q10 describes whether chemicals in container over 1L, are stored on shelves above 1.5m in height or not. Q19, Q20, Q21, Q22, Q24, Q28 are about safety concern. Q24 tells about the availability of first-aid facilities. Q22 says whether electric lines are checked regularly or not. Q28 depicts about keeping records of accidents and incidents in the tannery. Q21 is about any obstacle founds in the aisles. Q19 tells about the availability of appropriate fire extinguisher in the tannery, and Q20 depicts about the presence of proper fire suppression and protection system in the tannery.

3.2.8 Perception on Chemical Management Deviation in Relation to Employees' Characteristics

To find out the perception on chemical management deviations in tannery employees based on their demographic characteristics (Gender, Age, Education, Experience and Training) the authors conducted Ordinary Least Square (OLS) multiple regression model. To execute multiple regression analysis, multicollinearity test on employee's characteristics is done to check whether the multicollinearity exists or not in variables.

Multicollinearity within variables exists if the correlation coefficient among the independent variables is 0.9 and above i.e., the variables are highly correlated to each other (Shrestha, 2020). To examine the correlation among variables Bivariate analysis has been performed.

Table 11: Correlation coefficient among independent variables (demographic characteristics)

Correlations

Correlations

		Age	Gender	Education Level	Experience Year	Previous Experience	Employee Type	Chemical management training of workers and Employees
Age	Pearson Correlation	1	-.015	.475	.556	-.328	-.375	-.322
	Sig. (2-tailed)		.868	<.001	<.001	<.001	<.001	<.001
	N	125	125	125	125	125	125	125
Gender	Pearson Correlation	-.015	1	.147	-.085	-.076	-.189	-.093
	Sig. (2-tailed)	.868		.103	.349	.401	.035	.300
	N	125	125	125	125	125	125	125
Education Level	Pearson Correlation	.475	.147	1	.435	-.357	-.758	-.489
	Sig. (2-tailed)	<.001	.103		<.001	<.001	<.001	<.001
	N	125	125	125	125	125	125	125
Experience Year	Pearson Correlation	.556	-.085	.435	1	-.378	-.326	-.380
	Sig. (2-tailed)	<.001	.349	<.001		<.001	<.001	<.001
	N	125	125	125	125	125	125	125
Previous Experience	Pearson Correlation	-.328	-.076	-.357	-.378	1	.275	.356
	Sig. (2-tailed)	<.001	.401	<.001	<.001		.002	<.001
	N	125	125	125	125	125	125	125
Employee Type	Pearson Correlation	-.375	-.189	-.758	-.326	.275	1	.453
	Sig. (2-tailed)	<.001	.035	<.001	<.001	.002		<.001
	N	125	125	125	125	125	125	125
Chemical management training of workers and Employees	Pearson Correlation	-.322	-.093	-.489	-.380	.356	.453	1
	Sig. (2-tailed)	<.001	.300	<.001	<.001	<.001	<.001	
	N	125	125	125	125	125	125	125

In the bivariate test (see table 11) it is obvious that the independent variables are not highly corelated. From the table 11 it is seen that the maximum correlation coefficient is 0.556 and most of the variables are inversely correlated as the Pearson correlation are negative. So, there is no multicollinearity exists in the variables.

If the tolerance value in multiple regression analysis model is greater than 0.2 and Variance Inflation Factor (VIF) is less than 5 then it can be said that no multicollinearity exists between variables (Shrestha, 2020) (YouTube, 2022) (Youtube, SPSS: How to test multicollinearity in SPSS?, 2019) (Youtube, Understanding and Identifying Multicollinearity in Regression using SPSS, 2016). The following table 12 also justifies the hypothesis of existence of non-multicollinearity among the variables.

Table 12: Collinearity statistics between independent and dependent variables

Collinearity Statistics									
Dependent Variables									
Independent Variables		Factor 1		Factor 2		Factor 3		Factor 4	
		Tolerance	VIF	Tolerance	VIF	Tolerance	VIF	Tolerance	VIF
	Gender	0.930	1.075	0.930	1.075	0.930	1.075	0.930	1.075
	Age	0.617	1.619	0.617	1.619	0.617	1.619	0.617	1.619
	Education Level	0.355	2.818	0.355	2.818	0.355	2.818	0.355	2.818
	Experience Year (Current Factory)	0.597	1.675	0.597	1.675	0.597	1.675	0.597	1.675
	Previous Experience (Tannery or Other)	0.777	1.288	0.777	1.288	0.777	1.288	0.777	1.288
	Employee Type (Management or Worker)	0.410	2.438	0.410	2.438	0.410	2.438	0.410	2.438
	Chemical management training of workers and employees	0.687	1.456	0.687	1.456	0.687	1.456	0.687	1.456

In the case of multicollinearity test (see table 12), tolerance value is greater than 0.2 as well as the Variance Inflation Factor (VIF) is less than 5, then we can say that there is no multicollinearity exist between variables.

Analyzing the results of multiple regression model, it is found that all the four models have lower adjusted R^2 value (see table 13) which indicate that some of the variables which explain workers and employee's perception of chemical management deviations are not included in multiple regression models (Dewan Ahsan, 2020).

Durbin-Watson (DW) statistics is done to test autocorrelation in multilinear regression models' output. The DW statistics ranges from 0 to 4. A value of 2 indicates zero autocorrelation, values above 2 indicates negative autocorrelation and values below 2 means that there is a positive autocorrelation (KENTON, 2021). In our correlation table (see table 11) both positive and negative correlation exist and DW statistics values are found 1.011, 1.742, 2.357 and 1.850 (see table 13) for four models respectively i.e., the values range from 1.011 to 2.357 which indicates no autocorrelation problem in models' output (Cheong, 2010).

3.2.9 Multivariate Analysis of Variances (MANOVA)

As all the conditions of multivariate regression analysis has fulfilled, the authors have performed the multivariate analysis of variances (MANOVA) among independent (demographic characteristics of employees) and dependent variables (four factors). The demographic variables, nominal in nature, have different level of measurement e.g., age has five different level, educational qualification and experience each have four levels, employe type has two levels namely management and worker.

Table 13: Significance of independent variables on dependent variables

Independent Variables (Demographic Characteristics)	Significance (P) of Dependent Variables (Factors)			
	Factor 1	**Factor 2**	**Factor 3**	**Factor 4**
Gender	0.442	0.940	***0.100**	0.663
Age	***0.102**	0.173	0.258	0.221
Education Level	0.495	***0.107**	0.732	***0.093**
Experience (Current Factory)	0.643	0.284	0.146	0.826
Previous Experience (Tannery or Other)	0.988	0.961	0.593	0.833
Employee Type (Management or Worker)	0.873	***0.087**	***0.072**	0.155
Chemical Management Training	****0.000**	****0.002**	0.823	*****<0.001**
Adjusted R^2	**0.295**	**0.192**	**0.050**	**0.166**
Durbin-Watson	**1.011**	**1.742**	**2.357**	**1.850**

Note: ***, **, and * indicate statistical significance at 1%, 5% and 10% levels respectively

The above table (table 13) depicts the impact of employee's demographic characteristics on the four factors for chemical management deviation aspects in tanning industry of Bangladesh. The null hypothesis for each independent variable (demographic characteristics of employees) is that there is no significant difference in the means of two groups. If the p-value is less than 0.1, the null hypothesis can be rejected which indicates that there is a significant difference in two groups of demographic characteristics i.e.; the dependent variables rely on independent variable (Md Takibur Rahman, 2021).

From the table 13 it can be observed that experience has no significance on any factor whereas chemical management training has a notable significance on almost every factor except factor 3 (**Certification requirements and factual complications**). Gender has significance only on factor 3 **(Certification requirements and factual complications)** and age has impact on factor 1 **(Chemical storage and unloading knowledge).** Education level has impact on factor 2 **(Employers attitude on chemical effluent disposal and dosing)** and factor 4 **(Chemical training and safety concern).** Employee type has significance on factor 2 **(Employers attitude on chemical effluent disposal and dosing)** and factor 3 **(Certification requirements and factual complications)** respectively.

The above result unveiled that the demographic characteristics of the respondents has greater influence on the chemical management deviation factors. Age has a significant impact on the factor one (**Chemical storage and unloading knowledge)**. It is shown that age below 25 has responded negatively for factor 1. This might be happened due to the less experience and knowledge of workers on chemical storage and unloading. On the other hand, age above 25 years has responded comparatively more positive manner on chemical storage and unloading factor. This might be occurred for their more experience and knowledge on this factor. From the factor analysis, it also has been evident that education level has greater impact on factor 2 and factor 4 that is on employers' attitude on chemical effluent disposal and chemical dosing, and chemical training and safety concern. Employees who have finished their graduation

has responded more positively whether employees who have comparatively less education responded negatively and randomly. As the most of the employees who finished graduation are from the management side, so their response was comparatively positive. This could be happened due to the biasness to employers or they have the better understanding on these factors. But as the mentionable numbers of respondents were workers who have less education qualification, answered negatively to the questions of these factors. This could be happened due to their lack of education or they really expressed the actual scenario what they experienced in the tannery while working. Some workers have answered randomly to the questionnaire which might be occurred due to the lack of understanding and knowledge on these factors. It has been seen that employee type has the most significant influence on the responses to the questions under factor 2 and factor 3. Workers have responded almost opposite manner compare to the management. As factor 3 is related to the third-party certification, so the workers have almost no idea about the questionnaire of factor 3 (Certification requirements and factual complications), and the most of the workers has avoided to respond these questions except some of them were neutral. The top-level management has responded negatively to the questions of factor 3. This could be happened as they are still far behind to meet the criteria for being certified.

3.2.10 Opinions from Respondents Regarding Improvement of Chemical Management in Tannery

Upon being completed of different statistical test and analysis using SPSS statistical package software, the factors that contributes the chemical management deviation in Bangladesh tanning industry has been come out. Based on the survey questionnaire response on chemical management deviations, the authors then prepared an online form designed for asking suggestions from different personnel who possesses a greater knowhow on chemical deviations and chemical management in several fields including tanning industry about the ways to alleviate from chemical management deviations. The online google questionnaire form consisted of 28 questions (see table 15) about the improvement of chemical management in tannery asking them to what extent they agree or disagree with statement for example, the question 1 of the online google questionnaire was **"There is a lack of Chemical management related Laws, Guidelines, Standards, and Policy in Bangladesh",** and 15 experts respond with this statement as they are strongly agreeing where 1 opined as agree. Question no. 28 was **"Above all, coordination between workers, owners and government is needed to establish sound and safe chemical management in tanneries"**, the result of this question reveals that all the respondents were strongly agree with this hypothesis. The structure of the questionnaire is in the form of Likert scale where the respondent is given options to choose their response on a scale of 1 to 5. Option 1 refers to strongly disagree on the contrary, option 5 means strongly agree, option 2 denotes disagree whereas option 4 depicts agree, and 3 means neutral about response.

Demographic Characteristics of Respondents (Google Questionnaire)

Table 14 shows the demographic characteristics of the respondent in response to online survery questionnaire prepared for achieving opinions of chemical experts for the improvement of chemical management deviation in Bangladesh tanning industry. Sixteen responses have been received from the respondent where 14 (87.5%) persons were male and 2 (12.5%) females. The age of the respondents was found into three clusters for instance, age between 24-40 years, 41-60 years, and others. 11 respondents (68.8%) were found in the age of 24-40 years, 4 (25%) were 41-60 years, and one was more than 60 (6.3%) years old. Interestingly no respondent below age 24 has been found in the survey. The academic background of the respondents, it was seen that 10 (62.5%) persons have studied chemical related fields and 6 (37.5%) were from different fields of studies.

Table 14: Demographic characteristics of respondents (chemical experts)

Characteristics		**Frequency/Number (N)**	**Percentage (%)**
Gender	Male	14	87.5
	Female	2	12.5
Age	24-40 Years	11	68.8
	41-60 Years	4	25
	Others	1	6.3
Major Field of Studies	Chemical Related	10	62.5
	Others	6	37.5

Results of Respondents through Google Questionnaire

The following table (table 15) and figure (figure 13) illustrates the responses of different experts on online questions prepared for escalating from chemical management deviations and to establish a better chemical management system in Bangladesh tanning industries. From the table 15, it can be observed that the most of the respondents strongly agreed with 28 questions except question number 2 i.e.;" **In Bangladesh there should have a segregated Law or policy for chemical management in Tannery",** question 7 i.e.; **"Adequate training on chemical hazards should be provided to all workers/employees/officers employed"** and question 24 i.e.;**" A stronger role for workers/labor organizations is essential for improving existing chemical management".** One respondent strongly disagreed with question 2, 7 and 24. For example, in question number 2 regarding the requirement of a segregated law or policy for chemical management in tannery, a single respondent responded strongly disagree with this. In the comment section of the online questionnaire (see appendix VI), a respondent argues with a sole law or policy on tannery chemical management. The respondent suggested for a common law or policy in chemical management for industries in Bangladesh. Regarding question number 7, a respondent from management contradicted that statement and responded as disagree. But overall, most of the respondents strongly agreed with the questionnaire.

Table 15: Responses of chemical experts through google questionnaire

Variable No.	Variables	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1	Lack of Chemical management related Laws, Guidelines, Standards, and Policy in Bangladesh	0	0	0	1	15
2	In Bangladesh there should have a segregated Law or policy for chemical management in Tannery	1	0	1	1	13
3	Bangladesh government needs to increase monitoring and supervision for tannery chemical management.	0	0	0	1	15
4	Tanneries should have chemical management systems.	0	0	0	2	14
5	There should be managers/supervisors with chemical knowledge to oversee chemical management procedures.	0	0	0	0	16
6	Chemical risk must be determined periodically.	0	0	2	2	12
7	Adequate training on chemical hazards should be provided to all workers/employees/officers employed.	0	1	0	3	12
8	According to the Bangladesh Labor Act 2006, safety committees should be formed in factories where applicable.	0	0	0	0	16
9	There should be coordination between workers and superiors to prevent/remediate chemical hazards in the factory.	0	0	0	3	13

Variable No.	Variables	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
10	In case of emergency, the plant manager/supervisor should be informed immediately about the chemical hazard.	0	0	0	0	16
11	A dismissive attitude towards any chemical risk (however small it is) must be avoided.	0	0	0	3	13
12	When unloading containers carrying chemicals at the factory, it must be ensured that the lids of the containers are securely fastened.	0	0	0	4	12
13	There should be an inventory system of chemicals in the factory.	0	0	0	2	14
14	Chemical store should have approved layout.	0	0	0	2	14
15	Chemicals should be stored as per approved layout.	0	0	0	3	13
16	Chemicals should be stored separately according to the type of hazard.	0	0	0	3	13
17	A separate tray/container should be provided under each container to contain chemical spillage/leakage.	0	0	0	4	12
18	Provision of suitable fume hood should be ensured in every chemical store.	0	0	0	2	14
19	Chemical store should always be kept tidy.	0	0	0	2	14
20	Adequate lighting and ventilation should be provided in the chemical store.	0	0	1	2	13

Variable No.	Variables	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
21	label each chemical container should be ensured	0	0	0	1	15
22	The presence of MSDS for each chemical must be ensured.	0	0	1	1	14
23	Owners need to pay more attention to safe chemical management in tanneries.	0	0	0	2	14
24	A stronger role for workers/labor organizations is essential for improving existing chemical management.	1	0	0	0	15
25	Buyers' cooperation needs to be enhanced to improve existing chemical management.	0	0	0	1	15
26	Coordination among government agencies involved in chemical management is essential.	0	0	0	0	16
27	It is important to look into other aspects of chemical management (such as chemical stores, unloading, transfer, mixing, dosing) as well as buyer requirements for compliance certificates.	0	0	0	1	15
28	Above all, coordination between workers, owners and government is needed to establish sound and safe chemical management in tanneries	0	0	0	0	16

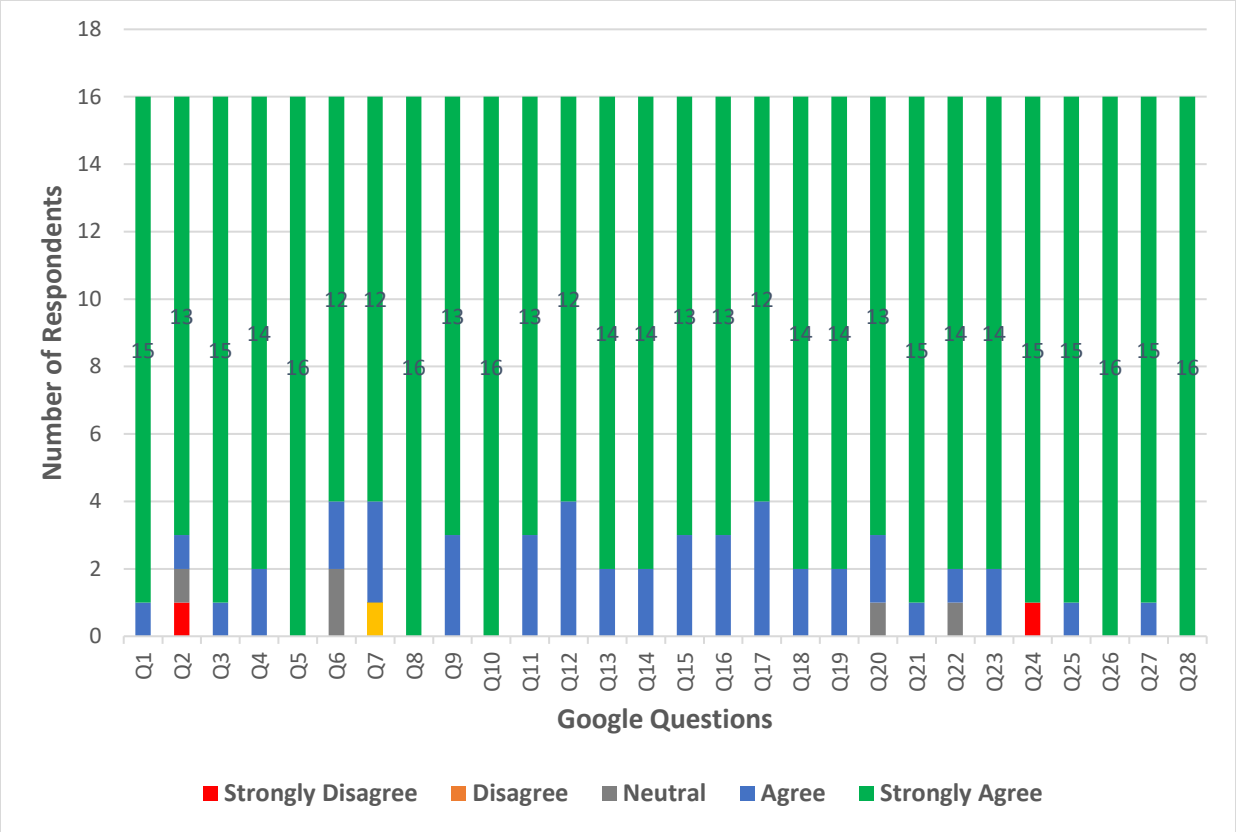


Figure 13: Graphical representation of responses from chemical experts

(Author's own figure)

Mean and Standard Deviation of Responses (Google Questionnaire)

The mean value of the responses unveils the issues that all the chemical experts (in this case 16 respondents) are agreed upon with the interventions that are required for confronting chemical management deviations in Bangladesh tanning industry. Table 16 and figure 14 represent the responses of chemical experts. It is obvious that the average mean value of responses is above 4.5 (see figure 14) which indicates no contradiction is found among the responses of chemical experts. In addition to that some of the experts have provided additional response for establishing a safe chemical management in tannery (see Appendix VI). Hence, along with other interventions, the suggestions of the experts will be provided in the recommendations chapter of this thesis paper.

