BINDURA UNIVERSITY OF SCIENCE EDUCATION

DEPARTMENT OF ENVIRONMENTAL SCIENCE

ASSESSING WORKER'S KNOWLEDGE, ATTITUDES AND PRACTICES TOWARDS THE SOURCES AND IMPACTS OF POLLUTION ON THE ENVIRONMENT AND OCCUPATIONAL SAFETY AND HEALTH. A CASE STUDY OF DELTA BEVERAGES, SOUTHERTON PLANT



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JUNE 2025

DECLARATION

To be compiled by the student

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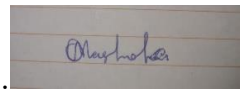
I, Caleb Mashoko, at this moment, declare that this Project is a result of my original work and has not been handed into any academic award in any other educational institute. Any sources that were referred to in the research project have been duly acknowledged through in-text citations and a properly formatted reference list.

Student Signature…… 

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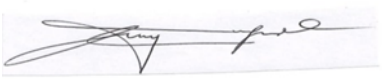
Signature 

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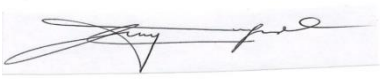

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DEDICATION

I dedicate this research project to my dear family and my friends for the support they have given me. Their encouragement, sacrifices, and love have been the driving force behind my success and achievements.

ACKNOWLEDGEMENTS

I want to thank the Almighty God, who has guided, strengthened and led me during this research journey. His grace and wisdom have been my constant companions, and I am forever grateful.

I also express my sincere gratitude to my supervisor, Mr Nyamugure, for his support and inspiration throughout this research. His proficiency and mentorship have been significant in guiding my studies and supporting me in achieving my objectives. Additionally, I extend my appreciation to the Department of Agriculture and Environmental Science for the encouragement and support they gave me.

Lastly, I want to express my gratitude to my mother for her everlasting support during my academic endeavours.

ABSTRACT

***Background**: Industrialization, while it drives economic growth, it remains a primary source of environmental degradation and occupational health hazards globally (ILO, 2024). In Zimbabwe, the beverage manufacturing sector faces significant challenges in managing effluent discharge, atmospheric emissions, and solid waste, which pose risks to both local ecosystems and worker safety (EMA, 2023). Despite a strong regulatory framework provided by the Environmental Management Act (Chapter 20:27) and the National Social Security Authority (NSSA), industrial pollution remains a persistent issue due to the human factor in safety compliance (NSSA, 2024).At the Delta Beverages Southerton Plant, the largest brewery in the country, the effectiveness of international standards such as ISO 14001 and ISO 45001 is largely dependent on the Knowledge, Attitudes, and Practices (KAP) of the workforce (Delta Corporation, 2024). Research suggest a compliance gap, where technical knowledge of pollution does not always translate into safe workplace practices (Zidana, 2023).This study aims to assess the KAP of workers at the Southerton Plant to identify barriers to environmental and occupational health excellence.*

***Materials and Methods:** A descriptive, cross-sectional study design was utilized to gather data from the plant floor at a single point in time. Stratified random sampling was used to divide the total plant population into mutually exclusive departmental subgroups, and convenience sampling was used to select three high-risk operational hubs: Packaging, Brewing, and Engineering. A sample size of n = 120 participants, consisting of an even split of 60 permanent employees and 60 short-term contractors across the three departments, was calculated using Slovin's formula. Primary data were collected through manually distributed questionnaires containing 15 knowledge questions, 10 attitude questions, and 9 practice questions. Statistical analysis was executed using Microsoft Excel 2013 and SPSS version 23, with KAP scores above 70% categorized as good, 51–69% as fair, and below 50% as poor*

***Results:** The workforce demonstrated a fair baseline knowledge score of 57.7%, a good attitude score of 75.9%, and a good practice score of 73.0%. A significant context-specific knowledge deficit was observed, 60.8% of workers were unaware that untreated brewery effluent depletes dissolved oxygen in local rivers, 69.2% did not recognize carbon dioxide (CO2) as a greenhouse gas, and local legal literacy regarding the Environmental Management Act [Chapter 20:27] was low (26.7%). Attitudinally, a distinct behavioural vulnerability emerged under production pressure, with 57.5% willing to bypass safety protocols to maintain*

production speeds. Structurally, a severe knowledge-do gap was identified in field practices; despite high theoretical awareness of chemical risks (93.3%), a startling 85.8% of respondents actively engaged in hazardous chemical storage practices.

Conclusion: *While the Delta Beverages workforce exhibits a positive moral inclination toward safety frameworks (ISO 14001 and ISO 45001) and strong daily waste-segregation routines, diagnostic blindness regarding progressive pathologies like Noise-Induced Hearing Loss (NIHL) and broader ecological impacts remains a critical vulnerability. Production-driven compliance fatigue and improper chemical handling present latent conditions for systemic operational failure.*

Recommendations: *Carry out training programs focused on industrial waste management, legal standards and industrial epidemiology. Carry out on job induction and toolbox talks for every shift. Introduce a peer to peer safety observation program, SHE Taskforce, which rewards teams for identifying near misses, unsafe conditions, PPE compliance and hazards at the workplace.*

Key terms*: Knowledge, Attitudes, and Practices (KAP); Brewery Effluent; Occupational Safety and Health; Production Pressure; Knowledge-Do Gap; Environmental Management Act.*

ACRONYMS AND ABBREVIATIONS

KAP	-	Knowledge, Attitude and Practices
SOP	-	Standard Operating Procedure
WHO	-	World Health Organization
SDS	-	Safety Data Sheet
NOx	-	Nitrogen Oxides
NSSA	-	National Social Security Authority
NH3	-	Ammonia
NaOH	-	Sodium Hydroxide (Caustic Soda)
NIHL	-	Noise-Induced Hearing Loss
ILO	-	International Labour Organization
ISO	-	International Organization for Standardization
CH4	-	Methane
CIP	-	Clean-in-Place
CO2	-	Carbon Dioxide
COD	-	Chemical Oxygen Demand
dB	-	Decibel
DO	-	Dissolved Oxygen
EMA	-	Environmental Management Agency
BOD	-	Biochemical Oxygen Demand

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CHAPTER 1: INTRODUCTION

1.0 BACKGROUND

The 21st century is defined by rapid industrial growth. Industrialization is a major part of modern economic development, yet it remains a primary driver of environmental degradation and occupational health risks. Globally, industrial activities contribute significantly to air, water, and soil pollution. According to the International Labour Organization (ILO, 2024), approximately 2.41 billion workers are exposed to excessive environmental hazards annually, highlighting the urgent need for integrated safety and health frameworks.

In the beverage manufacturing sector, pollution sources are diverse. Point-source pollution, such as the discharge of high-strength organic effluent, and non-point source pollution, like contaminated storm water runoff, pose severe threats to local ecosystems (JES-TM, 2025). The environmental impacts include eutrophication of water bodies due to high Chemical Oxygen Demand (COD) and Biological Oxygen Demand (BOD) in brewery wastewater, which can be 10 to 100 times more concentrated than domestic sewage (MDPI, 2023).

The pollution of the workplace environment also has direct physiological impacts on the workforce. Industrial noise is a pervasive pollutant in bottling and packaging lines, chronic exposure to levels exceeding 85 to 95 dB is a leading cause of Noise- Induced Hearing Loss (NIHL) and increased workplace stress (OSHA, 2024, Wouters et al., 2020). Furthermore, the frequent use of hazardous chemicals, such as caustic soda for Cleaning- in- Place (CIP) processes, poses risks of chemical burns and respiratory disorders if not managed through strict adherence to safety protocols (ILO, 2025).

In Zimbabwe, industrial operations are governed by the Environmental Management Act (Chapter 20:27), which mandates the prevention of pollution and the sustainable management of natural resources (EMA, 2003). Additionally, the National Social Security Authority (NSSA) enforces occupational safety standards to mitigate workplace injuries.

Delta Beverages, a subsidiary of Delta Corporation, has positioned itself as a corporate leader in sustainability. The company has officially committed to ISO 14001 (Environmental Management) and ISO 45001 (Occupational Health and Safety) standards across its operations (Delta Corporation, 2024). Specifically, the Southerton Plant, a high-volume hub for lager

beverage production, is a focal point for Delta's "A Cleaner World" initiative, which targets water stewardship and waste reduction (Delta Corporate Environmental Policy, 2024).

Despite the existence of Safety, Health and Environment (SHE) polices, the effectiveness of these systems relies on the human factor, which is the Knowledge, Attitudes, and Practices (KAP) of the workers. The workforce is exposed to various risk, including noise pollution, mechanical hazards, and chemical exposure whilst research suggest that a significant compliance gap often exist between what workers know and what they do. If workers lack knowledge or harbour negative attitudes towards safety protocols, the risk of accidents and environmental non-compliance increases.

Studies in similar industrial environments have shown that while workers may possess the Knowledge of safety risks, their Attitudes (perception of risk vs. productivity) often lead to unsafe Practices, such as the inconsistent use of Personal Protective Equipment (PPE), (Howari et al.,2017;NIOSH, 2019).

At the Delta Beverage Southerton Plant, the scale of operations means that minor lapses in worker practice can lead to significant environmental pollution or severe occupational accidents. This study, therefore, seeks to assess the current levels of Knowledge, Attitudes, and Practices among workers to ensure that Delta's sustainability goals are translated into daily operational reality.

1.2 PROBLEM STATEMENT

Despite the existence of environmental and safety regulations (such as NSSA and EMA standards) and ISO 14001 (Environmental) and ISO 45001 (Safety) standards, industrial accidents and environmental pollution incidents continue to occur in manufacturing sectors. There is often a disconnect between corporate safety manuals and the actual behavior of workers on the plant floor. If workers at the Southerton Plant do not fully grasp the long-term impacts of pollution or view safety gear as a hindrance to speed, they jeopardize both the environment and their own lives. This study seeks to investigate whether the workers' current KAP levels are sufficient to maintain a safe and sustainable working environment.

1.3 JUSTIFICATION

Carrying out this project,

For the company: It provides Delta Beverages management with data-driven insights to improve their SHE training programs.

For the workers: It highlights gaps in their safety knowledge, potentially reducing workplace injuries and long-term health issues.

For Policy Makers: It offers a case study for regulatory bodies like EMA on how industrial workers interact with environmental laws.

Academic Contribution: It adds to the body of literature regarding the human factor in industrial sustainability.

1.4 RESEARCH AIM

To assess the state worker's knowledge, attitude and practices towards the sources and impacts of pollution on the environment and occupational safety and health at Delta Beverages, Lagers Southerton Plant.

1.5 OBJECTIVES

1. To assess the level of knowledge workers have regarding the sources and impacts of industrial pollution on the environment and health.
2. To examine the attitudes of workers toward occupational safety and environmental protection protocols.
3. To evaluate the current practices of workers regarding waste management and the use of PPE (Personal Protective Equipment).
4. To identify the barriers preventing workers from adhering to standard safety and environmental procedures.

1.6 RESEARCH QUESTIONS

1. What do workers at the Southerton Plant know about the link between factory emissions and environmental health?
2. How do workers perceive the importance of the safety measures implemented by the company?
3. To what extent do workers consistently follow prescribed environmental and safety practices?

4. What factors (e.g., lack of training, time pressure, or equipment discomfort) lead to a lapse in safety and environmental compliance?

1.7 CHALLENGES

The researcher faced financial challenges, thus bus fare the researcher needed in order to travel to Delta Lagers Southerton Plant where the research was being conducted. The researcher also encountered communication barriers with some the respondents. The research also faced challenges with money for printing questioners.

CHAPTER 2: LITERATURE REVIEW

2.1: Assessing workers knowledge towards the sources of pollution on the environment and occupational safety and health.

The "knowledge" component in a KAP study refers to the capacity of individuals to acquire, retain and use information (Bethel et al., 2021). This knowledge includes Environmental Literacy which is understanding pollution and Occupational Health Literacy which is understanding workplace risks.

2.1.1 Knowledge of Environmental Pollution Sources

While workers are aware of visible pollution, they frequently lack knowledge towards invisible pollutants. These sources include:

1. Wastewater and Effluent: Wastewater is any water that has been used in domestic and industrial activities and contains waste products.it is typically contaminated and unsuitable for direct reuse without treatment as it contains a mix of pollutants such as organic matter, chemicals, and pathogens. Effluent is the outflow of water from treatment plant, sewer or industrial facility. It can be either treated or untreated and is released into the environment. Treated effluent has undergone processes to remove or reduce contaminants making it safer for discharge into water bodies like rivers and lakes.

   Many workers do not fully realize the chemical complexity of effluent. While they may know that spilling beer or cleaning agents is wasteful, they may not understand how the Biological Oxygen Demand (BOD) of that waste leads to oxygen depletion in local rivers, (Simate et al. 2011).
2. Atmospheric Emissions: Key greenhouse gases and their trends include:

   Carbon dioxide (CO_2) is the most significant greenhouse gas contributing to climate change. Global CO_2 levels have risen by more than 50% since 1800, reaching 423.9 parts per million (ppm) in 2024, up from 377.1 ppm in 2004, largely due to fossil fuel combustion, cement production and land-use changes. Annual global emissions now exceed 35 billion tonnes, with growth rates accelerating in recent decades, (Naciones Unidas, UN News 2024).

Methane (CH_4), the second-largest human-emitted contributor to warming, increased to 1,942 parts per billion (ppb) in 2024, primarily from fossil fuel extraction and landfill decomposition. Methane is more potent than CO_2 in trapping heat, though it remains in the atmosphere for a shorter period, (Naciones Unidas, UN News 2024).

Nitrogen oxides (NO_x) refers to the mixtures of nitric oxide (NO) and Nitrogen dioxide (NO_2) that are formed when combustion causes the nitrogen and oxygen in the atmosphere to combine to form NO, some of which then oxidizes further to NO_2. Combustion gases contain about 5% to 10% NO_2 mixed with NO, the most toxic of the NO_x, causes damage to the lung tissues at concentrations higher than usually found in ambient atmospheres (Ather et al.,2010).