Table 16: Mean and standard deviation of responses of chemical experts

Variable/ Question No.	Variables/Questions	Valid N	Missing	Mean	Std Deviation
1	Lack of Chemical management related Laws, Guidelines, Standards, and Policy in Bangladesh	16	0	4.94	0.250
2	In Bangladesh there should have a segregated Law or policy for chemical management in Tannery	16	0	4.56	1.094
3	Bangladesh government needs to increase monitoring and supervision for tannery chemical management.	16	0	4.94	0.250
4	Tanneries should have chemical management systems.	16	0	4.88	0.342
5	There should be managers/supervisors with chemical knowledge to oversee chemical management procedures.	16	0	5.00	0.000
6	Chemical risk must be determined periodically.	16	0	4.63	0.719
7	Adequate training on chemical hazards should be provided to all workers/employees/officers employed.	16	0	4.63	0.806
8	According to the Bangladesh Labor Act 2006, safety committees should be formed in factories where applicable.	16	0	5.00	0.000
9	There should be coordination between workers and superiors to prevent/remediate chemical hazards in the factory.	16	0	4.81	0.403
10	In case of emergency, the plant manager/supervisor should be informed immediately about the chemical hazard.	16	0	4.81	0.403
11	A dismissive attitude towards any chemical risk (however small it is) must be avoided.	16	0	4.81	0.403
12	When unloading containers carrying chemicals at the factory, it must be ensured that the lids of the containers are securely fastened.	16	0	4.75	0.447

Variable/ Question No.	Variables/Questions	Valid N	Missing	Mean	Std Deviation
13	There should be an inventory system of chemicals in the factory.	16	0	4.88	0.342
14	Chemical store should have approved layout.	16	0	4.88	0.342
15	Chemicals should be stored as per approved layout.	16	0	4.69	0.479
16	Chemicals should be stored separately according to the type of hazard.	16	0	4.75	0.577
17	A separate tray/container should be provided under each container to contain chemical spillage/leakage.	16	0	4.88	0.342
18	Provision of suitable fume hood should be ensured in every chemical store.	16	0	4.75	0.577
19	Chemical store should always be kept tidy.	16	0	4.94	0.250
20	Adequate lighting and ventilation should be provided in the chemical store.	16	0	4.94	0.250
21	label each chemical container should be ensured	0	0	4.94	0.250
22	The presence of MSDS for each chemical must be ensured.	0	0	4.81	0.544
23	Owners need to pay more attention to safe chemical management in tanneries.	0	0	4.88	0.342
24	A stronger role for workers/labor organizations is essential for improving existing chemical management.	1	0	4.75	1.000
25	Buyers' cooperation needs to be enhanced to improve existing chemical management.	0	0	4.94	0.250
26	Coordination among government agencies involved in chemical management is essential.	0	0	5.00	0.000
27	It is important to look into other aspects of chemical management (such as chemical stores, unloading, transfer, mixing, dosing) as well as buyer requirements for compliance certificates.	0	0	4.94	0.250
28	Above all, coordination between workers, owners and government is needed to	0	0	5.00	0.000

	establish sound and safe chemical management in tanneries				

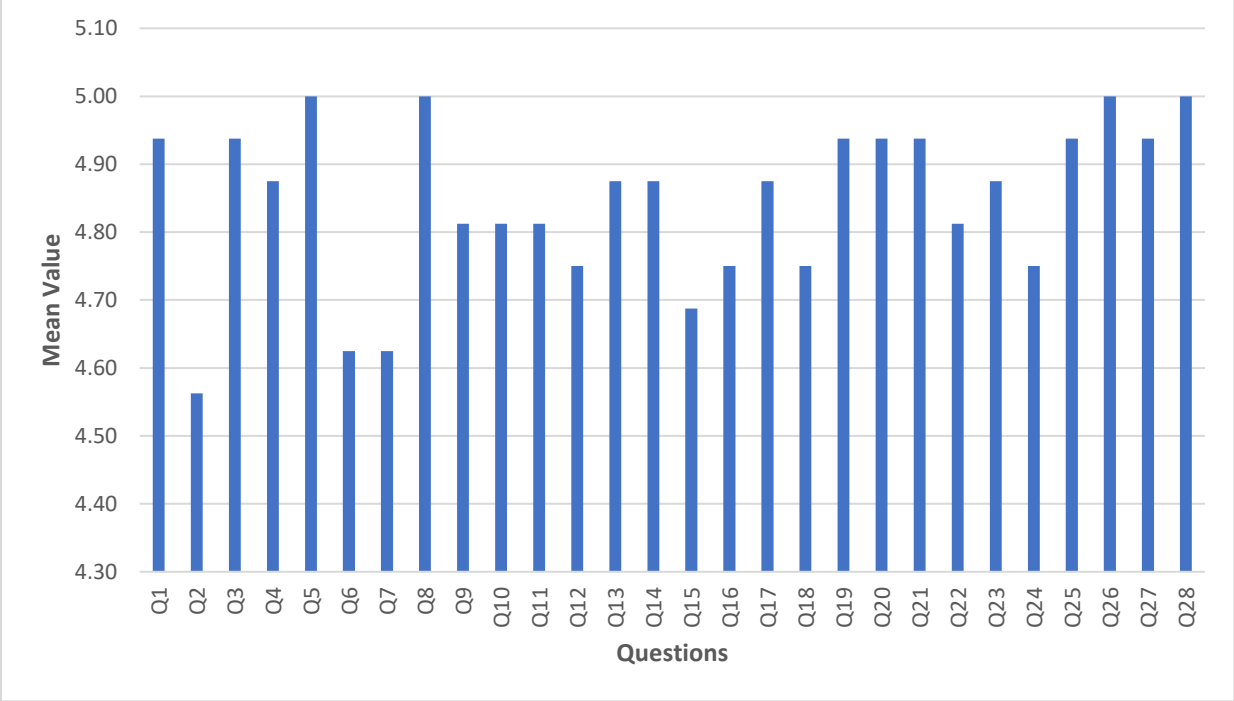


Figure 14: Graphical representation of mean and standard deviation of responses of chemical experts

(Author's own figure)

3.3 Stakeholder Analysis

This part focuses the stakeholder analysis in regards to chemical management system in Bangladesh tanning industry. The study inaugurated with the definition of stakeholders followed by stakeholder classifying, and involvement of stakeholders along with their influence in chemical management deviation issues in tanning industry of Bangladesh.

3.3.1 Stakeholder Definition

According to Freeman Stakeholders can be defined as a group of individuals who can be directly or indirectly affected by the execution of the organization's core objective (Freeman, 2010). In another way, the definition of a stakeholder is given as a person or a group of individuals or an enterprise who has interest or is affected by the activities of another individual or group of people or an organization. Therefore, it can be stated that the stakeholders of an organization, unit, project, or any scheme has a greater impact over the overall success of organization (Freeman, 2010).

The relationship and coordination among different stakeholders are one of the most vital aspects of an organization or a program managed publicly (Zwikael, 2019). Analysis of involved stakeholders within an organization are being thought as critical and intricate as the analysis depicts an overall scenario of stakeholders, the relationship among them, the weakness and strength between them, and the coordination level, so that an overview of stakeholders' roles and responsibility become obvious which is thought as an integral part of a stakeholder analysis.

3.3.2 Stakeholder Analysis Process

For accomplishing the stakeholder analysis in this work, firstly, the stakeholders have been identified followed by the categorization of them into several clusters based on three factors i.e.; power, legitimacy and urgency (Ronald K. Mitchell, 1997) to find out their influence and impact in the outcome of this study. In the following section of this thesis paper will be depicted about the classification of different stakeholders considering their power, legitimacy, and urgency.

3.3.3 Categorization of Stakeholders in Tanning Industry of Bangladesh

Basically, stakeholders are classified into two groups for instance, internal and external (FERNANDO, 2023). The activities of internal stakeholders include working directly within the organizations to manage the project for example, managing employees, managers, and the board of directors. On the other hand, the external stakeholders can be defined as a group of people or partners who contribute to achieve an organizational goal from the outside. After scrutinizing different literature and publications deeply and interviewing the workers of tannery industry by survey questionnaire, this study identified several internal and external stakeholders in tanning industry of Bangladesh. Workers, safety committee, management authority, tannery owners and their associations appeared as internal stakeholders whereas both national and international brand and buyers, government monitoring and supervising agencies, workers union or trade union, different NGO's, educational and training institutions, and different international donor agencies are act as an external stakeholder.

Moreover, according to three attributes: Power, legitimacy, and urgency, the stakeholders in tanning industry have been classified. Power can be defined as the capability of bringing out one's desired outcome. So, the stakeholders who can take out the expected outcome are in the power group. The stakeholders' legal position on the activity of interest falls into the legitimacy category and the attribute

of urgency can be classified as strong favor for the betterment project of interest (Ronald K. Mitchell, 1997).

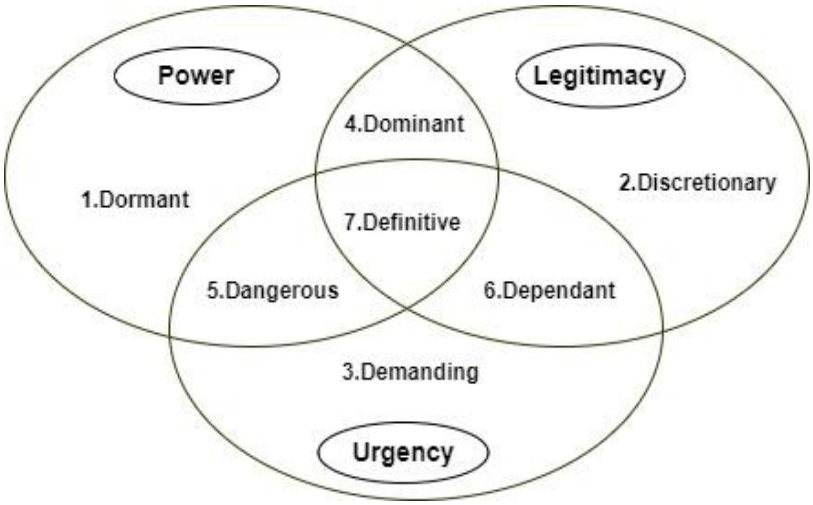


Figure 15: Stakeholder categorization according to attributes

(Source: (Ronald K. Mitchell, 1997)*)*

The stakeholders possessing any or all the attributes of power, legitimacy and urgency can be further classified into seven different types. For instance, the seven groups are namely Dormant, Discretionary, Demanding, Dominant, Dangerous, Dependent, and Discretionary (Ronald K. Mitchell, 1997). This classification has been shown in the figure 15. A stakeholder associated with definitive class will have all the attributes of power, legitimacy and urgency and known as the most influential stakeholder. In the same way dominant, dependent, and dangerous groups of stakeholders pose some common attributes as shown in the figure 15.

In this thesis work the authors classified the identified stakeholder according to the above-discussed seven categories in the following table 17.

Table 17: Stakeholders' classification and their responsibilities

Serial No.	Stakeholder	Activities of Stakeholder	Category
1	Government, monitoring and supervising authorities	Formulation and implementation of laws, policies, and guidelines	Definitive
2	BSCIC	Facilitate tannery with allocation of space, arrangement of CETP, Financial support, Enhancement of SMEs, Creating Employment	Definitive
3	Tannery Owners	Investors, sell product, pay workers, and expect the maximization of profit	Dormant
4	Buyers and Brands	These groups always look after their own interests. For example, to buy products with a lower cost.	Demanding
5	Technical and training institute	Train up people who works in factories	Discretionary
6	Educational Institutions	These are the organizations engaged with research and development (R&D) in leather industry and disseminate their knowledge for improving working environment.	Discretionary
7	NGOs	NGOs are involved with facilitating to ensure decent working conditions. Provide training and arrange social dialogue.	Demanding
8	Development partners	These organizations facilitate government with financial aid for developing infrastructure, work and health environment.	Demanding
9	Workers	They are the group who engaged in several works with different responsibilities in the tannery.	Dependent
10	Safety Committee	They are being worked in groups in different types of safety function for instance, chemical safety, fire safety, and structural safety.	Dependent
11	Workers' associations (Trade Union)	Involvement of bargaining with owners in respect to protect workers' rights according to law and regulations	Definitive
12	Employers' association (Tanners Association)	The organization of owners who always seek for their collective interest.	Dominant
13	Media	Can contribute by promoting chemical related safety in tanning industry.	Dependent

The above table (table 17) demonstrates different stakeholders along with their power, legitimacy, and urgency in Bangladesh tanning industries. As different stakeholders hold some sort of power, interest, and urgency in various fields of tannery, and hence they can contribute largely to establish a safe chemical management in Bangladesh tanning industry. To make a sustainable working environment and to protect the environment from the adverse impact of tanning chemical, the stakeholder's respective role and responsibility is absolutely needed. Table 17 shows there are thirteen different stakeholders, who have been specified in different groups based on their activities and playing role. For instance, government monitoring and supervising agencies such as DIFE, DoL, DoE, and another crucial agency BSCIC hold power, legitimacy, and urgency. Workers association includes Tannery Workers Union. Employees association comprise with BTA, LFMEAB and BHSMA.

3.3.4 Stakeholder Relationship and their Influence

In table 17 the stakeholders have been identified considering their participation and influence regarding the improvement of chemical management deviation in Bangladesh tanning industry. In this section it has been shown an entire pictorial representation of different stakeholders, their inter-connection, the weakness, and strength regarding to develop a safe chemical management culture in the tanning industry of Bangladesh.

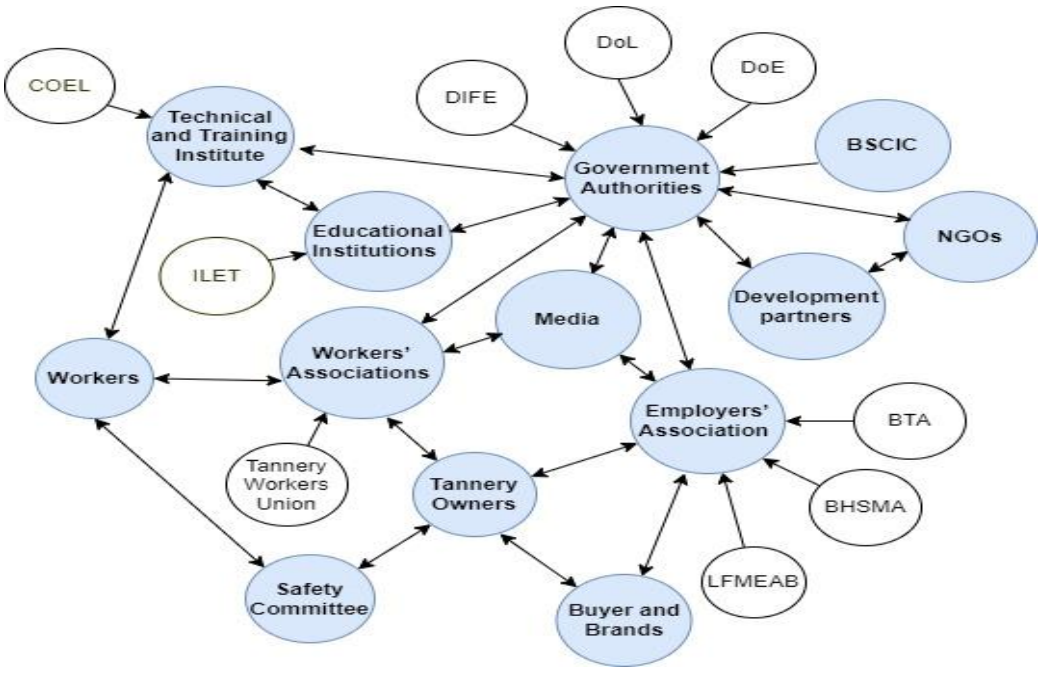


Figure 16: Stakeholders connectivity in regards to chemical management in tannery of Bangladesh (Author's own figure)

The above figure (figure 16) shows the connectivity among different stakeholders in tanning industry of Bangladesh who can contribute and promote a safe chemical management standing their own position and work as a cumulative way. From the figure 16 it is seen that numerous agencies of Bangladesh government who involved with supervision and monitoring of tannery in different aspect such as H&S (Health and Safety) issues pose power, legitimacy, and urgency. So, they can play a crucial role in promoting the safety aspects in tannery chemical management. The government of Bangladesh and its agencies in relation with tannery are considered the most influential stakeholder who can make a bridge

among other stakeholders regarding chemical management in tannery. The key function of government agencies is to build law, amendment of law, and implementation of those law in the tanning industry for establishing an organized chemical management system. Department of Inspection for Factories and Establishments (DIFE) is one of the core bodies in government that primary responsibility is work for building up a decent workplace in industries including tannery. As inspectors of DIFE have been empowered enough to supervise the health and safety issues in tannery, so they can play a vital role about chemical management in tannery. Department of labour (DoL) is another entity of Bangladesh government who monitors the trade union in industries. But both department works with Bangladesh Labour law and Bangladesh labour rules to implement in the enterprises level. Although DIFE and DoL have the supervision and monitoring power in tannery, the expected result is not achieved yet. The causes behind the staying away from desired result is lack of coordination among the agencies regarding establishment of a segregated section which include chemical safety issues. The Department of Environment (DoE) is another influential stakeholder from the government agencies under the Ministry of Environment, Forest, and Climate Change. One of the fundamental duties of DoE is to protect environment pollution and implement the environment related laws and rules to the industries that contributes environment quality deterioration by their activities. As the tanning industry of Bangladesh is closely related to the environment, hence the DoE should have been involved with huge activities in Bangladesh tanning industry in respect to protect environment pollution from the effluent disposed by the tannery. Ministry of industry has an autonomous body named as Bangladesh accreditation Board who provides accreditation for setting up chemical uses standards in laboratories, but they are not involve in tanning industry, although the authors think that the agency can play a vital role in tannery chemical management. Hence, the involvement of Ministry of Industries along with its competent agencies become an issue of rethink in Bangladesh tanning industry for a well-organized chemical management system. BSCIC, another definitive stakeholder is an organization of government under the ministry of Industries who hold power, legitimacy, and urgency. They facilitate tannery infrastructure development i.e., allocation of space, arrangement of CETP.