Sulphur dioxide (SO_2) emissions come from burning of sulphur-containing fossil fuels which may contain up to 6% sulphur. At relatively high concentrations, SO_2 causes severe respiratory problems (Badenhorst, 2007).

Knowledge regarding CO_2 is often limited to its role in carbonation. A lack of knowledge regarding fugitive CO_2 emissions and boiler stack gases (SO_x and NO_x) prevents workers from identifying leaks that contribute to global warming and localized respiratory issues.(Olajire,2020).

2.1.2 Knowledge of Occupational Safety and Health (OSH) Hazards

Occupational knowledge involves the recognition of immediate and latent dangers.

1. Chemical Hazards: While workers often recognize that chemicals are dangerous, many cannot correctly interpret Safety Data Sheets (SDS) or the Globally Harmonized System (GHS) symbols on containers,(Zidana, 2023).At a plant like Southerton, knowledge of the specific neutralization process for caustic soda is important for preventing chemical burns
2. Noise and Ergonomics: Many workers perceive noise as a nuisance rather than a pollutant. Lack of knowledge regarding the decibel (dB) scale leads workers to underestimate the risk of permanent hearing damage, as they do not realize the noise-induced hearing loss (NIHL) is often painless and gradual,(Wouters et al. 2020).

2.1.3 Assessing workers knowledge towards the types of pollution on the environment and occupational safety and health.

Knowledge on the types of pollution is important because the mitigation strategy for a chemical spill is totally different from that of an air emission or noise hazard.

2.1.4 Knowledge of physical pollutants

1. Noise pollution: As defined by the World Health Organization (WHO, 2024), noise is a silent physical pollutant. At the Southerton plant, this is generated by high-speed bottling lines and steam discharge. While workers recognize noise as annoyance, then often lack the technical knowledge to distinguish between continuous noise and impulse noise, and as a result, this leads to more immediate damage to the inner ear.
2. Thermal pollution: This occurs when heated water from boilers or pasteurizers is discharged into the environment. Industrial workers frequently lack knowledge regarding the ecological tipping points caused by thermal discharge, which can drastically reduce the oxygen-carrying capacity of local streams, (Simate et al.2011).

2.1.5 Knowledge of chemical pollutants

Chemical pollution in breweries is primarily associated with Cleaning –in- Place (CIP) cycles and refrigeration.

1. Acids and Alkalis: Workers are generally trained to recognize corrosive agents like Sodium Hydroxide (Caustic Soda). However, research by (Zidana 2023), highlights a knowledge gap in understanding the pH scale. Workers may know a chemical is strong may fail to understand that a slight change in pH during effluent discharge can sterilize a rivers microbial life.
2. Refrigerants: Modern plants use ammonia (NH3) or CO2. Knowledge of these as pollutants involves understanding their Global Warming Potential (GWP). Workers often view gas leaks solely as an immediate safety risk, specifically acute toxicity or suffocation rather than a long term environmental pollutant contributing to the greenhouse effect or localized ecological damage (Ciconkov, R.2018). Furthermore,

(Kilic,M.2020), argues that while training often emphasizes the danger of ammonia leaks to human life, it frequently neglects the pollution aspect such as the acidification of water bodies if leaked gas dissolves into industrial runoff.

2.1.6 Knowledge of biological pollutants

In a fermentation industry, biological pollution is a unique risk.

1. Organic loading: High concentrations of yeast, sugar, and spent grain residues are biological pollutants. Workers often misclassify these as natural and therefore harmless. However, knowledge assessment often reveals that workers do not understand Eutrophication which is the process where biological waste leads to algae blooms that kill fish (Olajire, 2020).
2. Pathogens: In damp environments like bottle-washing areas, the growth of mold or bacteria, for example, Legionella in cooling towers constitutes a biological hazard. Knowledge of microbiological control is often high among Quality Control (QC) staff but significantly lower among general operators (Pasquarella et al.2020). This disparity is critical, as operators are the ones most likely to interact with the standing water or aerosolized droplets that harbour these pathogens, yet they may lack the knowledge to recognize them (Ibrahim et al., 2022).

2.1.7 Knowledge of Occupational Health pollutants

Modern OSH literature now classifies poor ergonomics and inadequate lighting as forms of workplace pollution (ILO, 2024).

1. Ergonomic hazards: Repetitive strain from packaging lines is a pollutant of musculoskeletal system (Punnett, 2023; Vieira et al., 2022).
2. Light pollution: In 24-hour operations like Delta Beverages, light at night (LAN) can disrupt the circadian rhythms of shift workers. KAP studies in manufacturing often show that workers have the lowest level of knowledge in this category, viewing exhaustion merely as part of the job rather than a failure of occupational health management (Boivin et al., 2022; Lunn et al., 2020).

2.1.8 Assessing workers knowledge towards the impacts of pollution on the environment and occupational safety and health

According to, (Ajzen, 1991; Zidana, 2023), Knowledge of impacts refers to an employee's understanding of the casual relationship between industrial discharge and subsequent damage

to the ecosystem or human physiology. In a beverage industry, this knowledge is categorised into ecological literacy, which is the understanding of the environmental systems, and pathological awareness, which is the understanding of disease-causing workplace factors. Research suggest that while workers may be aware of safety rules, a lack of deep understanding regarding the long-term biological and ecological impacts leads to compliance fatigue, where safety protocols are viewed as bureaucratic hurdles rather than essential protections (Boiral, 2011; NSSA,2024).

1. Eutrophication: Brewery effluent is characterised by high organic loading. According to (Olajire, 2020), while workers may know that discharging waste into the drain is wrong, many lack the technical knowledge of deoxygenation. They may not understand that sugars and proteins from beer waste act as fertilizers for algae in local water bodies like the Mukuvisi River, leading to dead zones where fish cannot survive.
2. Atmospheric impacts and climate change: At the Southerton Plant, CO2 is both an ingredient and a by-product of fermentation. (Simate et al. 2011) notes that workers frequently view CO2 as a natural gas and fail to connect fugitive emissions to the broader impact of the Greenhouse Effect. Knowledge of the impact of boiler emissions (SOx and NOx) on acid rain is also often found to be lower among floor-level staff compared to management (JES-TM, 2025).

2.1.9 Knowledge of Occupational Health Impacts (Pathological Awareness)

This refers to the worker's understanding of how pollutants affect their own body**.**

1. Chronic vs Acute Impacts: Workers at high-volume plants like Southerton generally understand the acute impact of a chemical splash (burns). However, (Zidana, 2023), argues there is a significant knowledge deficit regarding system toxicity, thus how long term, low level exposure to cleaning chemicals or refrigerants can lead to kidney or liver damage over a decade.
2. Acoustic Impacts: Knowledge regarding noise is often superficial. (Wouters et al. 2020), highlight that workers often do not know that NIHL is permanent and results from the physical destruction of hair cells in the cochlea, which cannot regenerate.
3. Respiratory Impacts: Knowledge of the impact of dust from grain handling and chemical vapours is critical. Workers may recognize a cough, but they may not understand the impacts of sensitization, where repeated exposure to an industrial

pollutant makes the immune system hyper-reactive, leading to occupational asthma (ILO, 2024).

2.2.1 Assessing workers attitude towards the sources and impacts of pollution on the environment and occupational safety and health.

Attitude is a critical determinant of behavioural intention. At Delta Beverages, a worker's attitude towards the source, type and impact of pollution dictates whether they view SHE (Safety, Health and Environment) protocols as a core value or a burdensome formality (Ajzen, 1991).

2.2.2 Worker's Attitudes towards sources and types of pollution.

1. Risk perception and normalization: Research suggest that in high-volume environments like the Southerton Plant, workers often develop an attitude of normalization of deviance. This is where workers begin to view pollutants like excessive noise or CO2 leaks as part of the job rather than a hazard. According to (Vaughan 1996), when a hazardous source is present daily without causing an immediate accident, workers attitudes shift towards complacency, reducing their likelihood of reporting the issue.

2. Perception of responsibility: A common attitude found in industrial KAP studies is that pollution control is management's problem. (Boiral 2011), states that if workers feel they are not stakeholders in environmental goals, they develop an indifferent attitude toward waste segregation or effluent management, viewing these task as secondary to production targets.

2.2.3 Worker's Attitudes towards Occupational Health and Safety (OSH) protocols.

The attitude towards OSH is often a battle between Safety and Productivity.

1. PPE as a hindrance: In the brewing department, where temperatures in the Brewhouse can be high, workers often hold a negative attitude towards Personal Protective Equipment (PPE). Research by (NSSA, 2024) indicates that if PPE is perceived as uncomfortable or slowing down work, employees develop an avoidance attitude, wearing the gear on when supervisors are present.
2. Safety Culture and Peer Influence: According to (Zidana, 2023), attitudes are socially constructed. If a senior worker at a plant has a dismissive attitude towards safety

googles or hearing protection, junior workers are likely to adopt to the same attitude, regardless of their formal training.

2.2.4 Worker's attitude towards the impacts of pollution.

This refers to how much a worker actually cares about the consequences.

1. Environmental Fatalism: Some workers may possess an attitude of fatalism, believing that pollution is inevitable in a big factory. This attitude undermines sustainability initiatives like Delta's 'A Cleaner World', program. (Olajire, 2020) suggests that without seeing the direct impact, for example, visiting the contaminated river, workers remain emotionally detached from the environmental consequences of work.
2. Pro-Environmental Behaviour (PEB): Conversely, workers who hold a strong Pro-Environmental Attitude (PEA) are more likely to engage in discretionary safety behaviours, such as cleaning up a small oil spill even when no one is watching (Lamm et al.2013). Research states that shifting worker attitudes from compliance to commitment is the most effective way to reduce industrial impacts.

2.2.5 Assessing workers practices towards the sources, types and impacts of pollution on the environment and occupational safety and health.

Practices represent the application of safety and environmental protocols.

2.2.6 Practices towards sources and types of pollution.

Industrial practices are often governed by Standard Operating Procedures (SOPs), However workers ignore these written rules.

1. Waste segregation and disposal: In the brewing department, the separation of organic waste, for example, yeast and spent grains from inorganic waste which includes glass and plastic is a critical practice. According to (Rao et al. 2022), under production pressure, workers often resort to co-mingling waste, which prevents recycling and increases the organic load in general waste streams. At a bigger plant like Southerton, such practices leads to catastrophic environmental contamination.
2. Chemical handling and spill management: The practice of CIP requires precise chemical dosing. According to (Zidana, 2023), poor chemical practices such as failing to neutralize acidic or alkaline cleaning agents before discharge are a primary cause of effluent non-compliance. The practice of using excessive water to wash away spills is

a common but detrimental practice that increases wastewater volume unnecessarily, (Olajire, 2020).

2.2.7 Practices towards the impacts of pollution

This involves proactive behaviours meant to mitigate known environmental or health consequences.

1. Preventative Maintenance: Random inspections of seals onC02 tanks or ammonia lines directly mitigates atmospheric pollution. Proactive maintenance practices are often sacrificed for reactive breakdown maintenance in busy plants, leading to higher fugitive emissions (Ciconkov, 2018).
2. Emergency response practices: According to (ILO, 2024) emergency drills are practised regularly, workers real-world response is often disorganized, leading to greater environmental exposure. How a worker reacts to chemical spill or a fire determines the severity of the impact.

2.2.8 Occupational Safety and Health ((OSH) practices.

OHS practices are the first defence against workplace accidents.

1. Consistency in PPE usage: NSSA (2024) highlights that PPE practice is often situational, workers wear gear during inspections or high risk tasks but neglect it during routine operations. This is a major risk factor for chronic conditions like NIHL.
2. Safety silence vs reporting: A critical practice is the reporting of near misses. According to (Probst,2015) in many manufacturing plants, workers practice safety silence whereby they fail to report minor leaks or hazards to avoid paperwork or peer backlash. Developing a practice of transparent reporting is essential for a living safety culture, (Reason, 2016).