The above-mentioned government agencies possess power, legitimacy, and urgency in Bangladesh tanning industry and known as definitive stakeholder. They exercise their laws and rules to the activities of tannery. So, for establishing a sustainable chemical management system in tannery these authorities can contribute immensely.

Tannery industry' owners are dormant stakeholder who have power but no urgency and legitimacy. Even though, the tannery owners and its association have no legitimacy about laws and rules, but they can contribute for the establishment of chemical management system by investing more money in chemical safety aspect. But they neglect to invest in chemical safety for the perception that investment in workers' health and safety is mere waste of money. But in fact, an investment in safe working condition will ultimately well paid-off.

Buyers and brands in tannery industry are considered as the demanding segment stakeholders who have urgency but no power and legitimacy. This group always seek for placing a workorder with the cheapest price but keep pressurize the tannery owner to build up an occupational safety and health culture. Buyers and brands could work with factory owners regarding tannery chemical management deviation issues. Hence, they can always promote for a safe and healthy workplace and demand for different compliance third party certification related to safe workplace and chemical management to the owner of the industry.

Media can become one of the most crucial stakeholders in tanning industry for creating a safe chemical management system. They have legitimacy and urgency. Media can promote the health and environmental impact of chemicals to the public and impulse government to get more participation in tannery chemical management deviation.

Technical, training and educational institutions have been considered as discretionary stakeholders of Bangladesh tanning industry. These stakeholders have legitimacy but no power and urgency. Institute of Leather Engineering and Technology (ILET), Centre of Excellence for Leather Skill Bangladesh Limited (COEL) are the major stakeholders in this regard. ILET and COEL play the role of knowledge dissemination in tanning industry.

The NGOs are demanding stakeholders who have urgency but lack of power and legitimacy. They play a vital role by advocating and arranging workshops for the betterment of this industry. This group must be connected more with the regulatory bodies to collectively enforce and pursue the tannery owners on implementing chemical risk management strategies. So, both national and international NGOs can promote chemical management in tanning industry largely by increasing the social dialogue among different stakeholders.

Development partners also have been considered as demanding stakeholders. These organizations facilitate government with financial assistance for infrastructural development in tannery sector for example functioning the ETP, constructing connecting roads etc. They can also contribute to develop the health and working environment in tanning industry of Bangladesh. Moreover, to include chemical standards, empowering the existing laws and regulations with chemical related clauses, and if possible, to suggest government to promulgate a segregated law on chemical management, they can cooperate with government for creating a better working environment.

In the tanning industry of Bangladesh workers are being thought as dependent stakeholders have urgent legitimate claims but no power. Workers are dependent on other stakeholders for the power to achieve their expectations (Ronald K. Mitchell, 1997). Workers are the largest group in tanning industry who exposed to adverse effect of chemicals while chemical handling. They are the main victim of chemical management deviation in tanning industry.

Another dependent stakeholder is safety committee in tanning industry. The active and functional safety committee in tanning industry can promote chemical management as they have been assigned and empowered with some responsibilities according to the existing Bangladesh labour law and rules.

In tanning industry workers' associations are identified as definitive stakeholder. They have power, legitimacy, and urgency to protect the rights of workers. Whenever any deviations occur in chemical management, they can raise voices to claim a safe chemical management system according to international standards and keep pressurizing towards tannery owners for taking measures against chemical management deviations so that workers health can be protected from the adverse effect of chemicals.

Employers' associations possesses both power and legitimacy so that they are known as dominant stakeholder. They always seek for their own interest merely think about workers well-being. They exercise their power on workers only for their benefit i.e.; pay less and demand more. Even though, the government agencies urge them to comply with legal issues but they always try to skip to obey the existing

rules and regulations. If they opine with the adverse impact of chemical management and realize the issue as a threat posing subject to worker and environment, the chemical management deviation in tanning industry can be avoided largely.

Chapter 4: Discussion and Recommendations

Upon being completion of qualitative and quantitative analysis in previous chapter, the authors found the consistency in both analyses for the factors that cause chemical management deviation in tanning industry of Bangladesh. In this chapter at first, a general discussion on existing Acts and Rules in regard to chemical management in Bangladesh has been accomplished. Then emphasize is given to recommendations that have been suggested based on the four factors which are being considered the key elements for chemical management deviation in tanning industry of Bangladesh. Some recommendations from chemical experts for strengthening chemical management system have also been provided. Later, interventions to strengthen local Acts and Rules for chemical management system were suggested. Finally, focus has been given to strengthen the stakeholders' roles and responsibility for establishing a safe chemical management in Bangladesh tanning industry.

4.1 Discussion on Existing Acts and Rules related to Chemical Management in Bangladesh

Now a general discussion regarding the existing acts and rules about chemical management will be conducted in the following section. Apparently, in Bangladesh the authors found two core laws and two rules that deals with chemical management. Bangladesh Labour Law, 2006 and the Bangladesh Environment Conservation Act (Amendment), 2010 are the two laws that focuses about the chemical management whereas Bangladesh Labour Rules, 2015 and the Environment Conservation Rules, 2023 emphasize on chemical management for industries in Bangladesh. An explanatory discussion about the existing acts and rules are given below.

4.1.1 Bangladesh Labour Law, 2006 and Bangladesh Labour Rules, 2015

Bangladesh Labour Law 2006 and Bangladesh Labour Rules 2015 are currently considered as the core elements for the inspection of factories and establishments including tanneries. Different section in the Labour Law and Rules have discussed and focused on the occupational safety and Health issues. But the tannery chemical safety aspect has not been specified directly in the Labour law and Labour rules. Only a few sections of Bangladesh Labour Law and Bangladesh Labour Rules generally focused on the chemical safety concern matter. In regards to chemical management Bangladesh Labour Law 2006 and Bangladesh Labour Rules illustrates as follows:

In Section 52 of Bangladesh Labour Law 2006, regarding the ventilation and temperature in a factory, it is stated that there it must be maintained the facility and availability of adequate ventilation in every work-room so that fresh air can be circulated. To ensure the ventilation facility, every factory should made suitable and effective provisions. The section emphasized for fresh air circulation so that the workers can be secured and avail the reasonable conditions of comfort as well as for the prevention of workers' health injury. (Bangladesh Labour Law , 2006).

The Section 53 of Bangladesh Labour Law 2006 focuses on the dust and fume management of industries. It stated that if any factory or establishment is engaged to such a work which produces dust or fumes in their manufacturing process in a way and in an extent that the workers within the factory can be exposed or be injured by process, the factory should install exhaust system as near as possible to the source of dust and fumes so that the workers are not affected by dust or fumes or any other impurities by inhalation. (Bangladesh Labour Law , 2006).

The Section 75 of Bangladesh Labour Law 2006 focuses on the eye's protection of workers in any factory where the possibility of eye injury become obvious by any particles or fragments that have been thrown

off from a manufacturing process. It says that effective and suitable goggles should be provided to the workers who are involved with this type of manufacturing process that can harm their eyes. (Bangladesh Labour Law , 2006).

As per Bangladesh Labour law 2006, Sec- 78(a), Mandatory use of personal safety equipment has been emphasized by clearly mentioning that "(1) In an applicable case, an employer shall not engage any workers in work without providing and ensuring use of personal safety equipment, and in doing so, a record book shall be maintained as designated by the owner. (2) In spite of supply of personal safety equipment if those are not used by workers concerned, they are to be held liable thereof. (3) For ensuring professional health and safety for workers at workplace, each of workers shall have to be aware on the risk of the work through trainings" (Bangladesh Labour Law , 2006).

Liming and tanning raw hides and processing is considered as hazardous activities according to the section 79 of Bangladesh labour Law 2006 and rules 68(1) of Bangladesh Labour Rules 2015 (Bangladesh Labour Law , 2006) (Bangladesh Labour Rules, 2015).

In the section 90a, regarding the formation of safety committee in the factory, it is stated that for the factories with employees fifty or more than fifty, they must have to formulate a functional safety committee who will be empowered with taking care of different safety aspects for instance, Chemical management safety, Electrical Safety and Fire Safety (Bangladesh Labour Law , 2006).

Regarding the MSDS of chemical, in Bangladesh Labour Rules 2015, rule 68(10), it is clearly illustrated that "The owner shall place Material Safety Data Sheet (MSDS) of dangerous materials in an easily noticeable place so that the employed worker can be well-informed about the possible hazards" (Bangladesh Labour Rules, 2015).

4.1.2 The Bangladesh Environment Conservation Act (Amendment), 2010 and the Environment Conservation Rules, 2023

The other competent agency of Bangladesh government who inspects and provide environment clearance certificate to the tanning industry of Bangladesh is the Department of Environment (DoE) under the Ministry of Environment, Forest and Climate Change according to the Bangladesh Environment Conservation Act (Amendment), 2010 and The Environment Conservation Rules, 2023. The functionality of this department in Bangladesh tanning industry has been illustrated in the following section:

As per the section 12 of The Bangladesh Environment Conservation Act (Amendment), 2010, without being certified from the Director General (DG) for the clearance of Environment issues, no industrial unit shall be established. In the case of the violation of section 12 of The Bangladesh Environment Conservation Act (Amendment), 2010, the sanction is the imprisonment not exceeding three years or a fine of not exceeding three hundred thousand BDT or both (The Bangladesh Environment Conservation (Amendment) Act, 2010)

According to the Environment Conservation Rules, 2023, the tanning industry has been classified as RED category industrial unit based on its impact on environment in schedule 1. In rules 7 of the environment conservation rules, 2023, it is stated that for factory that fall in red category need to achieve a location clearance first, then environmental Clearance Certificate can be received. It also stated that If the Director General (DG) is satisfied enough with the application of an industry, a factory can get an environment clearance directly without the Location Clearance certificate (Environment Conservation Rules, 2023).

In rules7(6)(d) of the Environment Conservation Rules, 2023, it is clearly mentioned that to achieve the Environment Clearance Certificate for red category industry availability of the report on the Initial Environmental Examination (IEE) in regards to the industrial unit is a must, and also the terms of reference (ToR) for the Environmental Impact Assessment (EIA) of the unit and its Process Flow Diagram (PFD) is required; or Environmental Impact Assessment (EIA) report which is prepared on the considering the terms of reference that is approved previously by the Department of Environment, along with the Layout Plan which indicates the location of ETP, Process Flow Diagram, time schedule and design of the ETP of the unit. It should be mentioned here that these requirements are applicable for a proposed industrial unit. On the other hand, for an existing or running industry, to get the Environment Clearance Certificated, the requirements that must be meet are- the report on the Environmental Management Plan (EMP) the Process Flow Diagram, Layout Plan which shows the location of Effluent Treatment Plant (ETP) in the industry, design and information about the effectiveness of the Effluent Treatment Plan (ETP) (Environment Conservation Rules, 2023).

4.2 Recommendations to Establish a Safe Chemical Management in Tanning Industry of Bangladesh

This part of the thesis paper depicts about the recommendations for a safe chemical management in Bangladesh tanning industry. The recommendations that have been provided are based on the factors that need to be tackled for establishing a safe chemical management system. Recommended actions from chemical experts for building a sustainable chemical management system are also given. Moreover, to develop the existing acts and rules, some interventions also been provided. On top of that for strengthening the stakeholders' activities, the required actions also given in the following part of this thesis paper.

4.2.1 Interventions for tackling Chemical Deviation Factors in Bangladesh Tannery

Now focus will be given to some interventions that must be taken for a chemical management scenario that comply with international standards, guidelines, policies, legislations, and best practices used in tannery sector globally. The interventions are required to overcome the factors (in this case four factors) that triggered the chemical management deviation in Bangladesh tanning industry.

Factor 1- **"chemical storage and unloading knowledge"** depicts that workers knowledge on chemical storage and unloading largely impact the chemical management deviation in tanning industry. The most proportion of the tannery workers and employees have less knowledge about the chemical storage and unloading as they have not been provided adequate training. To tackle the first factor, the initiative that need to be implemented are; to provide adequate training of workers on chemical unloading and presence of chemical supervisor must be ensured while unloading chemicals. The safety datasheet should be prepared in a language that are easily comprehensible to the workers. Arrangement of chemical inventory in the storage need to be ensured and restricted area in the tannery need to be marked so that an unauthorized person cannot enter this area. Segregation of chemical according to their hazards category must be ensured. Installation of proper fume hood in the storage, presence of approved layout of storage, and storage of chemicals according to the approved layout must be ensured. Sufficient illumination and ventilation facility in the storage need to be provided. As the above-mentioned interventions are related to the factory owners and top-level management, hence the owners must be come in front and take proper step for providing a safeguard against the chemical management deviations caused by this factor.

"Employers' attitude on chemical disposal and dosing" is another crucial factor that contributes largely to the chemical management deviation in Bangladesh tanning industry. Initiatives that need to be taken for the second factor are consists of ensuring the functional Effluent Treatment Plant (ETP) in the tanning industry, arrangement of separate container for solid and liquid effluent, allocation of dedicated area to store the effluent and washes of empty chemical containers must be ensured for chemical disposal. In the case of chemical dosing steps that are suggested include; provide adequate training to workers, presence of chemical supervisor while dosing, commencement of automatic dosing system, implementation of engineering control while pouring the chemicals to drums or pit, and supply of adequate and proper PPE to workers. As the most of the interventions are depend on factory owners and some of them are related to the government, so the attitude of factory owners towards chemical disposal and chemical dosing needs to be changed and the government must be cooperative to facilitate the owners which issues could not be solved by them for instance, the functionality of ETP should immediately ensure to avoid chemical management deviation in tanning industry.

Another important factor that has been considered as a key player for chemical management deviation in tanning industry of Bangladesh is "**certification requirements and factual complications"** confront by the tannery owners. The result depicts that most of the tannery does not fulfill the minimum criteria to achieve third party compliance certification like LWG (Leather Working Group) certification. Proper chemical management is one of the prerequisite criteria to achieve the LWG certification. The overall status of Bangladesh tanning industry have a negative image to the international leather market for not being eligible to be certified. From the survey responses attained from the tannery owners and top-level management on certification related questionnaire, some facts become obvious to the authors for their incapabilities to fulfil the requirements for certification. The facts that worked behind the noncompliance with third party certification requirements are economical insolvency of the tannery owners, inadequate space allotted by BSCIC for tannery, less concentration of buyers and brands to increase products price mere looking for cheaper rate of products, and non-involvement of international donor agencies in regards to finance in Bangladesh tanning industry. The steps that can be implemented for factor 3, i.e., "certification requirements and factual complications" are consist of availability of proper chemical management procedure, recruitment of chemical supervisor from chemical related field, providing indication about the experience of the responsible individual for chemical management, state the name, position and qualification of the responsible individual for chemical management, maintaining a register that records the compliance against client MRSL (Manufacturing Restricted Substances List) requirements must be ensured in the tannery, and describes whether the actual proportion of the factory's incoming chemicals is obtained from companies that have been documented compliance to MRSL. The questions under this factor are about third-party requirements, and some fact create a complicacy to ensure the required steps. These factual complications are related to economic issue, space related issues and buyers and brands support issue. so, the financial insolvency of the tannery owner can be solved by the aid of government or involvement of international donor agencies. The buyers and brands should be more flexible in regards to their requirements for compliance issues. In the meantime, they should be more supportive to the tannery owners by increasing the price of the products.

"Chemical training and safety concern" become another obvious factor for chemical management deviation in tannery. Deficiency of trained personnel both management and workers are largely liable for chemical management deviation. From the survey result, it is evident that majority portion of the employees are not well trained on chemical handling and management. Some of them become careless on the hazardous impact of chemical due to lack of training on chemical safety. To tackle the issues related to factor four- "**chemical training and safety concern"**, the measures that can be carried out are arrangement of fire drill in the tannery in a regular interval along with presence of evacuation plan,

familiarizing of employees and workers with chemical related standards, guidelines, legislation, policies, and best practices, availability of first aid facility, and checking of electric lines regularly must be ensured.