CHAPTER 3: RESEARCH METHODOLOGY

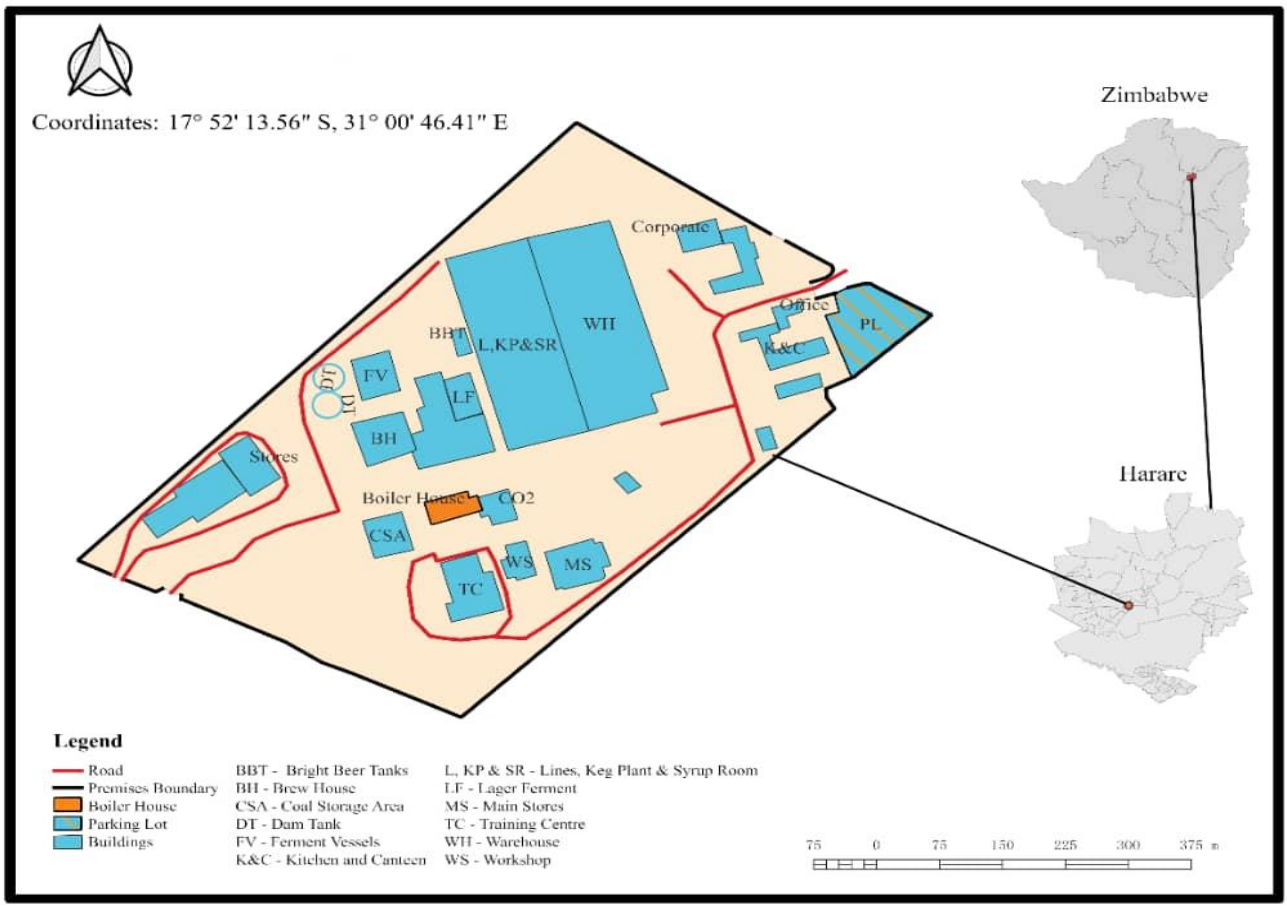
3.0 INTRODUCTION

The research study area, tools, and procedures that were utilized to assess the KAP of workers regarding pollution sources and their impacts on the environment and occupational safety and health (OHS) at Delta Beverages, Southerton Plant are described in this chapter. Also it details the sample size, sampling procedures, target population, and research plan. This chapter also covers the research instruments, research reliability, research validity, research ethics, and analysis plan.

3.1 STUDY AREA

The research was conducted at the Delta Beverages Southerton Plant, located at 17° 52` 13.56``S, 31°° 00` 46.41" E in Southerton, Harare, Zimbabwe. The site was selected due to its status as a large scale manufacturing facility with significant potential for environment emissions such as effluent, solid waste, and air emissions and inherent occupational hazards, making it an ideal case study.

Figure 1: Map showing Delta Beverages, Southerton Plant



3.2 STUDY DESIGN

A descriptive cross-sectional study design was utilized for this study. A cross-sectional design involves the collection of data from a sample of the population at a single point in time, providing a snapshot of the characteristics, behaviours, or attitudes of interest (Bhattacherjee, 2012). This design is appropriate for KAP studies as it efficiently captures the current state of knowledge, prevailing attitudes, and self-reported practices among a defined population without changing any variables (WHO, 2008). Since the study was descriptive, the data collected through questionnaires were analysed using both qualitative and quantitative tools. Cross-sectional studies are relatively quick and efficient to conduct, they can help to identify specific groups that may be at increased risk for a given condition, which can be helpful in planning interventions, and they can be used to collect baseline data that can be used for studies. A sample of 120 participants was used to collect data during the research.

3.3 DATA SOURCES

The researcher used primary and secondary sources. Primary data is information that researchers have directly gleaned from primary sources through questionnaire, surveys, or interviews. The primary sources of primary data were the workers. Secondary data was obtained from e-journals and other websites on the internet.

3.4 SAMPLING METHOD

A Stratified Random Sampling technique was utilized in the research to make the sampling process more practicable because it involves dividing the total population of the Southerton Plant into mutually exclusive subgroups based on their specific departments such as Brewing, Packaging, Engineering, Stores, Quality Assurance, and Human Resources. Convenience sampling was used to select 3 departments where data would be collected. Convenience sampling is a method for collecting samples that involve capturing samples that are conveniently placed close to a location (Thomas et al., 2017). The departments selected were Packaging, Brewing, and Engineering. Lastly the researcher used random sampling of 120 respondents which included workers from Packaging (20 contractors and 20 employees), workers from Brewing (20 contractors and 20 employees) and Engineering (20 contractors and 20 employees). The advantages of simple random sampling are that it allows results to apply to the whole demographic and it offers an equal chance of selection for everybody within the population group. As each person has the same chance of being selected and becoming a member of the sample, this provides an opportunity to gather information from all departments.

3.5 SAMPLE SIZE

Slovin formulae says:

$n = N/ (1+Ne^2)$

n = expected sample size

N = population

e = level of precision

The above formula was used to calculate sample size.

Since the estimated populations of workers from the Engineering, Packaging and Brewing department were known computations and proportional calculations were done using Microsoft excel to randomly select 40 respondents from Engineering, 40 respondents from Packaging and 40 respondents from Brewing to make a total of 120 respondents as shown below.

Table 1: Sample sizes

Department	**Population of workers in each department**	**Population of employees in each department**	**Population of contractors in each department**	**Sample size**
Engineering	70	38	32	40
Packaging	220	200	20	40
Brewing	75	55	20	40
Total	**365**	**293**	**72**	**120**

3.6 RESEARCH TOOLS

The researcher used questionnaires with both closed and open-ended questions as a research tool. A questionnaire is a sequence of questions asked to participants to gain statistically useful information about a given topic (Roopa et al., 2012). The questionnaires were manually distributed by the researcher to the target populations at the chosen departments. The researcher waited patiently for the respondents to finish the questionnaire.

The questionnaire consisted of four sections:

1. Demographic background
2. Knowledge about the sources and impacts of industrial pollution
3. Attitudes towards the sources and impacts of industrial pollution
4. Practices towards the sources and impacts of industrial pollution

The questionnaires were taken by the researcher for analysis.

3.7 RELIABILITY AND VALIDITY OF RESEARCH INSTRUMENTS

Reliability refers to the consistency, stability and dependability of a research instrument. A reliable instrument produces the same result on repeated occasions, for example if the same measurement procedure is applied to the same subject multiple times, it should yield similar scores each time (Bhattacherjee, 2012). Validity refers to the accuracy, truthfulness and appropriateness of a research instrument (Creswell & Creswell, 2018).

The researcher examined the results' consistency with other measures of the same concept and known theories over time, among different observers, and across various test sections to determine their reliability and validity.

3.8 STATISTICAL ANALYSIS

Microsoft Excel 2013 and SPSS version 23 were used in the data analysis process. The research questionnaire had 15 questions to ascertain the participants' knowledge, 10 questions to assess their attitudes, and 9 questions to ascertain their practices regarding the sources and impacts of industrial pollution. Each correct score response received a score of 1, while incorrect and don't know response received a score of 0. Each character's average score was determined and the response were classified as "Good", if the score was above 70% "Fair", if the score was from 51-69% or "Poor" if it was less than 50%. The overall KAP scores were calculated by combining the scores. The total KAP score was used to rank the level of knowledge, attitude, and practice of the participants towards sources and impacts of pollution. Tables were used to display the data after analysis.

3.9 RESEARCH ETHICS

Research ethics can be defined as the moral principles and professional standards that guide researchers to conduct studies with honesty, respect for participants, and responsibility to society, ensuring that the rights, dignity and well-being of all participants are protected (Resnik, 2020; Israel & Hay, 2006). The researcher requested for permission from the SHE Executive to conduct a study at Delta Lagers, Southerton Plant, and with the assistance of the Supervisor and SHE Manager, permission was granted with limitations.

The research subjects participated willingly without being forced. Participants were assured by the researcher that declining to participate would have no negative effects or penalties. The researcher gave participants all the information they required on the study, such as benefits,

risks and potential improvements to workplace conditions resulting from evidence-based recommendations made to management. Also the researcher understood and followed the ethical principles which included, protecting their privacy and enhancing confidentiality.

CHAPTER 4: RESULTS

4.0 INTRODUCTION

Chapter 4 presented, analysed and discussed findings. The researcher used tables to present data.

4.1 SECTION A: DEMOGRAPHY

Table 2: Summary of demographic characteristics

Demographic variable	**Category**	**n=120**	**%=100**
Sex	Male	73	60.8
	Female	47	39.2
Age	18-25	50	41.7
	26-34	21	17.5
	35-40	25	20.8
	41-49	15	12.5
	50+	9	7.5
Highest Education	Primary	0	0
Level	Secondary	35	29.2
	Tertiary	85	70.8
Category	Employees	60	50
	Contractors	60	50
Department	Packaging	40	33.3
	Brewing	40	33.3
	Engineering	40	33.3

Are you aware that brewery effluent (wastewater) can deplete Oxygen in local rivers if not treated?	Yes	47	39.2
	No	73	60.8
Can long-term exposure to noise above 85dB cause permanent hearing loss?	Yes	42	35
	No	78	65
Is Carbon dioxide (CO2) classified as a greenhouse gas that contributes to climate change?	Yes	37	30.8
	No	83	69.2

The study had a balanced distribution across the three operational departments, Packaging (33.3%), Brewing (33.3%) and Engineering (33.3%). The workforce is predominantly male (60.8%). A significant portion of the participants are relatively young, with 41.7% falling within the 18- 25 age bracket, suggesting a youthful workforce at the Southerton plant. The participants had a high level of literacy, with 70.8% having attained tertiary education. The workforce is split exactly evenly between permanent employees (50%) and Contractors (50%), which is a critical factor when analysing the consistency of safety training. Despite 70.8% of the participants having tertiary education, the majority failed to correctly identify the impacts of factory pollutants. For example, 69.2% did not recognize C02 as a greenhouse gas. The highest area of ignorance was regarding NIHL (65%) unaware. This is more worrying for the packaging department, where high-speed bottling lines often exceed safety decibel limits. With 60.8% of workers unaware of how brewery effluent impacts local river oxygen levels, there is a high risk of negligent discharge practices and the participants are less likely to adhere to strict wastewater SOPs.

4.2 SECTION B: KNOWLEDGE ON THE SOURCES AND IMPACTS OF INDUSTRIAL POLLUTION ON THE ENVIRONMENT AND OCCUPATIONAL SAFETY AND HEALTH

Table 1: Knowledge on the sources and impacts of industrial pollution on the environment and health.

Knowledge Variable	**Participant response**	**n**	**%**	**Preferred response**	**Score**
Q1. Does discharging untreated brewery effluent(wastewater) into the city drainage system deplete oxygen levels in local rivers?	YES	83	69.2	YES	**0.692**
Q2. Permanent hearing loss may result from prolonged exposure to industrial machinery noise levels higher than 85 decibels (dB).	YES	97	80.8	YES	**0.808**
Q3. Carbon Dioxide (CO2) released during fermentation is a greenhouse gas that contributes to global climate change.	YES	47	39.2	YES	**0.392**
Q4. Mixing organic waste (like spent yeast or grain) with inorganic waste (like plastic or glass) prevents effective recycling.	YES	60	50	YES	**0.500**
Q5. Inhaling high concentrations of Ammonia (NH3)from a refrigeration leak can cause severe	YES	112	93.3	YES	**0.933**

respiratory damage or asphyxiation.					
Q6. Environmental pollution and workplace hazards cannot always be detected using human sense organs (e.g., odourless gases, microscopic particles).	YES	55	45.8	YES	**0.458**
Q7. A worker operating high-speed machinery while fatigued or under stress poses an increased risk of workplace accidents.	YES	91	75.8	YES	**0.758**
Q8. Keeping workstation floors clean and dry minimizes the risk of slips, trips, and chemical wash-down accidents.	YES	84	70.0	YES	**0.700**
Q9. Fugitive atmospheric emissions (steam, gas leaks) within the plant can compromise indoor air quality and worker respiratory health.	YES	107	89.2	YES	**0.892**
Q10. Reusing industrial chemical containers for domestic or non-designated purposes presents a high toxic risk.	YES	39	32.5	YES	**0.325**
Q11. Consistently wearing earplugs, safety boots, and goggles can significantly reduce the risk of chronic occupational injuries.	YES	116	96.7	YES	**0.967**
Q12. The legal guidelines for factory	YES	32	26.7	YES	**0.267**

environmental management in Zimbabwe are primarily governed by the Environmental Management Act [Chapter 20:27].					
Q13. Full-time employees, short-term contractors, and administrative staff face the exact same level of daily risk regarding floor-level chemical spills.	NO	73	60.8	NO	**0.608**
Q14. Chronic diseases like Noise-Induced Hearing Loss (NIHL) can be transmitted or exacerbated by poor workplace ergonomics and safety environments.	NO	25	20.8	NO	**0.208**
Q15. Basic workplace safety training (such as initial induction) completely eliminates the risk of future operational accidents.	NO	18	15	NO	**0.150**
TOTAL KNOWLEDGE SCORE					**8.658**

According to Table 3, the overall score on knowledge is 8.658 out of 15, meaning the percentage knowledge score is 57.7%, which is fairly reasonable.

The vast majority of responders (69.2%) were aware that local rivers' oxygen levels are lowered when untreated brewery wastewater is dumped into the city drainage system. The majority of participants (80.8%) accurately indicated that extended exposure to industrial machinery noise levels more than 85 decibels (dB) may cause irreversible hearing loss. However, just 39.2% of participants acknowledged that fermentation releases carbon dioxide (CO2), a greenhouse gas that contributes to global climate change, and precisely half (50%) were aware that combining organic and inorganic trash hinders efficient recycling.