4.2.2 Recommendations from Chemical Experts to improve Chemical Management in Tannery

Apart from the above-mentioned suggestions and interventions, more initiative can be implemented based on the chemical expert's opinion which have been obtained from online questionnaire. These recommendations include- availability of chemical management related Laws, Guidelines, Standards, and Policy in Bangladesh, separate law or policy for chemical management in tannery, emphasize on monitoring and supervision of government agencies, availability of tannery own chemical management system, frequent assessment of chemical risk, arrangement of adequate training or workshop for both workers and management, formation of safety committee in tannery, attentiveness of owners for establishing a safe chemical management in tannery, stronger role for workers and labor organizations for improving existing chemical management, buyers' cooperation to improve existing chemical management, strong coordination among government agencies involved in chemical management, and coordination between workers, owners and government is needed to establish a sound and safe chemical management in tanning industry of Bangladesh. These above-mentioned suggestions have been received from different personnel who have expertise on different chemical fields for instance, some experts are pursuing their PHD on chemical safety, some have been working as a tannery compliance auditor, and some have been working in the renowned chemical company. Beside the response of questionnaire posed to them, they have provided some additional suggestions that could be implemented in the tanning industry of Bangladesh to protect the existing chemical management deviation. These suggestions include emphasizing on certification and standards requirements as they become crucial to sustain Bangladesh tanning industry in the long run. They also added that without being certified from third party for example LWG certification, SLF (Sustainable Leather Foundation) certification, OEKO TEX etc., there remain a fear of losing competition in international leather market. On top of that they suggested that as the process of certification is a lengthy and too expensive, besides Bangladesh government some international donor agencies for example IMF, World Bank, Switch Bank and other agencies should finance in the tannery sector. If the enough financial aid can be received from these agencies, then the tannery sector will definitely become a top export earning sector in Bangladesh economy like the RMG sector. Some expert also suggested for a collaborative supervising agency in tanning industry combined with government, owners' association, workers association and other competent agencies.

4.2.3 Strengthening the Local Act and Rules on Chemical Management

As the Department of Inspection for Factories and Establishments (DIFE) is being thought as one of the core bodies to inspect tanning industry of Bangladesh according to the existing law and rules, it frequently visits tannery within a regular interval by a prepared checklist based on law and rules. Enough sections or rules are not available in the labour law and Labour rules for chemical management in tannery. Moreover, the existing Labour Law, 2006 and Bangladesh Labour Rules, 2015 are not comprising with clauses that solely talks about the tannery chemical management issues. Hence, inclusion of section and clause regarding tannery chemical management aspect in the existing law and rules become a vital issue. Now look have been given to other crucial government monitoring agency; The Department of Environment, Bangladesh.

In Bangladesh, the Department of Environment is a government entity which deals with the conservation of environment in terms of solid and liquid industrial effluent. Even though, there are some sections and rules available in the respective Environment Conservation Act and Rules, but the authors thought that

these are not enough to protect the environment from the pollution of tannery effluent and the health issues of workers in tanning industry should be more emphasized in the law and rules. Moreover, fewer sections in the law and rules that discussed about the hazardous impact of chemicals used in the tannery. So, inclusion of clause in the law and rules on tannery chemicals hazardous effect is an increasing demand to establish a sustainable tannery chemical management.

4.2.4 Stakeholders Responsibilities to improve Chemical Management

After analyzing the stakeholders' part of this thesis report, the authors came across some discrepancies raised among the different stakeholders which include lack of power, legitimacy, and urgency. Workers and safety committee has legitimacy and urgency, but they possess no power. Hence, the authors think that like workers union, the workers and safety committee in the tannery should have been given power in the case of any discrepancies occur in tannery in respect to chemical management deviations and other safety issues. For example, if any worker observes any deviations in chemical management or any negligence of tannery owners, he should be empowered with raising his voice so that the management can be aware about the safety matter. The safety committee also be given the power so that they can act as a definitive stakeholder. Even though the workers union in tannery known as definitive stakeholder but they rarely can exercise their power for the improvement of tannery chemical management deviation. Sometimes they are seen working with a bias towards employers for their own interest and the cumulative well-being of workers is neglected. In addition, considering their roles and responsibilities, some weakness among stakeholders have been identified. The most obvious weakness found in the stakeholders' analysis is poor communication and lack of coordination among the stakeholders. Hence, the empowerment of stakeholders in tanning industry of Bangladesh draws deep attention. Strengthening the communication and coordination between different stakeholders in common issues is considered as a vital element to establish a safe chemical management system in leather sector of Bangladesh. The activities of workers and trade union in tanning industry should be increased largely in the case of chemical management issue. The employers must be more liable and accountable to the government for any deviations occur in chemical management. They should avoid the carelessness towards chemical safety issues in tannery and the well-being of workers and employees must be taken care of according to the existing laws, rules, standards, guidelines, and best practices on chemical safety. The profit should not be the sole point of concentration of tannery owners rather investment in chemical management need to be emphasized. The media could be act as a whistle blower in the case of any deviations occur in chemical management of tanning industry. They should raise their voice and create pressure to government and employer to establish a well decorated chemical management system. The NGOs should be more active for arranging the social dialogue between the government, tannery owners, chemical specialist, worker union and international donor agencies in respect to chemical management deviation in tannery. The government monitoring and supervising agencies need to initiate more proactive action rather reactive participation for establishing a safe chemical management system, if the employers are found noncompliant with laws, rules, standards, guidelines, and available best practices in respect to tannery chemical management. Chemical safety related more provision should be included in existing law and rules. A segregated law on chemical safety in industries including tannery should be a prioritized issue for the government of Bangladesh. The international donor agencies should be included in tannery for creating a safe working environment including a safe chemical management system. The tannery related education and training institution should be involved more actively to train workers regarding the safe handling of tannery chemical and they must be aware about the hazardous effect of tanning chemical on their health. The authors suggest the inclusion of another training institute on chemical safety named Training Institute for

Chemical Industries (TICI) of Bangladesh Chemical Industries Corporation (BCIC) under the ministry of industries can also play a vital role in Bangladesh tanning industry providing training specially about chemical management issues. Overall, the active engagement of related stakeholders and coordination among them in tanning industry is highly required to avoid chemical management deviation. Each of the stakeholder need to perform their respective job with transparency and enthusiasm. The accumulated endeavor and relentless effort of stakeholders can contribute to achieve the desired outcome in Bangladesh tanning industry for establishing a safe chemical management.

Chapter 5: Conclusion

As Bangladesh tanning industry has been struggling to fulfill the requirements of international brands and buyers for not being certified in compliance issue due to its unsafe chemical handling that results in losing buyers, reputation, workorders, and impact the workers' health adversely, hence a safe chemical management become an obviously demanding subject for the tannery sector of Bangladesh. This thesis focuses the core factors that are being considered as obstacles in the way for establishing a safe chemical management system in tanning industry of Bangladesh and provides recommendations for tackling these hindrances to build up a sustainable chemical management in Bangladesh tanning industry. To achieve the goal, the authors commence with accomplishment of a qualitative analysis followed by a quantitative analysis. From Factor Analysis (FA) four factors have been identified that are liable for chemical management deviation in Bangladesh tanning industry.

The first factor- "chemical storage and unloading knowledge" reveals how workers knowledge on chemical storage and unloading impact the chemical management deviation in tannery. It is obvious in factor 1 that the majority of the workers have inadequate knowledge in chemical storage and unloading due to the lack of training. The second factor illustrates about the "employers' attitude on chemical effluent disposal and dosing". How employers attitude contributes chemical management deviation in regards to chemical disposal and dosing are clearly stated by factor 2. The third factor elaboratively discusses about the "certification requirements and factual complications" in Bangladesh tanning industry. What types of complexities confronted by the tannery owners to meet the minimum standards for being compliance certified like to achieve LWG certification are also mentioned by this factor. According to the tannery owners, financial scarcity, inadequate space, government and buyers' non-cooperation are some main obstacles to achieve the LWG certification. The fourth factor- "chemical training and safety concern" is considered as another obvious reason for chemical management deviation in Bangladesh tanning industry. Lack of trained employees in tannery is the key factor for chemical management deviation. It is seen that mentionable portion of the workers have not been trained in chemical dealing and management.

To overcome the chemical management deviations in Bangladesh tanning industry, some interventions have been suggested based on the standards, guidelines, legislation, policies, and best practices that are followed globally in tannery sector. Suggestions from the chemical experts also provided by conducting online survey in google form for developing tannery chemical management in Bangladesh.

The recommended actions that could be implemented against the four chemical management deviation factors and for the improvement of chemical management in Bangladesh tanning industry are mainly to provide adequate training, presence of approved layout for chemical storage, separation of chemicals based on their hazard category, administrative control, automation in chemical dosing, engineering control, separate law for tannery chemical management system, common law for chemical management, involvement of buyers and brands on chemical safety issues, financial aid by the international donors agencies, formation of safety committee in tannery, functional Effluent Treatment Plant (ETP), factory own chemical management procedure, recruitment of chemical supervisor from chemical background, and providing workers adequate training on chemical related law, standards, and guidelines. As the recommendations are not solely depend on single authority rather cumulative actions are required for the implementation of these interventions, hence the coordination and cooperation among workers,

tannery owners, and government become an immense criterion for the smooth implementation of these recommendations to establish a safe chemical management system in Bangladesh tanning industry.

After being analyzed of local law and rules on chemical management issues, some suggestions have been taken out. These recommendations include inclusion of more clause or sections on chemical management in existing Bangladesh Labour Law and Rules. Moreover, Environment Act and Rules should include more sections emphasizing the protection of the workers' health impact and to provide a safeguard for protecting environment pollution.

Some recommendations for strengthening stakeholders' contribution in Bangladesh tanning industry have also been provided. These recommendations comprise of strengthening the communication and coordination among stakeholders in the case of chemical management deviation need to be ensured. The workers and workers union, employers and employers' association, government monitoring agencies, NGO's, Buyers and Brands, international donor agencies should work more intensively for establishing a safe chemical management system in Bangladesh tanning industry.

Overall, active participation and strong coordination of different stakeholders, strengthening the chemical related law and rules, establishing a separate law for tannery chemical management, tannery owners' moral obligation and honest intentions, and cooperation of government and buyers accumulatively can protect chemical management deviation and establish a sustainable chemical management system in the tanning industry of Bangladesh.

Chapter 6: Gaps and Further Scope of Research

Even though, finding out the factors for chemical management deviation in Bangladesh tanning industry has been accomplished and recommendations were provided to encounter the chemical deviation factors and for the establishment of a safe chemical management system that comply with Laws and rules, standards, guidelines, policies, and best practices throughout the global tannery sector, the authors think that still there remain gaps in this thesis work and there are some areas that could be further explored. A comparative study between the third party certified and non-certified tannery could be included in this thesis, but it was not done. The authors conducted the empirical data analysis by surveying 125 employees of six different tanneries but still the authors think that, if the survey procedure could have been conducted with the inclusion of more employees and in more factories, then the result of the analysis might have been more concrete and reliable in the case of credibility. In addition, the authors conducted an online survey to chemical experts asking their suggestions for tackling the existing chemical management deviation factors and for building up a sustainable chemical management system in Bangladesh tanning industry. But if the survey could be conducted face to face interview, there might have been a possibility to acquire more solid and focused suggestions from the chemical experts. Hence, the above-mentioned areas can be explored by further research.

References

iAuditor by SafetyCulture,. (2023). *Chemical Handling, Storage and Disposal Checklist.* Retrieved from https://public-library.safetyculture.io/products/chemical-safety-inspection: https://public-library.safetyculture.io/products/chemical-safety-inspection

(BIDA), B. I. (February 2021). *Leather & Leather Goods Industries.* Bangladesh Investment Development Authority (BIDA).

A. B. M. Wahid Murad, A. C.-T.-Z. (2016). NONCONVENTIONAL USE OF BASIC CHROMIUM SULPHATE FOR WET BLUE LEATHER PRODUCTION- AN ATTEMPT FOR ABATEMENT OF POLLUTION. *World Journal of Engineering Research and Technology, Volume-2*(Issue-3).

Abul Kashem, R. I. (2022, March 14). *Bangladesh eyes $10b exports in leather goods by 2030.* Retrieved from https://www.tbsnews.net: https://www.tbsnews.net/economy/industry/bangladesh-eyes-10b-exports-leather-goods-2030-384472

assomac. (2023, March 03). *Bangladesh: assiting the tanneries to get the LWG certification.* Retrieved from https://assomac.it: https://assomac.it/en/news/news-from-world/bangladesh-assiting-the-tanneries-to-get-the-lwg-certification/

Bangladesh Labour Law . (2006). *Bangladesh Labour Law 2006*. Dhaka, Bangladesh: BG Press.

Bangladesh Labour Rules. (2015). *Bangladesh Labour Rules 2015*. Dhaka, Bangladesh: BG Press.

BizVibe. (2023). *Global Leather Industry Factsheet 2020: Top 10 Largest Leather Producing Countries, Largest Exporters & Importers.* Retrieved from https://blog.bizvibe.com: https://blog.bizvibe.com/blog/top-10-largest-leather-producing-countries

CCCA. (2014). *National Profile of Chemicals Management in China.* Retrieved from https://cwm.unitar.org: https://cwm.unitar.org/national-profiles/publications/cw/np/np_pdf/China-National-Profile-English-version-finalized-according-to-the-final-Chinese-version-in-Dec-2014.pdf

Chakma, J. (2023, 03 05). *Leather exporters stare at grim prospects in 2023.* Retrieved from https://www.thedailystar.net: https://www.thedailystar.net/business/economy/news/leather-exporters-stare-grim-prospects-2023-3263221

Cheong, F. (2010). PERCEPTIONS OF RISK AND RISK MANAGEMENT IN VIETNAMESE CATFISH FARMING: AN EMPIRICAL STUDY. *Taylor & Francis Online*, Pages 282-314.

Darren George, P. M. (2006). *SPSS for Windows step-by-step: A simple guide and reference.* Boston: Allyn & Bacon.

Dewan Ahsan, M. T. (2020). Perceived Risk and Risk Management Strategies in Pond Aquaculture. *The University of Chicago Press Journals*, Marine Resource Economics, volume 36, number 1.

DIFE. (2023). *Inspection Checklist.* Retrieved from http://dife.gov.bd: http://dife.gov.bd/site/page/d60953be-00d2-4325-9637-f81d5a35f6e3/-

DONALDSON, T. (1995). THE STAKEHOLDER THEORY OF THE CORPORATION: CONCEPTS, EVIDENCE AND IMPLICATION. Vol 20.

Dr Abdur Razzaque, D. M. (2019). *Promoting Decent Work and Acceptable Working Conditions in the Tannery Sector in Bangladesh: Tannery Sector and its Relocation.* Research and Policy Integration for Development (RAPID).

Dr. (Mrs.) Nalini Bhat, D. (. (2009). *TECHNICAL EIA GUIDANCE MANUAL FOR LEATHER/SKIN/HIDE PROCESSING INDUSTRY.*

Dr. L. Sudershan Reddy, P. K. (2019). Performing the KMO and Bartlett's Test for Factors Estimating the Warehouse Efficiency, Inventory and Customer Contentment for E-retail Supply Chain. *International Journal for Research in Engineering Application & Management (IJREAM)*, ISSN : 2454-9150 Vol-05, Issue-09.

Dr. Norbert Reintjes, D. C. (2012). Checklist based on best available techniques in the leather industry. *Federal Environment Agency (Umweltbundesamt)* .

ECOLEBAN. (n.d.). Guidelines on best Sustainable Consumption and Production (SCP) practices for the leather sector in Bangladesh. *Guidelines on best Sustainable Consumption and Production (SCP) practices for the leather sector in Bangladesh*. SWITCHASIA. Retrieved from https://www.switch-asia.eu: https://www.switch-asia.eu/site/assets/files/1663/d1_1-ii_guidelines_on_best_scp_practices_final_version.pdf

Environment Conservation Rules. (2023). *Environment Conservation Rules, 2023*. Dhaka, Bangladesh: BG Press.

FERNANDO, J. (2023, March 7). *What Are Stakeholders: Definition, Types, and Examples.* Retrieved from https://www.investopedia.com: https://www.investopedia.com/terms/s/stakeholder.asp#:~:text=Internal%20stakeholders%20are%20people%20whose,and%20outcomes%20of%20the%20business

Freeman. (2010). *Strategic Management: A Stakeholder Approach.* Cambridge University Press.

George F Patrick, W. N. (1997). Sources of and responses to risk: factor analyses of large-scale US cornbelt farmers. *Risk management strategies in agriculture*.

Google Maps. (2023). Retrieved from https://www.google.com/maps: https://www.google.com/maps/@23.7879279,90.2431381,1133m/data=!3m1!1e3

Handan Akcaoz, H. K. (2009). Risk Management Strategies in Dairy Farming: A Case Study in Turkey. *Journal of Animal and Veterinary Advances*, 8(5): 949-958.

Hira Paul, P. A. (2013). Bangladeshi Leather Industry: An Overview of Recent Sustainable Developments.

Hüseyin Ata Karavana, B. B. (2011). Heavy metal contents of bootee leathers tanned with different process recipes. *Researchgate*.

IFC. (2007). *Environmental, Health, and Safety Guidelines for Tanning and Leather Finishing.* Retrieved from https://documents1.worldbank.org:

https://documents1.worldbank.org/curated/zh/874161491555046600/pdf/114073-WP-ENGLISH-Tanning-and-Leather-Finishing-PUBLIC.pdf

Islam, K. M. (2022, September 8). *Necessity of Leather Working Group Certificate.* Retrieved from https://www.dailytribunal24.com: https://www.dailytribunal24.com/sub-editorial/33119

Islam, K. W. (2022, January 7). *Leather Industry of Bangladesh: Challenges and Opportunities.* Retrieved from https://businessinspection.com.bd: https://businessinspection.com.bd/leather-industry-of-bangladesh/?utm_content=cmp-true

ISO. (2009). *ISO 11014.* Retrieved from http://masflex.com.ph: http://masflex.com.ph/wp-content/uploads/2019/03/Safety-Data-Sheet-International-Standard-ISO-11014.pdf

IULTCS. (2018). *IUE 11 – Occupational Health and Safety in the use of Chemicals in Tanneries.* Retrieved from https://iultcs.org: https://iultcs.org/wp-content/uploads/2020/07/IUE_11.pdf

Josehp F. Hair JR, W. C. (2006). *Multivariate data analysis.* Upper Saddle River, NJ: Pearson Prentice Hall.