In addition, an overwhelming 93.3% knew that inhaling high amounts of Ammonia (NH3) from a refrigerator leak can cause severe respiratory damage or asphyxiation. Less than half (45.8%) accurately indicated that human sense organs are not always capable of detecting environmental contamination and occupational risks. 70% of respondents knew that keeping workstation floors dry and clean reduces the chance of slips, trips, and chemical wash-down incidents, and a sizable percentage (75.8%) comprehended that a worker using high-speed machinery when exhausted or under stress offers an elevated risk of workplace accidents.

Additionally, 89.2% of respondents were right when they said that the plant's fugitive atmospheric emissions could jeopardize interior air quality and the respiratory health of its employees. Merely 32.5% of respondents were aware of the substantial hazardous risk associated with reusing industrial chemical containers for non-designated or household uses. 96.7% of respondents correctly identified that wearing safety boots, goggles, and earplugs on a regular basis can greatly lower the risk of chronic occupational injuries, according to the portion with the highest score.

In contrast, local legal literacy was relatively low, with just 26.7% of the respondents recognizing that the legal standards for factory environmental management in Zimbabwe are principally governed by the Environmental Management Act [Chapter 20:27]. 60.8% of respondents correctly noted that the daily danger of floor-level chemical spills varies among full-time employees, temporary contractors, and administrative staff. Lastly, the lowest score showed that only 15% of the participants were aware that basic workplace safety training does not totally eliminate the risk of future operational accidents, and only 20.8% of the participants were correct in knowing that chronic diseases like Noise-Induced Hearing Loss (NIHL) cannot be transmitted or made worse by poor workplace ergonomics.

4.3 SECTION C: ATTITUDES TOWARDS OCCUPATIONAL SAFETY AND ENVIRONMENTAL PROTECTION PROTOCOLS

Table 2: Attitudes towards occupational safety and environmental protection protocols

Attitude Variable	Participant response	n	%	Preferred response	Score
Q16. Different waste bins must be used strictly for sorting glass, plastics, and organic brewery residues.	YES	117	97.5	YES	**0.975**
Q17. It is unsafe to operate a production line without wearing the full required Personal Protective Equipment (PPE) for even a short period.	YES	69	57.5	YES	**0.575**
Q18. Is it important to report a minor chemical or water leak immediately, even if it does not interfere with production targets?	YES	86	1.7	YES	**0.717**
Q19. Is industrial pollution an inevitable by-product of a large factory that individual workers cannot control?	NO	74	61.7	NO	**0.617**
Q20. Achieving maximum production speed should replace stopping a machine to address a minor environmental safety hazard.	NO	51	42.5	NO	**0.425**

Q21. Regular monitoring of environmental pollution metrics throughout a shift is needless for general plant operators	NO	110	91.7	NO	**0.917**
Q22. Should one follow international standards, like ISO 14001 or ISO 45001 even when supervisors are not actively watching?	YES	117	97.5	YES	**0.975**
Q23. Bypassing safety guards on machinery to clear a product jam quickly should not be done under any circumstances.	YES	107	89.2	YES	**0.892**
Q24. Excessive ambient noise on the packaging line could permanently damage a worker's long-term health and personal life.	YES	99	82.5	YES	**0.825**
Q25. Workers who notice a breakdown in safety protocols by a colleague should report it to management to prevent accidents.	YES	80	66.7	YES	**0.667**
TOTAL ATTITUDE SCORE					**7.585**

According to Table 4, the total score on attitudes is 7.585 out of 10, meaning the percentage attitude score is 75.9%, which suggests a highly favourable and respectable approach toward occupational safety and environmental conservation.

The vast majority of responders (97.5%) concurred that glass, plastics, and organic brewery leftovers should only be sorted in separate waste bins. It is dangerous to operate a production line without wearing all necessary Personal Protective Equipment (PPE), even for brief periods of time, according to more than half of the participants (57.5%). Even if a small chemical or water leak doesn't affect production goals, a sizable percentage (71.7%) understood the significance of reporting it right away. Furthermore, a high feeling of personal accountability

was demonstrated by the 61.7% of respondents who rejected the idea that industrial pollution is an unavoidable outcome of a vast factory that individual workers cannot influence.

The claim that reaching maximum production speed should take the place of stopping a machine to address a minor environmental safety hazard, however, was correctly rejected by less than half (42.5%) of the participants, revealing a blatant behavioural vulnerability where production pressure clashes with safety. Positively, the overwhelming majority (91.7%) accurately said that general plant operators do not need to regularly check environmental pollution measures during a shift.97.5% of respondents, who tied for the highest score in this part, were adamant that one should adhere to international standards, such as ISO 14001 or ISO 45001, even when supervisors are not actively monitoring.

Additionally, 89.2% of respondents were aware that it is never appropriate to circumvent safety measures on machinery in order to swiftly clear a product jam. Eighty-five percent of the respondents acknowledged that workers' long-term health and personal lives could be irreversibly harmed by excessive ambient noise on the packing line. In order to prevent accidents, 66.7% of the participants demonstrated a proactive safety culture by agreeing that employees should report a colleague's violation of safety procedures to management.

4.4. SECTION D: PRACTICES TOWARDS WASTE MANAGEMENT AND THE USE OF PPE (Personal Protective Equipment).

Table 3: Practices towards waste management and the use of PPE (Personal Protective Equipment).

Practices	**Participant response**			**Preferred**	**Score**
Variable		**n**	**%**	**response**	
Q26. Do you clean up or report small chemical/oil spills at your workstation before starting a different task?	YES	73	60.8	YES	**0.608**
Q27. Do you check safety valves, seals,	YES	102	85	YES	**0.85**

or emergency shut-offs that need no active maintenance before your shift begins?					
Q28. Do you wear your required personal protective equipment (earplugs, respirator, and goggles) during your full shift?	YES	89	74.2	YES	**0.742**
Q29. Do you cover or isolate malfunctioning, leaking, or hazardous machinery until a maintenance technician arrives?	YES	92	76.7	YES	**0.767**
Q30. Do you use the same general waste bin for disposing of recyclable materials like cullet or plastic wraps?	NO	88	73.3	NO	**0.733**
Q31. Do you store volatile chemicals or hazardous cleaning agents at unregulated temperatures or in open spaces?	NO	17	14.2	NO	**0.142**
Q32. Do you use proper neutralizing agents and water after chemical handling to safely wash down the floor surfaces?	YES	106	88.3	YES	**0.883**
Q33. Do you check environmental safety signs and equipment hazard symbols when working with unfamiliar tools?	YES	110	91.7	YES	**0.917**
Q34. Do you participate in safety "Toolbox	YES	111	92.5	YES	**0.925**

Talks" or environmental brief meetings before your factory shift begins?	
TOTAL PRACTICES SCORE	**6.567**

According to Table 5, the overall score on practices is 6.567 out of 9, meaning the percentage practice score is 73.0%. This shows a high degree of proactive behavioural compliance and field-level implementation of safety, housekeeping, and waste management procedures.