Joseph A. Gliem, R. R. (2003). Calculating, Interpreting, and Reporting Cronbach's Alpha Reliability Coefficient for Likert-Type Scales. *2003 Midwest Research to Practice Conference in Adult, Continuing, and Community Education*.

KENTON, W. (2021, August 04). *Durbin Watson Test: What It Is in Statistics, With Examples.* Retrieved from https://www.investopedia.com: https://www.investopedia.com/terms/d/durbin-watson-statistic.asp#:~:text=The%20Durbin%20Watson%20statistic%20is,above%202.0%20indicates%20negative%20autocorrelation.

Khan, M. A. (2023, February 16). *Footwear, leather industries in Bangladesh: A boost to the economy.* Retrieved from https://businesspostbd.com: https://businesspostbd.com/opinion-todays-paper/footwear-leather-industries-in-bangladesh-a-boost-to-the-economy-2023-02-16#:~:text=The%20leather%20and%20leather%20goods,per%20cent%20to%20the%20GDP

Leather industry in Bangladesh. (2023). Retrieved from https://en.wikipedia.org: https://en.wikipedia.org/wiki/Leather_industry_in_Bangladesh

LWG. (2021). *Leather Working Group (LWG).* Retrieved from https://ergasis.files.wordpress.com: https://ergasis.files.wordpress.com/2021/06/audit-7.0.pdf

M M Rahman, M. R. (2022, April). *Health Problems of Bangladeshi Tannery Workers.* Retrieved from https://pubmed.ncbi.nlm.nih.gov: https://pubmed.ncbi.nlm.nih.gov/35383761/

M&S. (2021). *ECP MINIMUM STANDARDS FACTORY SELF-AUDIT: TANNERIES.* Retrieved from https://corporate.marksandspencer.com: https://corporate.marksandspencer.com/sites/marksandspencer/files/marks-spencer/sustainability/our-products/responsible-chemicals-requirement/m-and-s-ecp-minimum-standards-factory-self-audit-for-tanneries-english.pdf

Md Takibur Rahman, R. N. (2021). Perceived Risk and Risk Management Strategies in Pond Aquaculture. *Marine Resource Economics*, 36(1), 43-69.

Mirdha, R. U. (2019, November 04). *Tanners long way off LWG certification.* Retrieved from https://www.thedailystar.net: https://www.thedailystar.net/business/news/tanners-long-way-lwg-certification-1822861

NAPE. (2019). *SAFE USE OF CHEMICALS IN THE TANNERY INDUSTRY IN UGANDA.* NAPE.

OSHA. (2012). *Hazard Communication Standard: Safety Data Sheets.* Retrieved from https://www.osha.gov: https://www.osha.gov/sites/default/files/publications/OSHA3514.pdf

OSHA. (2013). *HAZARD COMMUNICATION.* Retrieved from https://www.osha.gov: https://www.osha.gov/sites/default/files/publications/OSHA3695.pdf

OSHA. (2013). *Hazard Communication Standard: Labels and Pictograms.* Retrieved from https://www.osha.gov: https://www.osha.gov/sites/default/files/publications/OSHA3636.pdf

Pallant, J. F. (2007). SPSS Survival Manual: A Step by Step Guide to Data Analysis Using SPSS for Windows . *ResearchGate*.

R.B.M. Huirne, J. H. (1997). Risk Management Strategies in Agriculture: State of the Art and Future Perspectives. *Mansholt Studies, Wageningen: Wageningen Agricultural University*, 45-53.

Rakib, M. A. (2020). Export Trend of the Leather Industry of Bangladesh: Challenges to Sustainable Development. *Volume 1, Pg: 163-187*.

RAUSAND, M. (2011). *RISK ASSESSMENT: Theory, Methods, and Applications* . Hoboken, New Jersey: Published by John Wiley & Sons, Inc.

Ronald K. Mitchell, B. R. (1997). Toward a Theory of Stakeholder Identification and Salience: Defining the Principle of who and What Really Counts. *JSTOR, Vol. 22*, 853-886.

Shilpy Basak, A. F. (2020). Solid Waste Management in the Leather Sector of Bangladesh. *The Journal of Scientific and Engineering Research (ResearchGate)* , 124-130.

Shrestha, N. (2020). Detecting Multicollinearity in Regression Analysis. *American Journal of Applied Mathematics and Statistics*, 8(2):39-42.

Tanneries and leather products Sub-sectoral Environmental and Social Guidelines. (2009, June). European Bank for Reconstruction and Development.

Terje Aven, O. R. (2009). *Risk Management and Governance.*

The Bangladesh Environment Conservation (Amendment) Act. (2010). *The Bangladesh Environment Conservation (Amendment) Act, 2010*. Dhaka, Bangladesh: BG Press.

UNIDO. (1999). *Occupational Safety and Health Aspects of Leather Manufacture.* UNIDO.

UNIDO. (2021). *Occupational Safety and Health Aspects of Leather Manufacturing.* UNIDO.

West Virginia University. (2023). *West Virginia University Environmental Health and Safety Chemical Safety.* Retrieved from https://www.ehs.wvu.edu/files/d/52d67e3b-33af-46b9-9455-ab4fad5971e2/chemical-safety-checklist.pdf: https://www.ehs.wvu.edu/files/d/52d67e3b-33af-46b9-9455-ab4fad5971e2/chemical-safety-checklist.pdf

Youtube. (2016). *Understanding and Identifying Multicollinearity in Regression using SPSS.* Retrieved from https://www.youtube.com: https://www.youtube.com/watch?v=pZsOn6wnGSo

Youtube. (2019). *SPSS: How to test multicollinearity in SPSS?* Retrieved from https://www.youtube.com: https://www.youtube.com/watch?v=sJfO95sbfBo

YouTube. (2022). *How to check the Multi collinearity and Auto correlation Assumptions in Multiple Regression Analysis.* Retrieved from https://www.youtube.com: https://www.youtube.com/watch?v=_fejur3ap1A

Zwikael, J. R. (2019). *Project Management: A benefit Realisation Approach.* Springer.

Appendix

Appendix I: Questionnaire (80 questions) in Bengali before Piloting

জরিপ প্রশ্নাবলি

বাংলাদেশের সাভারে অবস্থিত ট্যানিং শিল্পে রাসায়নিক ব্যবস্থাপনার বর্তমান অবস্থা পর্যালোচনা করার উদ্দেশ্যে এই জরিপ প্রশ্নাবলি করা হয়েছে।

প্রশ্নপত্রটি বিভিন্ন রাসায়নিক ব্যবস্থাপনা স্ট্যান্ডার্ড, নির্দেশিকা, সর্বোত্তম অনুশীলন যেগুলো বিশ্বব্যাপি অনুসরণ করা হয় তার ভিত্তিতে এবং রাসায়নিক বিশেষজ্ঞদের সাথে পরামর্শ করে তৈরি করা হয়েছে।

কারখানার নামঃ

শ্রমিক/ব্যবস্থাপনা কর্মকর্তার নামঃ

পদবিঃ

বয়সঃ ☐ ১৮-২৪ বছর ☐ ২৫-৩৫ বছর ☐ ৩৬-৫০ বছর ☐ ৫১-৬০ বছর ☐ অন্যান্য

লিঙ্গঃ ☐ পুরুষ ☐ নারী ☐ তৃতীয় লিঙ্গ

শিক্ষাঃ ☐ ১ম-৫ম ☐ ৬ষ্ঠ-১০ম ☐ ৯ম-১০ম ☐ স্নাতক ☐ অন্যান্য

অভিজ্ঞতা (বর্তমান কারখানায়): ☐ ০-২ বছর ☐ ২-৫ বছর ☐ ৫-১০ বছর ☐ ১০ বছরের বেশি

পূর্ববর্তী অভিজ্ঞতা (যদি থাকে): ☐ ট্যানারি ☐ অন্যান্য

কেমিক্যাল সেইফটি সংক্রান্ত প্রশিক্ষণঃ ☐ আছে ☐ নাই

রাসায়নিক আনলোডিং প্রক্রিয়ায় রাসায়নিক ব্যবস্থাপনা সম্পর্কে আপনি কতটুকু সম্মত বা অসম্মত? (প্রশ্নঃ১ - প্রশ্নঃ৫)						
প্রশ্ন নং	**প্রশ্ন**	**কোনভাবেই একমত নই** (১)	**একমত নই** (২)	**নিরপেক্ষ** (৩)	**একমত** (৪)	**সম্পূর্ণ একমত** (৫)
১	কেমিক্যাল কন্টেইনারের ঢাকনা শক্তভাবে লাগানো থাকে।					
২	কেমিক্যাল কন্টেইনারসমূহে কোন ধরণের লিকেজ থাকেনা।					
৩	কেমিক্যালসমূহ সবসময় তাদের মূলপাত্রেই সংরক্ষণ করা হয়।					
৪	কর্মরত শ্রমিক/কর্মচারীগণ কেমিক্যাল আনলোডিং বিষয়ে প্রশিক্ষণপ্রাপ্ত।					
৫	কেমিক্যাল সুপারভাইজারের উপস্থিতিতে আনলোডিং করা হয়।					
রাসায়নিক স্টোরে রাসায়নিক ব্যবস্থাপনা সম্পর্কে আপনি কতটুকু সম্মত বা অসম্মত? (প্রশ্নঃ৬ - প্রশ্নঃ৩৮)						
প্রশ্ন নং	**প্রশ্ন**	**কোনভাবেই একমত নই** (১)	**একমত নই** (২)	**নিরপেক্ষ** (৩)	**একমত** (৪)	**সম্পূর্ণ একমত** (৫)
৬	কেমিক্যাল ইনভেন্টরি সংরক্ষণ করা হয়।					
৭	কেমিক্যাল স্টোরের অনুমোদিত লে-আউট বিদ্যমান।					
৮	লে-আউট অনুযায়ি কেমিক্যালসমূহ স্টোর করা হয়।					

৯	কেমিক্যাল স্টোরের জন্য উপযুক্ত কন্টেইনার ব্যবহার করা হয়।					
১০	কেমিক্যালসমূহের ঝুকির ধরণ (ক্ষয়কারী, দাহ্য) অনুযায়ি আলাদা আলাদাভাবে সংরক্ষণ করা হয়।					
১১	আলদা বৈশিষ্ট্যের কেমিক্যালসমূহ আলাদাভাবে সংরক্ষণ করা হয়।					
১২	কেমিক্যাল স্পিলেজ/লিকেজ ধারণ করার জন্য প্রতিটি কন্টেইনারের নিচে আলাদা ট্রে/পাত্র রাখার ব্যবস্থা আছে।					
১৩	**১ লিটার এর বেশি কেমিক্যাল আছে এমন কন্টেইনার, ১.৫ মিটার উচ্চতার উপরে তাকগুলিতে সংরক্ষণ করা হয়।**					
১৪	**কেমিক্যালসমূহ তাপ এবং সরাসরি সূর্যালোকে সংরক্ষণ করা হয়।**					
১৫	কেমিক্যাল স্টোর সবসময় গোছালোভাবে রাখা হয়।					
১৬	প্রতিটি কেমিক্যাল স্টোরে উপযুক্ত ফিউমহুড এর ব্যবস্থা আছে					
১৭	পর্যাপ্ত বায়ুচলাচল ব্যবস্থা আছে।					
১৮	পর্যাপ্ত আলোর ব্যবস্থা আছে।					
১৯	কেমিক্যাল স্টোরে প্রবেশাধিকার নিষিদ্ধ সংক্রান্ত চিহ্ন/সাইনেজ আছে।					
২০	কেমিক্যাল স্টোরে অননুমোদিত ব্যাক্তির প্রবেশের সীমাবদ্ধতা আছে।					
২১	প্রতিটি কেমিক্যাল কন্টেইনারে লেবেল আছে।					
২২	প্রতিটি কেমিক্যাল এর এমএসডিএস এর উপস্থিতি আছে।					
২৩	কেমিক্যালের এসডিএস শ্রমিকদের নিকট সহজে পাঠযোগ্য।					
২৪	কেমিক্যাল স্পিলেজ পরিষ্কার করা হয় বা অবিলম্বে সুপারভাইজারকে রিপোর্ট করা হয়।					
২৫	পর্যাপ্ত হাত, মুখ ধোয়া এবং পরিষ্কারের সুবিধা আছে।					
২৬	চোখ ধোয়া ও জরুরী প্রয়োজনে গোসলের ব্যবস্থা আছে।					
২৭	কেমিক্যাল বর্জ্যের জন্য উপযুক্ত স্টোরেজ এলাকা বিদ্যমান।					
২৮	কেমিক্যাল স্টোরে পর্যাপ্ত পরিমান ও যথোপযুক্ত অগ্নি-নির্বাপক যন্ত্রের সরবরাহ আছে।					
২৯	সঠিক অগ্নি-নির্বাপণ/দমন এবং অগ্নি-নিরোধক/সুরক্ষা ব্যবস্থা আছে।					
৩০	বর্হিগমন পথ বাধামুক্ত অবস্থায় থাকে।					
৩১	আইলস এ কোন প্রতিবন্ধকতা থাকেনা।					
৩২	বৈদ্যুতিক লাইনসমূহ নিয়মিত চেক করা হয়।					
৩৩	যথোপযুক্ত ইভাকুয়েশন প্ল্যান আছে এবং নিয়মিত ড্রিল করা হয়।					
৩৪	প্রাথমিক চিকিৎসা সরঞ্জাম বিদ্যমান থাকে।					
৩৫	কেমিক্যাল হ্যাজার্ড ও ব্যাবস্থাপনা সম্পর্কে পর্যাপ্ত প্রশিক্ষণ প্রদান করা হয়।					
৩৬	যথোপযুক্ত ব্যক্তিগত সুরক্ষা সরঞ্জাম সরববাহ ও ব্যবহার নিশ্চিত করা হয়।					
৩৭	শ্রমিক-কর্মচারীগণ কেমিক্যাল সম্পর্কিত আইন সম্পর্কে অবগত আছে।					
৩৮	সকল ধরনের দূর্ঘটনার রেকর্ড সংরক্ষণ করা হয়।					

রাসায়নিক স্থানান্তর/বহন প্রক্রিয়ায় রাসায়নিক ব্যবস্থাপনা সম্পর্কে আপনি কতটুকু সম্মত বা অসম্মত? (প্রশ্নঃ৩৯ - প্রশ্নঃ৫০)						
প্রশ্ন নং	**প্রশ্ন**	**কোনভাবেই একমত নই** (১)	**একমত নই** (২)	**নিরপেক্ষ** (৩)	**একমত** (৪)	**সম্পূর্ণ একমত** (৫)
৩৯	স্টোরেজ থেকে কর্মক্ষেত্রে সরবরাহের ক্ষেত্রে লিকেজ হয় এমন কেমিক্যালসমুহ ঘনঘন পরীক্ষা করা হয়।					
৪০	কেমিক্যালসমূহ স্থানান্তরের সময় ঢাকনা মজবুতভাবে লাগানো থাকে।					
৪১	এসিড স্থানান্তরের ক্ষেত্রে পিস্টন পাম্পের ব্যবহার করা হয়।					
৪২	ফ্যাটলিকারিং এর সময় ব্যরেলসমুহ হরিজন্টালি রাখা হয়।					
৪৩	**কেমিক্যালসমুহ সাধারনত ম্যানুয়াল পদ্ধতিতে বহন করা হয়।**					
৪৪	কেমিক্যালসুমূহ সবসময় ট্রলির সাহায্যে স্থানান্তর করা হয়।					
৪৫	**সাধারনত খোলা কন্টেইনারে কেমিক্যাল বহন করা হয়।**					
৪৬	কেমিক্যালসমূহ সবসময় ঢাকনাযুক্ত কন্টেইনারে করে স্থানান্তর করা হয়।					
৪৭	কোন ধরনের কেমিক্যাল স্পিলেজ হলে তা তাতক্ষণিকভাবে পরিষ্কার করা হয় এবং সুপারভাইজারকে অবহিত করা হয়।					
৪৮	কেমিক্যাল স্পিলেজ পরিষ্কার করার জন্য এসওপি বিদ্যামান আছে এবং তা যথাযথভাবে অনুসরণ করা হয়।					
৪৯	কেমিক্যাল স্পিলেজ কিট ব্যবহার করার জন্য কর্মচারীদের প্রশিক্ষণ প্রদান করা হয়।					
৫০	সঠিক পিপিই সরবরাহ করা হয় এবং তার যথাযথ ব্যবহার নিশ্চিত করা হয়।					
রাসায়নিক ডোজিং প্রক্রিয়ায় রাসায়নিক ব্যবস্থাপনা সম্পর্কে আপনি কতটুকু সম্মত বা অসম্মত? (প্রশ্নঃ৫১ - প্রশ্নঃ৬০)						
প্রশ্ন নং	**প্রশ্ন**	**কোনভাবেই একমত নই** (১)	**একমত নই** (২)	**নিরপেক্ষ** (৩)	**একমত** (৪)	**সম্পূর্ণ একমত** (৫)
৫১	**কেমিক্যাল ড্রামে সরাসরি কেমিক্যাল ঢালা হয়।**					
৫২	কারখানায় অটোমেটিক কেমিক্যাল ডোজিং পদ্ধতি বিদ্যমান রয়েছে।					
৫৩	কেমিক্যাল ডোজিং এর সময় উপযুক্ত যন্ত্রপাতি যেমন, স্পুন, স্ক্যাপুলা, কাপ ব্যবহার করা হয়।					
৫৪	**বিভিন্ন ধরণের কেমিক্যাল মিশানোর জন্য একই স্পুন, স্ক্যাপুলা ব্যবহার করা হয়।**					
৫৫	ড্রামে ম্যানুয়ালি কেমিক্যাল ডোজিং এর সময় ইঞ্জিনিয়ারিং পদ্ধতি যেমন ড্রামের সাথে একটা ফানেল তৈরি করা হয় যাতে সহজে কেমিক্যাল ড্রামে ঢালা যায়।					
৫৬	সব ধরনের কেমিক্যাল স্পিলেজ পরিষ্কার করা হয় এবং তা সুপারভাইজরকে অবহিত করা হয়।					
৫৭	কেমিক্যাল মিক্সিং ও ডোজিং এর সময় উপুযুক্ত ব্যক্তিগত সুরক্ষা সরঞ্জাম যেমন- হ্যান্ড গ্লাভস, গগলস, রেস্পাইরেটরি মাস্ক, এপ্রোন,বুট এর ব্যবহার নিশ্চিত করা হয়।					
৫৮	কেমিক্যাল ডোজিং এর স্থানে হাত ও মুখ ধোঁয়ার জন্য ওয়াশিং এবং জীবানুনাষক সাবান এর ব্যবস্থা করা হয়।					

৫৯	শ্রমিক/ কর্মচারীদের কেমিক্যাল ডোজিং সংক্রান্ত প্রশিক্ষণ প্রদান করা হয়।					
৬০	কেমিক্যাল ডোজিং এর সময় সুপারভাইজার উপস্থিত থাকে।					

রাসায়নিক ডিস্পোজিং প্রক্রিয়ায় রাসায়নিক ব্যবস্থাপনা সম্পর্কে আপনি কতটুকু সম্মত বা অসম্মত? (প্রশ্নঃ৬১ - প্রশ্নঃ৭১)						
প্রশ্ন নং	**প্রশ্ন**	**কোনভাবেই একমত নই (১)**	**একমত নই (২)**	**নিরপেক্ষ (৩)**	**একমত (৪)**	**সম্পূর্ণ একমত (৫)**
৬১	**কর্মক্ষেত্রে খালি কেমিক্যাল কন্টেইনার রেখে দেওয়া হয়।**					
৬২	কেমিক্যাল এর খালি কন্টেইনার রাখার জন্য আলাদা জায়গার ব্যবস্থা করা আছে।					
৬৩	ডিস্পোজিং করার পূর্বে কন্টেইনারগুলো ওয়াশ করা হয়।					
৬৪	**কেমিক্যাল বর্জ্যগুলো (তরল) সরাসরি কারখানার বাহিরে নিস্কাশন করা হয়।**					
৬৫	কারখানায় কেমিক্যাল এর তরল বর্জ্য পরিশোধনের জন্য ইটিপি এর ব্যবস্থা রয়েছে।					
৬৬	**সকল ধরনের বর্জ্য (সলিড ও লিকুইড) একই কন্টেইনারে রাখা হয়।**					
৬৭	কেমিক্যাল এর তরল বর্জ্য রাখার জন্য আলাদা সিংক এর ব্যবস্থা রয়েছে এবং তা মার্কিং করা আছে।					
৬৮	এসডিএস অনুযায়ি কেমিক্যাল বর্জ্য ব্যবস্থাপনার পদ্ধতি রয়েছে।					
৬৯	বিদ্যমান আইন অনুযায়ি কেমিক্যাল বর্জ্য ব্যবস্থাপনা করার ব্যবস্থা রয়েছে।					
৭০	**খালি কেমিক্যাল কন্টেইনারগুলো পানি পান করার পাত্র হিসেবে ব্যবহৃত হয়।**					
৭১	শ্রমিক/ কর্মচারীদের কেমিক্যাল বর্জ্য ডিস্পোজাল সংক্রান্ত প্রশিক্ষণ প্রদান করা হয়।					

LWG ধারা-১৬ ভিত্তিক প্রশ্নাবলি

তৃতীয় পক্ষের সার্টিফিকেশনের উপর ভিত্তি করে সাধারণ প্রশ্নাবলী (LWG স্ট্যান্ডার্ড)						
প্রশ্ন নং	**প্রশ্ন**	**কোনভাবেই একমত নই (১)**	**একমত নই (২)**	**নিরপেক্ষ (৩)**	**একমত (৪)**	**সম্পূর্ণ একমত (৫)**
৭২	কারখানায় একটি রাসায়নিক সিস্টেম বা ব্যবস্থাপনা পদ্ধতি অনুসরণ করা হয়।					
৭৩	ম্যানেজমেন্ট সিস্টেম বা পদ্ধতিতে রাসায়নিক ব্যবস্থাপনার জন্য দায়িত্বপূর্ণ ব্যক্তির নাম, পদবি এবং যোগ্যতা সম্পর্কে স্পষ্টভাবে বলা আছে।					
৭৪	রাসায়নিক ব্যবস্থাপনার জন্য কারখানায় দায়িত্বশীল ব্যক্তি রয়েছে।					

৭৫	রাসায়নিক ব্যবস্থাপনার জন্য দায়িত্বশীল ব্যক্তির অভিজ্ঞতা স্পষ্টভাবে নির্দেশিত আছে।					
৭৬	রাসায়নিক ব্যবস্থাপনার জন্য দায়িত্বশীল ব্যক্তির শিক্ষাগত যোগ্যতা শর্ত অনুযায়ি আছে (রসায়ন ভিত্তিক ডিসিপ্লিন থেকে স্নাতক) ।					
৭৭	স্বাভাবিক কাজের সময় যেসব পদ্ধতি অনুসরণ করতে হবে সেই পদ্ধতিগুলি স্পষ্টভাবে উল্লেখ আছে।					
৭৮	জরুরী ইভেন্টের সময় (যেমন উল্লেখযোগ্য স্পিলেজ) যেসব পদ্ধতি অনুসরণ করতে হবে সেই পদ্ধতিগুলি স্পষ্টভাবে উল্লেখ আছে।					
৭৯	কারখানায় একটি রেজিস্টার (যেমন, স্প্রেডশীট) রক্ষণাবেক্ষণ করা হয় যেখানে ক্লায়েন্ট এর এমআরএসএল প্রয়োজনীয়তার সাথে সম্মতি সংক্রান্ত রেকর্ড থাকে।					
৮০	কারখানায় আগত রাসায়নিকের প্রকৃত অনুপাত (ভর দিয়ে) সেইসব কোম্পানিগুলি থেকে প্রাপ্ত হয় যেগুলি এমআরএসএল-এর সাথে কমপ্লায়েন্স হিসেবে নথিভুক্ত করা হয়েছে।					

Appendix II: Final Questionnaire (50 questions) in Bengali

জরিপ প্রশ্নাবলি

বাংলাদেশের সাভারে অবস্থিত ট্যানিং শিল্পে রাসায়নিক ব্যবস্থাপনার বর্তমান অবস্থা পর্যালোচনা করার উদ্দেশ্যে এই জরিপ প্রশ্নাবলি করা হয়েছে।

প্রশ্নপত্রটি বিভিন্ন রাসায়নিক ব্যবস্থাপনা স্ট্যান্ডার্ড, নির্দেশিকা, সর্বোত্তম অনুশীলন যেগুলো বিশ্বব্যাপি অনুসরণ করা হয় তার ভিত্তিতে এবং রাসায়নিক বিশেষজ্ঞদের সাথে পরামর্শ করে তৈরি করা হয়েছে।

কারখানার নামঃ

শ্রমিক/ব্যবস্থাপনা কর্মকর্তার নামঃ

পদবিঃ

বয়সঃ ☐ ১৮-২৪ বছর ☐ ২৫-৩৫ বছর ☐ ৩৬-৫০ বছর ☐ ৫১-৬০ বছর ☐ অন্যান্য

লিঙ্গঃ ☐ পুরুষ ☐ নারী ☐ তৃতীয় লিঙ্গ

শিক্ষাঃ ☐ ১ম-৫ম ☐ ৬ষ্ঠ-১০ম ☐ ৯ম-১০ম ☐ স্নাতক ☐ অন্যান্য

অভিজ্ঞতা (বর্তমান কারখানায়): ☐ ০-২ বছর ☐ ২-৫ বছর ☐ ৫-১০ বছর ☐ ১০ বছরের বেশি

পূর্ববর্তী অভিজ্ঞতা (যদি থাকে): ☐ ট্যানারি ☐ অন্যান্য

কেমিক্যাল সেইফটি সংক্রান্ত প্রশিক্ষণঃ ☐ আছে ☐ নাই

রাসায়নিক আনলোডিং প্রক্রিয়ায় রাসায়নিক ব্যবস্থাপনা সম্পর্কে আপনি কতটুকু সম্মত বা অসম্মত? (প্রশ্নঃ১ - প্রশ্নঃ৫)						
প্রশ্ন নং	**প্রশ্ন**	**কোনভাবেই একমত নই** (১)	**একমত নই** (২)	**নিরপেক্ষ** (৩)	**একমত** (৪)	**সম্পূর্ণ একমত** (৫)
১	কেমিক্যাল কন্টেইনারের ঢাকনা শক্তভাবে লাগানো থাকে।					
২	কেমিক্যাল কন্টেইনারসমূহে কোন ধরণের লিকেজ থাকেনা।					
৩	কেমিক্যালসমূহ সবসময় তাদের মূলপাত্রেই সংরক্ষণ করা হয়।					
৪	কর্মরত শ্রমিক/কর্মচারীগণ কেমিক্যাল আনলোডিং বিষয়ে প্রশিক্ষণপ্রাপ্ত।					
৫	কেমিক্যাল সুপারভাইজারের উপস্থিতিতে আনলোডিং করা হয়।					
রাসায়নিক স্টোরে রাসায়নিক ব্যবস্থাপনা সম্পর্কে আপনি কতটুকু সম্মত বা অসম্মত? (প্রশ্নঃ৬ - প্রশ্নঃ৩৮)						
প্রশ্ন নং	**প্রশ্ন**	**কোনভাবেই একমত নই** (১)	**একমত নই** (২)	**নিরপেক্ষ** (৩)	**একমত** (৪)	**সম্পূর্ণ একমত** (৫)
৬	কেমিক্যাল ইনভেন্টরি সংরক্ষণ করা হয়।					
৭	লে-আউট অনুযায়ি কেমিক্যালসমূহ স্টোর করা হয়।					
৮	কেমিক্যালসমূহের ঝুকির ধরণ (ক্ষয়কারী, দাহ্য) অনুযায়ি আলাদা আলাদাভাবে সংরক্ষণ করা হয়।					

৯	কেমিক্যাল স্পিলেজ/লিকেজ ধারণ করার জন্য প্রতিটি কন্টেইনারের নিচে আলাদা ট্রে/পাত্র রাখার ব্যবস্থা আছে।					
১০	**১ লিটার এর বেশি কেমিক্যাল আছে এমন কন্টেইনার, ১.৫ মিটার উচ্চতার উপরে তাকগুলিতে সংরক্ষণ করা হয়।**					
১১	**কেমিক্যালসমূহ তাপ এবং সরাসরি সূর্যালোকে সংরক্ষণ করা হয়।**					
১২	প্রতিটি কেমিক্যাল স্টোরে উপযুক্ত ফিউমহুড এর ব্যবস্থা আছে					
১৩	পর্যাপ্ত বায়ুচলাচল ও আলোর ব্যবস্থা আছে।					
১৪	কেমিক্যাল স্টোরে প্রবেশাধিকার নিষিদ্ধ সংক্রান্ত চিহ্ন/সাইনেজ ও অননুমোদিত ব্যাক্তির প্রবেশের সীমাবদ্ধতা আছে।					
১৫	প্রতিটি কেমিক্যাল এর এমএসডিএস এর উপস্থিতি আছে।					
১৬	কেমিক্যালের এসডিএস শ্রমিকদের নিকট সহজে পাঠযোগ্য।					
১৭	কেমিক্যাল স্পিলেজ পরিষ্কার করা হয় বা অবিলম্বে সুপারভাইজারকে রিপোর্ট করা হয়।					
১৮	পর্যাপ্ত হাত, মুখ ধোয়া এবং পরিষ্কারের সুবিধা আছে।					
১৯	কেমিক্যাল স্টোরে পর্যাপ্ত পরিমান ও যথোপযুক্ত অগ্নি-নির্বাপক যন্ত্রের সরবরাহ আছে।					
২০	সঠিক অগ্নি-নির্বাপণ/দমন এবং অগ্নি-নিরোধক/সুরক্ষা ব্যবস্থা আছে।					
২১	আইলস এ কোন প্রতিবন্ধকতা থাকেনা।					
২২	বৈদ্যুতিক লাইনসমূহ নিয়মিত চেক করা হয়।					
২৩	যথোপযুক্ত ইভাকুয়েশন প্ল্যান আছে এবং নিয়মিত ড্রিল করা হয়।					
২৪	প্রাথমিক চিকিৎসা সরঞ্জাম বিদ্যমান থাকে।					
২৫	কেমিক্যাল হ্যাজার্ড ও ব্যাবস্থাপনা সম্পর্কে পর্যাপ্ত প্রশিক্ষণ প্রদান করা হয়।					
২৬	যথোপযুক্ত ব্যক্তিগত সুরক্ষা সরঞ্জাম সরববাহ ও ব্যবহার নিশ্চিত করা হয়।					
২৭	শ্রমিক-কর্মচারীগণ কেমিক্যাল সম্পর্কিত আইন সম্পর্কে অবগত আছে।					
২৮	সকল ধরনের দূর্ঘটনার রেকর্ড সংরক্ষণ করা হয়।					

রাসায়নিক স্থানান্তর/বহন প্রক্রিয়ায় রাসায়নিক ব্যবস্থাপনা সম্পর্কে আপনি কতটুকু সম্মত বা অসম্মত? (প্রশ্নঃ৩৯ - প্রশ্নঃ৫০)

প্রশ্ন নং	প্রশ্ন	কোনভাবেই একমত নই (১)	একমত নই (২)	নিরপেক্ষ (৩)	একমত (৪)	সম্পূর্ণ একমত (৫)
২৯	এসিড স্থানান্তরের ক্ষেত্রে পিস্টন পাম্পের ব্যবহার করা হয়।					
৩০	**কেমিক্যালসমূহ সাধারনত ম্যানুয়াল পদ্ধতিতে বহন করা হয়।**					
৩১	কেমিক্যালসমূহ সবসময় ঢাকনাযুক্ত কন্টেইনারে করে স্থানান্তর করা হয়।					
৩২	কেমিক্যাল স্পিলেজ কিট ব্যবহার করার জন্য কর্মচারীদের প্রশিক্ষণ প্রদান করা হয়।					

রাসায়নিক ডোজিং প্রক্রিয়ায় রাসায়নিক ব্যবস্থাপনা সম্পর্কে আপনি কতটুকু সম্মত বা অসম্মত? (প্রশ্নঃ৫১ - প্রশ্নঃ৬০)						
প্রশ্ন নং	**প্রশ্ন**	**কোনভাবেই একমত নই** (১)	**একমত নই** (২)	**নিরপেক্ষ** (৩)	**একমত** (৪)	**সম্পূর্ণ একমত** (৫)
৩৩	কারখানায় অটোমেটিক কেমিক্যাল ডোজিং পদ্ধতি বিদ্যমান রয়েছে।					
৩৪	কেমিক্যাল ডোজিং এর সময় উপযুক্ত যন্ত্রপাতি যেমন, স্পুন, স্ক্যাপুলা, কাপ ব্যবহার করা হয়।					
৩৫	ড্রামে ম্যানুয়ালি কেমিক্যাল ডোজিং এর সময় ইঞ্জিনিয়ারিং পদ্ধতি যেমন ড্রামের সাথে একটা ফানেল তৈরি করা হয় যাতে সহজে কেমিক্যাল ড্রামে ঢালা যায়।					
৩৬	কেমিক্যাল মিক্সিং ও ডোজিং এর সময় উপযুক্ত ব্যক্তিগত সুরক্ষা সরঞ্জাম যেমন- হ্যান্ড গ্লাভস, গগলস, রেস্পাইরেটরি মাস্ক, এপ্রোন,বুট এর ব্যবহার নিশ্চিত করা হয়।					
৩৭	কেমিক্যাল ডোজিং এর সময় সুপারভাইজার উপস্থিত থাকে।					
রাসায়নিক ডিস্পোজিং প্রক্রিয়ায় রাসায়নিক ব্যবস্থাপনা সম্পর্কে আপনি কতটুকু সম্মত বা অসম্মত? (প্রশ্নঃ৬১ - প্রশ্নঃ৭১)						
প্রশ্ন নং	**প্রশ্ন**	**কোনভাবেই একমত নই** (১)	**একমত নই** (২)	**নিরপেক্ষ** (৩)	**একমত** (৪)	**সম্পূর্ণ একমত** (৫)
৩৮	কেমিক্যাল এর খালি কন্টেইনার রাখার জন্য আলাদা জায়গার ব্যবস্থা করা আছে।					
৩৯	ডিস্পোজিং করার পূর্বে কন্টেইনারগুলো ওয়াশ করা হয়।					
৪০	কারখানায় কেমিক্যাল এর তরল বর্জ্য পরিশোধনের জন্য ইটিপি এর ব্যবস্থা রয়েছে।					
৪১	কেমিক্যাল এর তরল বর্জ্য রাখার জন্য আলাদা সিংক এর ব্যবস্থা রয়েছে এবং তা মার্কিং করা আছে।					
৪২	বিদ্যমান আইন অনুযায়ি কেমিক্যাল বর্জ্য ব্যবস্থাপনা করার ব্যবস্থা রয়েছে।					

LWG ধারা-১৬ ভিত্তিক প্রশ্নাবলি

তৃতীয় পক্ষের সার্টিফিকেশনের উপর ভিত্তি করে সাধারণ প্রশ্নাবলী (LWG স্ট্যান্ডার্ড)						
প্রশ্ন নং	**প্রশ্ন**	**কোনভাবেই একমত নই** (১)	**একমত নই** (২)	**নিরপেক্ষ** (৩)	**একমত** (৪)	**সম্পূর্ণ একমত** (৫)
৪৩	কারখানায় একটি রাসায়নিক সিস্টেম বা ব্যবস্থাপনা পদ্ধতি অনুসরণ করা হয় এবং রাসায়নিক ব্যবস্থাপনার জন্য কারখানায় দায়িত্বশীল ব্যক্তি রয়েছে।					

৪৪	ম্যানেজমেন্ট সিস্টেম বা পদ্ধতিতে রাসায়নিক ব্যবস্থাপনার জন্য দায়িত্বপূর্ণ ব্যক্তির নাম, পদবি এবং যোগ্যতা সম্পর্কে স্পষ্টভাবে বলা আছে।					
৪৫	রাসায়নিক ব্যবস্থাপনার জন্য দায়িত্বশীল ব্যক্তির অভিজ্ঞতা স্পষ্টভাবে নির্দেশিত আছে।					
৪৬	রাসায়নিক ব্যবস্থাপনার জন্য দায়িত্বশীল ব্যক্তির শিক্ষাগত যোগ্যতা শর্ত অনুযায়ি আছে (রসায়ন ভিত্তিক ডিসিপ্লিন থেকে স্নাতক) ।					
৪৭	স্বাভাবিক কাজের সময় যেসব পদ্ধতি অনুসরণ করতে হবে সেই পদ্ধতিগুলি স্পষ্টভাবে উল্লেখ আছে।					
৪৮	জরুরী ইভেন্টের সময় (যেমন উল্লেখযোগ্য স্পিলেজ) যেসব পদ্ধতি অনুসরণ করতে হবে সেই পদ্ধতিগুলি স্পষ্টভাবে উল্লেখ আছে।					
৪৯	কারখানায় একটি রেজিস্টার (যেমন, স্প্রেডশীট) রক্ষণাবেক্ষণ করা হয় যেখানে ক্লায়েন্ট এর এমআরএসএল প্রয়োজনীয়তার সাথে সম্মতি সংক্রান্ত রেকর্ড থাকে।					
৫০	কারখানায় আগত রাসায়নিকের প্রকৃত অনুপাত (ভর দিয়ে) সেইসব কোম্পানিগুলি থেকে প্রাপ্ত হয় যেগুলি এমআরএসএল-এর সাথে কমপ্লায়েন্স হিসেবে নথিভুক্ত করা হয়েছে।					

Appendix III: Final Questionnaire (50 questions) in English

Survey Questionnaire

The survey questionnaire is being conducted for the purposes of reviewing the current status of chemical management in tanning industry, Savar, Bangladesh.

The questionnaire has been developed taking knowledge from different chemical management standards, guidelines, best practices that are followed worldwide and consulting with chemical experts.

Factory Name:

Worker/Managerial Officer Name:

Designation:

Age: ☐ 18-24 Years ☐ 25-35 Years ☐ 36-50 Years ☐ 51-60 Years ☐ Others

Gender: ☐ Male ☐ Female ☐ Transgender

Education: ☐ i-v ☐ vi-x ☐ xi-xii ☐ Graduate ☐ Otheres

Experience (Current Factory): ☐ 0-2 Years ☐ 2-5 Years ☐ 5-10 Years ☐ Above 10 Years

Previous Experience (If Any): ☐ Tannery ☐ Others

Training on Chemical Safety: ☐ Yes ☐ No

To what extent do you agree or disagree in chemical unloading process?(Q1-Q5)						
Q. No.	**Questions**	**Strongly Disagree (1)**	**Disagree (2)**	**Neutral (3)**	**Agree (4)**	**Strongly Agree (5)**
1	Chemical containers lids are tightly sealed while unloading from vehicle					
2	Packaging and containers are free from leakage					
3	Chemical substances are held in their original containers					
4	Employees are trained about chemical unloading					
5	Unloading is done in presence of chemical supervisor					
To what extent do you agree or disagree in chemical storage? (Q6 - Q38)						
Q. No.	**Questions**	**Strongly Disagree (1)**	**Disagree (2)**	**Neutral (3)**	**Agree (4)**	**Strongly Agree (5)**
6	Chemical inventory is maintained					

7	Chemicals are stored according to layout					
8	Chemicals are grouped according to their hazard category (corrosives, flammables, etc.)					
9	Secondary containment or trays are used to contain leaks or spills of chemicals					
10	**Chemicals in container over 1L, are stored on shelves above 1.5m in height**					
11	**Chemicals are stored in heat and direct sunlight**					
12	Proper fume hood installed					
13	Adequate light and ventilation system available					
14	Availability of access prohibiting signage and unauthorized access restriction					
15	Presence of MSDS of each chemical					
16	SDS is easily readable to employees					
17	Chemical spillage is cleaned up or reported immediately to the supervisor					
18	Enough washing and cleaning facilities					
19	Availability of appropriate fire extinguisher					
20	Proper fire suppression and protection system					
21	No obstacles in aisles					
22	Regular checking of electric lines					
23	Proper evacuation plan and drill regularly					
24	Availability of first-aid facilities					
25	Adequate training on chemical hazards and management					
26	Provide appropriate PPE and using properly					
27	Employees are Familiar with chemical related legislations, standards and guidelines					
28	Keep records of accidents and incidents					

To what extent do you agree or disagree in chemical Transfer/Carrying process? (Q39 – Q50)

Q. No.	Questions	Strongly Disagree (1)	Disagree (2)	Neutral (3)	Agree (4)	Strongly Agree (5)
29	While transferring acids, hand piston pumps are used					
30	**Chemicals are being carried manually**					
31	Chemicals are being carried in closed containers					

32	For using of spill kits training is provided					

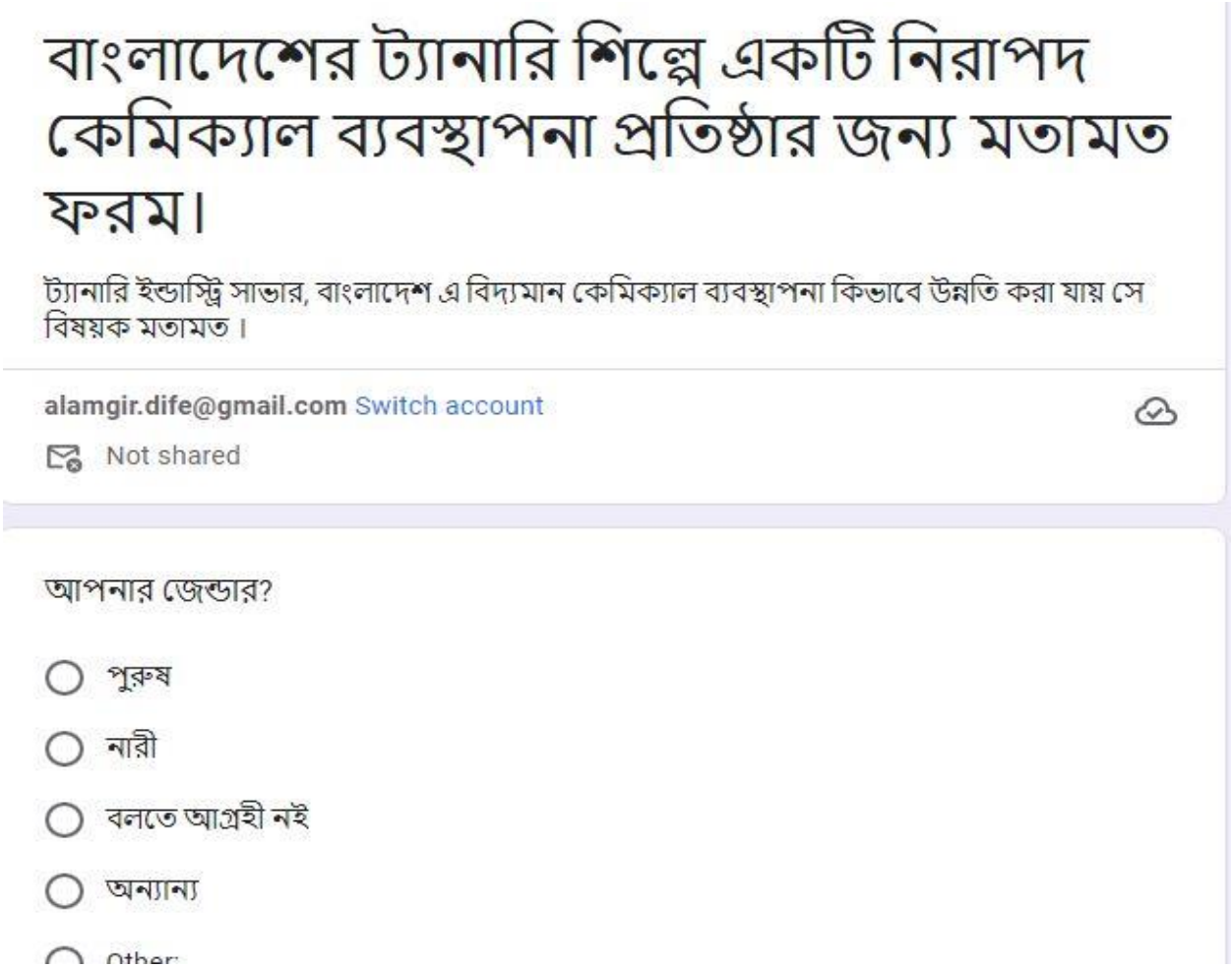
To what extent do you agree or disagree in chemical dosing process? (Q51 – Q60)						
Q. No.	**Questions**	**Strongly Disagree (1)**	**Disagree (2)**	**Neutral (3)**	**Agree (4)**	**Strongly Agree (5)**
33	Availability of automatic dosing systems					
34	During chemical dosing appropriate tools for instance: scoops, spatulas and measuring cups are used					
35	While pouring chemicals to drums or pits engineering controls such as mounting a fixed funnel or IBC tank with drum axle are applied					
36	Wearing proper PPE (respiratory masks, safety googles, gloves, boots)					
37	Presence of chemical supervisor is ensured during chemical dosing					

To what extent do you agree or disagree in chemical disposal process? (Q61 – Q71)						
Q. No.	**Questions**	**Strongly Disagree (1)**	**Disagree (2)**	**Neutral (3)**	**Agree (4)**	**Strongly Agree (5)**
38	Empty chemical containers are stored in a designated area					
39	Before disposing containers are washed					
40	Chemical waste water is sent to Effluent Treatment Plant (ETP)					
41	Availability of dedicated sink for liquid chemical waste					
42	Disposal of waste chemicals are done according to local laws and regulations					

LWG Clause-16 based questionnaire

General questionnaire based on third party certification (LWG standard)						
Q. No.	**Questions**	**Strongly Disagree (1)**	**Disagree (2)**	**Neutral (3)**	**Agree (4)**	**Strongly Agree (5)**
43	A chemical management system has been followed in the factory and responsible individual available for chemical management					
44	The management system or procedure clearly stated about the name, position and qualification of the responsible individual for chemical management					
45	The experience of the responsible individual for chemical management are clearly indicated					
46	The educational qualification of the responsible person for chemical management is met. (Graduate from chemistry-oriented discipline)					
47	The procedures to be followed during normal working conditions are clearly stated					
48	The procedures to be followed during emergency events (such as significant spillages) are clearly stated.					
49	The factory maintains a register (e.g., spreadsheet) that records the compliance against client MRSL requirements.					
50	The actual proportion of the factory's incoming chemicals (by mass) is obtained from companies that have been documented compliance to MRSL					

Appendix IV: Bengali Questionnaire in Google Form for Online Survey



বাংলাদেশের ট্যানারি শিল্পে একটি নিরাপদ কেমিক্যাল ব্যবস্থাপনা প্রতিষ্ঠার জন্য মতামত ফরম।

ট্যানারি ইন্ডাস্ট্রি সাভার, বাংলাদেশ এ বিদ্যমান কেমিক্যাল ব্যবস্থাপনা কিভাবে উন্নতি করা যায় সে বিষয়ক মতামত।

alamgir.dife@gmail.com Switch account

Not shared

আপনার জেন্ডার?

- পুরুষ
- নারী
- বলতে আগ্রহী নই
- অন্যান্য
- Other:

আপনার বয়স?

- ১৮-২৫ বছর
- ২৬- ৪০ বছর
- ৪১- ৬০ বছর
- অন্যান্য
- Other: _____

আপনার কলেজ/বিশ্ববিদ্যালয়ের শিক্ষার মেজর বিষয়?

- কেমিক্যাল বিষয়ক
- গনিত
- সামাজিক বিজ্ঞান
- অন্যান্য
- Other: _____

আপনার কর্মক্ষেত্র (অনুগ্রহ করে কর্মক্ষেত্রের নাম লিখুন)

Your answer

অভিজ্ঞতা (বছর), দয়া করে সংখ্যায় লিখুন।

Your answer

ট্যানারিতে কেমিক্যাল ব্যবস্থাপনা উন্নতির জন্য সম্মতি/অসম্মতি স্কেলে(১ থেকে ৫ স্কেল, যেখানে ১= কোনভাবেই একমত নই, ৫= পুরোপুরি একমত), নিম্নলিখিত বিষয়সমূহের উপর আপনি কতটুকু সম্মত বা অসম্মত।

	১	২	৩	৪	৫
বাংলাদেশে বিদ্যমান কেমিক্যাল ব্যবস্থাপনা বিষয়ক আইন/নীতিমালা/ স্ট্যান্ডার্ড এর অভাব রয়েছে।	○	○	○	○	○
ট্যানারি কেমিক্যাল ব্যবস্থাপনার জন্য স্বতন্ত্র আইন প্রনয়ন ও নীতিমালার প্রয়োজন রয়েছে।	○	○	○	○	○
ট্যানারি কেমিক্যাল ব্যবস্থাপনার জন্য বাংলাদেশ সরকারি নজরদারি ও তদারকি বাড়ানো দরকার।	○	○	○	○	○

ট্যানারিতে কেমিক্যাল ব্যবস্থাপনা পদ্ধতি থাকতে হবে।	○	○	○	○	○
কেমিক্যাল ব্যবস্থাপনা পদ্ধতি তদারকির জন্য রাসায়নিক জ্ঞাণসম্পূর্ণ ব্যবস্থাপক/ সুপারভাইজার থাকতে হবে।	○	○	○	○	○
নির্দিষ্ট সময় পর পর কেমিক্যাল ঝুঁকি (রিস্ক) নিরুপণ করতে হবে।	○	○	○	○	○
কর্মরত সকল শ্রমিক/কর্মচারি/ কর্মকর্তাকে কেমিক্যাল ঝুঁকি সংক্রান্ত পর্যাপ্ত প্রশিক্ষণ প্রদান করতে হবে।	○	○	○	○	○

বাংলাদেশ শ্রম আইন ২০০৬ অনুযায়ি প্রযোজ্য ক্ষেত্রে কারখানায় সেইফটি কমিটি গঠন করতে হবে।	○	○	○	○	○
কারখানায় কেমিক্যাল ঝুঁকি প্রতিরোধ/ প্রতিকারের জন্য শ্রমিক এবং উপরস্ত কর্মকর্তাগণের মধ্যে সমন্বয়ের ব্যবস্থা থাকতে হবে।	○	○	○	○	○
জরুরি ক্ষেত্রে কেমিক্যাল ঝুঁকি বিষয়ে তাৎক্ষনিকভাবে কারখানার ব্যবস্থাপক/ সুপাভাইজারকে অভহিত করতে হবে।	○	○	○	○	○

কোন ধরনের কেমিক্যাল ঝুঁকি (তা যত ছোট হোক না কেন) অবহেলা করর মানসিকতা পরিহার করতে হবে।	○	○	○	○	○
কারখানায় কেমিক্যাল বহনকারী কন্টেইনার আনলোড করার ক্ষেত্রে কন্টেইনারের ঢাকনা মজবুতভাবে লাগানো আছে কিনা তা নিশ্চিত হতে হবে।	○	○	○	○	○
কারখানায় ব্যবহারকৃত কেমিক্যালের ইনভেন্টরি ব্যবস্থা থাকতে হবে।	○	○	○	○	○
কেমিক্যাল স্টোর এর অনুমোদিত লে-আউট থাকতে হবে।	○	○	○	○	○

অনুমোদিত লে-আউট অনুযায়ি কেমিক্যাল সংরক্ষণ করতে হবে।	○	○	○	○	○
কেমিক্যালসমূহের ঝুকির ধরণ অনুযায়ি আলাদা আলাদাভাবে সংরক্ষণ করতে হবে।	○	○	○	○	○
কেমিক্যাল স্পিলেজ/লিকেজ ধারণ করার জন্য প্রতিটি কন্টেইনারের নিচে আলাদা ট্রে/পাত্র রাখার ব্যবস্থা করতে হবে।	○	○	○	○	○
প্রতিটি কেমিক্যাল স্টোরে উপযুক্ত ফিউমহুড এর ব্যবস্থা নিশ্চিত করতে হবে।	○	○	○	○	○

কেমিক্যাল স্টোর সবসময় গোছালোভাবে রাখতে হবে।	○	○	○	○	○
কেমিক্যাল স্টোরে পর্যাপ্ত পরিমান আলো-বাতাস এর ব্যবস্থা রাখতে হবে।	○	○	○	○	○
প্রতিটি কেমিক্যাল কন্টেইনারে লেবেল আছে কিনা তা নিশ্চিত হতে হবে।	○	○	○	○	○
প্রতিটি কেমিক্যাল এর এমএসডিএস এর উপস্থিতি নিশ্চিত হতে হবে।	○	○	○	○	○
ট্যানারিতে নিরাপদ কেমিক্যাল ব্যবস্থাপনার জন্য মালিকদের আরো অধিক মনোযোগি হওয়া দরকার।	○	○	○	○	○

বিদ্যমান কেমিক্যাল ব্যবস্থাপনার উন্নয়নের জন্য শ্রমিকদের/শ্রমিক সংগঠনের আরো জোরালো ভূমিকা থাকা জরুরী।	○	○	○	○	○
বিদ্যমান কেমিক্যাল ব্যবস্থাপনা উন্নয়নের জন্য ক্রেতা (বায়ারদের) সহযোগিতা বাড়ানো প্রয়োজন।	○	○	○	○	○
কেমিক্যাল ব্যবস্থাপনা নিয়ে কাজ করে এমন সরকারি সংস্থাগুলোর মধ্যে সমন্বয় সাধন অতীব জরুরী।	○	○	○	○	○

কমপ্লায়েন্স সার্টিফিকেট এর জন্য বায়ারদের চাহিদার পাশাপাশি কেমিক্যাল ব্যবস্থাপনার অন্যান্য দিকগুলোর(যেমন- কেমিক্যাল স্টোর, আনলোডিং, ট্রান্সফার, মক্সিং, ডোসিং) উপর নজর দেওয়া জরুরী।	○	○	○	○	○
সর্বোপরি ট্যানারিতে একটি সুষ্ঠ ও নিরাপদ কেমিক্যাল ব্যবস্থাপনা প্রতিষ্ঠার জন্য শ্রমিক, মালিক ও সরকারের মধ্যে সমন্বয় বাড়ানো দরকার।	○	○	○	○	○

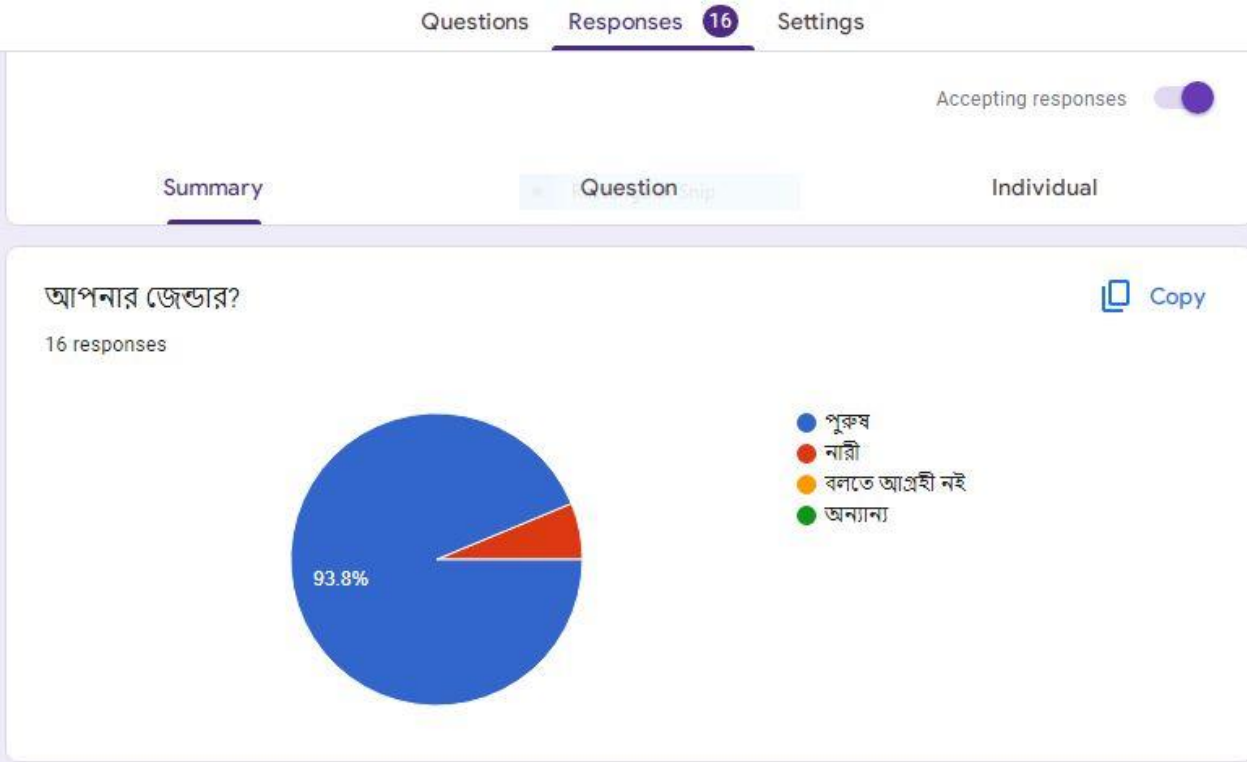
উপরোক্ত বিষয়সমূহ ছাড়াও আপনি যদি কোন মন্তব্য করতে চান দয়া করে নীচে আপনার পরামর্শ/মন্তব্য প্রদান করুন।

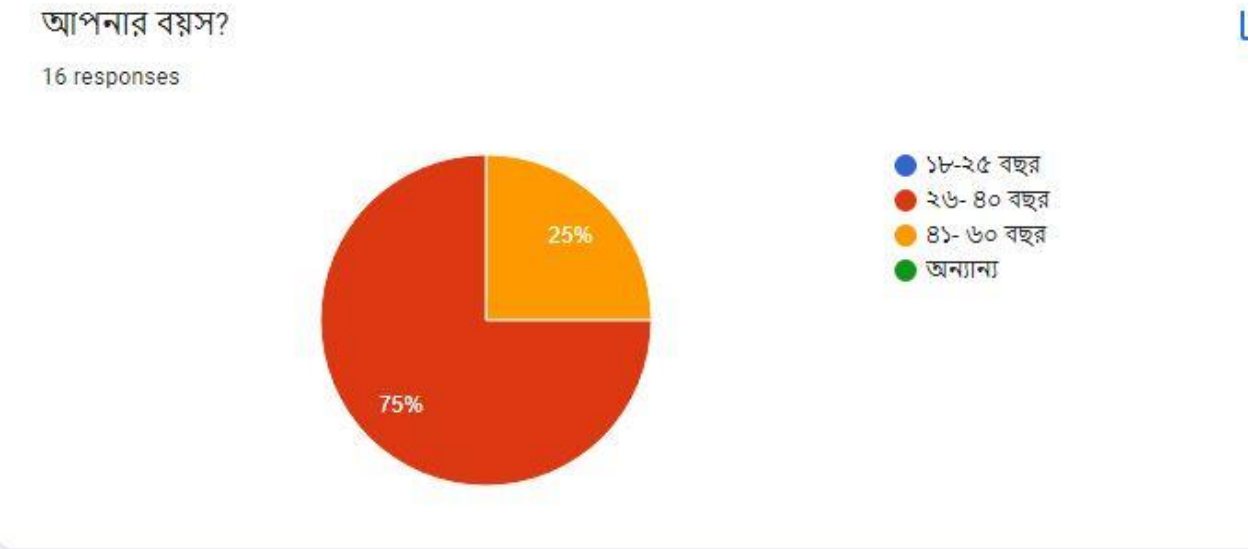
Appendix V: English Questionnaire in Google Form for Online Survey

1. Lack of Chemical management related Laws, Guidelines, Standards, and Policy in Bangladesh
2. In Bangladesh there should have a segregated Law or policy for chemical management in Tannery
3. Bangladesh government needs to increase monitoring and supervision for tannery chemical management.
4. Tanneries should have chemical management systems.
5. There should be managers/supervisors with chemical knowledge to oversee chemical management procedures.
6. Chemical risk must be determined periodically.
7. Adequate training on chemical hazards should be provided to all workers/employees/officers employed.
8. According to the Bangladesh Labor Act 2006, safety committees should be formed in factories where applicable.
9. There should be coordination between workers and superiors to prevent/remediate chemical hazards in the factory.
10. In case of emergency, the plant manager/supervisor should be informed immediately about the chemical hazard.
11. A dismissive attitude towards any chemical risk (however small it is) must be avoided.
12. When unloading containers carrying chemicals at the factory, it must be ensured that the lids of the containers are securely fastened.
13. There should be an inventory system of chemicals in the factory.
14. Chemical store should have approved layout.
15. Chemicals should be stored as per approved layout.
16. Chemicals should be stored separately according to the type of hazard.

17. A separate tray/container should be provided under each container to contain chemical spillage/leakage.
18. Provision of suitable fume hood should be ensured in every chemical store.
19. Chemical store should always be kept tidy.
20. Adequate lighting and ventilation should be provided in the chemical store.
21. label each chemical container should be ensured
22. The presence of MSDS for each chemical must be ensured.
23. Owners need to pay more attention to safe chemical management in tanneries.
24. A stronger role for workers/labor organizations is essential for improving existing chemical management.
25. Buyers' cooperation needs to be enhanced to improve existing chemical management.
26. Coordination among government agencies involved in chemical management is essential.
27. It is important to look into other aspects of chemical management (such as chemical stores, unloading, transfer, mixing, dosing) as well as buyer requirements for compliance certificates.
28. Above all, coordination between workers, owners and government is needed to establish sound and safe chemical management in tanneries.
29. If you have any comments in addition to the above, please provide your suggestions/comments below.

Appendix VI: Online Survey Response





আপনার কলেজ/বিশ্ববিদ্যালয়ের শিক্ষার মেজর বিষয়?

Copy

16 responses

আপনার কর্মক্ষেত্র (অনুগ্রহ করে কর্মক্ষেত্রের নাম লিখুন)

15 responses

DIFE, Bangladesh

বাংলাদেশ এ্যাক্রেডিটেশন বোর্ড (বি এবি)

ITS Labtest Bangladesh Ltd.

Environmental Lab

BVCPS BD LTD

পূবালী ব্যাংক লিমিটেড

DIFE

বিশ্ববিদ্যালয়ের শিক্ষক।

PHD

আপনার কর্মক্ষেত্র (অনুগ্রহ করে কর্মক্ষেত্রের নাম লিখুন)

15 responses

DIFE

বিশ্ববিদ্যালয়ের শিক্ষক।

PHD

Post Doctoral(USA)

SADAR TANNERY PVT. LTD.

iDEA TREE

iDEA TREE

Labour Inspector, Health, DIFE, Gazipur

University of Arkansas, USA

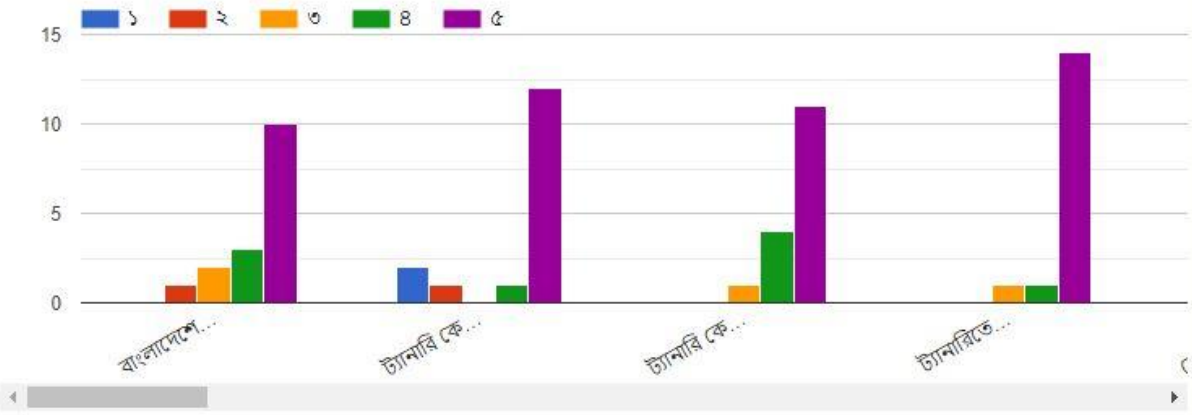
অভিজ্ঞতা (বছর), দয়া করে সংখ্যায় লিখুন।

Copy

16 responses

ট্যানারিতে কেমিক্যাল ব্যবস্থাপনা উন্নতির জন্য সম্মতি/অসম্মতি স্কেলে(১ থেকে ৫ স্কেল, যেখানে ১= কোনভাবেই একমত নই, ৫= পুরোপুরি একমত), নিম্নলিখিত বিষয়সমূহের উপর আপনি কতটুকু সম্মত বা অসম্মত।

Copy



উপরোক্ত বিষয়সমূহ ছাড়াও আপনি যদি কোন মন্তব্য করতে চান দয়া করে নীচে আপনার পরামর্শ/মন্তব্য প্রদান করুন।

11 responses

কেমিক্যাল এর জন্য আলাদা আইন থাকা দরকার। মালিক পক্ষকে আইনের প্রতি শ্রদ্ধাশীল হতে হবে। শ্রমিকদের ট্রেনিং এর ব্যবস্থা করতে হবে। সরকারি সংস্থাগুলোকে দূর্নীতিমুক্ত হতে হবে।

We all are doing work & create awareness about chemical & liquid waste management i.e. ETP but no body work solid waste managemen which will be gret problem for future. Need effective initiative about this. Thankst

লিকেজ/ স্পয়েল কেমিক্যাল ব্যবস্থাপনার জন্য নীতিমালা প্রয়োজন। এক্ষেত্রে LIFO করতে হবে। কোন কোন ক্ষেত্রে এগুলো কিভাবে ইটিপিতে যাবে তার ব্যবস্থাপনা পরিকল্পনা থাকতে হয়।

যেখানে কেমিক্যাল সমূহ বড় কন্টেনার হতে ছোট কন্টেনারে ঢালা হয়, সেখানে প্রতিটি কেমিক্যাল কন্টেনারের জন্য আলাদা ট্রে রাখা প্রয়োজন। কিন্তু যেখানে একই ধরনের কেমিক্যাল একত্রে রাখা হয় সেখানে শুধুমাত্র একটি বৃহৎ ট্রে থাকাই যথেষ্ট । বাংলাদেশের আইন ও ভাষা বিবেচনা করে এম এস ডি এস বাংলা ভাষায় হওয়া উচিত, যা ট্রান্সলেট করার পর অবশ্যই একজন এক্সপার্ট দ্বারা পরীক্ষা করিয়ে নিতে হবে। অনুরূপে লেবেল সমূহ বাংলায় সহজবোধ্য হওয়া দরকার। আরো পরামর্শের জন্য যোগাযোগ করুন। ধন্যবাদ।

Excellent Initiative.

উপরোক্ত বিষয়সমূহ ছাড়াও আপনি যদি কোন মন্তব্য করতে চান দয়া করে নীচে আপনার পরামর্শ/মন্তব্য প্রদান করুন।

11 responses

প্রতিটি ট্যানারিতে অন্তত একজন করে কেমিস্ট থাকতে হবে। ট্যানারির কেমিক্যাল এর জন্য আলাদা আইন দরকার নাই। কেমিক্যাল ব্যবস্থাপনার জন্য একটি সমন্বিত আইন থাকা আবশ্যক। মালিকপক্ষকে কেমিক্যাল ব্যবস্থাপনার প্রতি আরো মনোযোগি হতে হবে। শ্রমিকদের কেমিক্যাল সম্পর্কে ট্রেনিং দিতে হবে।

Dr. Muhammad Nazrul Islam

There should have a common chemical standards for all sectors in Industry

বর্তমানে সারাবিশ্বে সার্টিফিকেশন এবং স্টান্ডারডাইজেশন এর প্রতি জোর দেয়া হচ্ছে। ট্যানারি শিল্পের জন্য তেমন কয়েকটি হল: LWG, SLF, OEKO TEX ইত্যাদি। এমন গুঞ্জন শুনতে পারা যায় যে এই সার্টিফিকেশন গুলো ছাড়া ২-১ বছর পরই ট্যানারি গুলো দেশের বাইরে রপ্তানি করতে পারবে না। বিষয় টা যে কতটা ভয়াবহ তা আমরা যারা এই সেক্টরের সাথে সম্পৃক্ত আছি খুব ভাল করেই অনুভব করতে পারি। ত আমাদের ট্যানারি গুলোও এই বিষয়ে সচেতন। তারাও সার্টিফাইড ট্যানারি হওয়ার স্বপ্ন দেখেন। তাদের এ স্বপ্নে মূল অন্তরায় হল অর্থায়ন। এক সার্টিফাইড হওয়ার প্রসেস টা কয়েক মাসের নয়, বরং কয়েক বছরের। এর সাথে জড়িত ট্যানারি গুলোর ক্রমাগত উন্নয়ন এবং সফলতা। তবে এই সার্টিফিকেশন গুলো বেশ ব্যয় সাপেক্ষ। এক্ষেত্রে যদি বিদেশি বিনিয়োগ বা অনুদান বাংলাদেশ সরকার ব্যবস্থা করে দিতে পারেন তাহলে এদেশের ট্যানারি শিল্পের পুনরুত্থান আমরা আশা করতেই পারি। ওয়ার্ল্ড ব্যাংক, সুইস ব্যাংক সহ অনেক আন্তর্জাতিক সংগঠন ই বাংলাদেশ কে অনুদান দেয় যার সুফল ভোগ করে দেশের পোষাক সহ অন্যান্য শিল্প। তবে, চামড়া শিল্প কেন নয়?

সরকার, নিয়ন্ত্রক, মালিক সমিতি এবং শ্রমিকদের মাঝে সমন্বয়ের পাশাপাশি সংশ্লিষ্ট প্রতিষ্ঠানের সদস্যদের নিয়ে একটি নির্দিষ্ট সময় পর পর তদারকির ব্যবস্থা রাখতে হবে। এছাড়া ইন্টারন্যাশনাল লেবার ল এবং অন্যান্য গাইডলাইন অনুসারে অবকাঠামোগত উন্নয়ন করতে হবে। কেমিক্যাল স্টোরেজ এরিয়াতে ক্যামিকেল সংরক্ষনের গাইডলাইন অনুযায়ী তাপমাত্রা ও হিউমিডিটি, লাইট লেবেল, ভাইব্রেশন লেবেল মেইনটেইন করতে হবে। যেখানে সেখানে মানে আবাসিক এলাকায় কেমিক্যাল সংরক্ষণের নিষেধাজ্ঞা আরোপ করতে হবে। পর্যাপ্ত প্রশিক্ষণের কর মূল্যায়নের মাধ্যমে শুধুমাত্র সনদপ্রাপ্ত শ্রমিক কিংবা সুপারভাইজার এর তত্বাবধানে দাহ্য কিংবা রাসাণিক কেমিক্যাল হ্যান্ডলিং করতে হবে।

সবধরনের শিল্পকারখানার জন্য একটি ক্যামিক্যাল ম্যানেজম্যান্ট সিস্টেম থাকাই যথেষ্ট।