Before beginning a new activity, the vast majority of respondents (60.8%) stated that they clean up or report minor chemical or oil spills at their workplace. Before starting their shift, an astounding 85.0% of participants reported checking safety valves, seals, or emergency shut-offs that don't require ongoing maintenance. In terms of physical personal protection, a sizable 74.2% of respondents said they use the necessary goggles, respirators, and earplugs for the duration of their shift. Furthermore, 76.7% of employees said they cover or isolate dangerous, leaky, or malfunctioning equipment until a maintenance expert shows up.

In terms of trash management, 73.3% of the respondents accurately scored a "No" by refusing to dispose of recyclables like plastic wraps or cullet (broken glass) in the same general waste container, demonstrating a strong daily commitment to waste separation. Only 14.2% of participants correctly stated that they do not store volatile chemicals or hazardous cleaning products at uncontrolled temperatures or in open places, which was the lowest score in this section and indicated a severe behavioural vulnerability. This indicates that a startling 85.8% of people store hazardous chemicals on the ground.

Positively, an overwhelming 88.3% of respondents said they safely clean floor surfaces after handling chemicals by using the right neutralizing agents and water. Most people (91.7%) checked equipment hazard symbols and environmental safety indicators when using new instruments. With 92.5% of respondents reporting that they regularly participate in safety "Toolbox Talks" or environmental brief meetings before to the start of their factory shift, the best score in this sector showed outstanding institutional alignment.

CHAPTER 5: DISCUSSION OF RESULTS

5.1 KNOWLEDGE ON THE SOURCES AND IMPACTS OF INDUSTRIAL POLLUTION ON THE ENVIRONMENT AND OCCUPATIONAL SAFETY AND HEALTH

The results of this study show a startling contradiction between the workforce's strong general literacy and their low context-specific environmental and occupational health literacy. According to Table 2, the participants' overall baseline knowledge score was a dismal 57.7% (8.658 out of 15), despite the fact that 70.8% of them had completed postsecondary education. According to (Arcury 1990), who asserts that formal, generic education does not inevitably result in understanding of particular ecological or occupational safety. Technical environmental literacy, on the other hand, necessitates focused, sector-specific training.

The respondents' knowledge of greenhouse gasses and industrial wastewater management is where this shortcoming is most obvious. Just 39.2% of participants agreed that the fermentation process releases carbon dioxide (CO2), a greenhouse gas that contributes to climate change. Fermentation produces extremely clean streams of CO2 in a brewery setting. It appears that employees see climate change as a far-off event unconnected to their current operational tasks if they fail to identify this gas as an environmental problem. Additionally, Table 2 shows that 60.8% of the employees were not aware that surrounding water bodies' dissolved oxygen levels can be lowered by untreated brewery effluent.

Due to residual sugars, soluble starches, and spent yeasts, brewery wastewater usually has a high Chemical Oxygen Demand (COD), a high Biochemical Oxygen Demand (BOD), and a significant organic load, (Olajire, 2012). When this organic debris is released untreated, microbial breakdown quickly depletes dissolved oxygen (DO), causing severe aquatic asphyxiation and localized eutrophication. This pervasive misunderstanding presents a significant operational risk because employees who don't understand effluent chemistry are much more likely to use careless disposal techniques or view wastewater standard operating procedures (SOPs) as formalities.

Positively, 80.8% of participants acknowledged that prolonged exposure to noise levels above 85 dB from machinery results in permanent hearing loss (Table 3, Q2). However, Table 2 revealed a paradoxical result: 65% of the respondents did not know what noise-induced hearing loss (NIHL) was. This internal contradiction suggests that although workers are aware of loud

noise as a potential hazard, they do not understand NIHL as a progressive, irreversible systemic illness. Because high-speed glass bottling lines, conveyors, and pasteurizers frequently above the 85dB threshold, this is especially risky in the packing sector (Gyamfi et al., 2016).

Additionally, just 26.7% of respondents identified the Environmental Management Act [Chapter 20:27] as Zimbabwe's principal environmental regulatory framework, indicating a very low level of local legal literacy. Institutional accountability is compromised by this legal blind spot. Workers cannot compare factory performance to legal duties if they are unaware of national statutory requirements, which leads to a reactive rather than proactive compliance posture (Mapfumo & Muroyiwa, 2021).

5.2: ATTITUDES TOWARDS OCCUPATIONAL SAFETY AND ENVIRONMENTAL PROTECTION PROTOCOLS

An encouraging overall attitude score of 75.9% (7.585 out of 10) was shown by the staff, indicating a strong baseline desire for safety compliance and an awareness for international standards. For instance, even in the absence of active supervisory monitoring, 97.5% of respondents believed that following international standards such as ISO 14001 (Environmental Management Systems) and ISO 45001 (Occupational Health and Safety Management Systems) is essential. According to Zwetsloot et al. (2017), this high percentage indicates that the workforce has a moral tendency toward proper operational conduct and values formal safety systems.

Furthermore, 61.7% of the participants showed a strong sense of personal accountability by rejecting the fatalistic idea that industrial pollution is an unavoidable by-product that individual workers cannot prevent.

However, when safety directly conflicted with productivity aims, a key behavioural vulnerability was shown. The claim that pausing a machine to address a minor environmental safety threat should be replaced by maximum production speed was rejected by less than half of the participants (42.5%). This suggests that in order to maintain production throughput, the majority (57.5%) would voluntarily circumvent or postpone safety procedures.

This prioritization of production over protection creates latent conditions for systemic failure, (Reason's, 1997) Swiss Cheese Model of accidents. This mind set directly transfers into risky

real-world behaviours in a brewery setting, including disregarding a chemical pump that is leaking or disabling a safety interlock on a high-speed packing machine in order to meet hourly volume requirements.

This production pressure is compounded by the demographic profile of the workforce. According to Table 2, 41.7% of the participants are in the youth cohort (18–25 years old). Younger, less experienced employees are statistically more likely to take risks; they frequently overestimate their physical capabilities and give in to perceived demands for operational speed (Salminen, 2004).

Peer accountability is another indication of the culture; just 66.7% of employees believed that they should notify management of a co-worker's safety infraction. This reluctance points to a residual social friction or fear of being labelled a whistle-blower. Peer-to-peer responsibility must be seen as an act of mutual protection rather than betrayal in order for a safety culture to be truly resilient (Conchie & Donald, 2009).

5.3: PRACTICES TOWARDS WASTE MANAGEMENT AND THE USE OF PPE (Personal Protective Equipment).

The study recorded a commendable practice score of 73.0% (6.567 out of 9), highlighting strong field-level execution of basic housekeeping, PPE usage, and administrative safety tools. One noteworthy accomplishment is the 92.5% attendance percentage at pre-shift "Toolbox Talks." Before operators engage with heavy machinery, these quick safety briefings act as an efficient administrative control by keeping risk awareness current in their minds (Albert & Hallowell, 2013). Additionally, 73.3% of employees actively engaged in trash segregation at the source, refusing to combine organic waste with recyclables like plastic wrap or cullet (broken glass). Glass cullet and spent grains must be kept apart in a brewery to avoid contamination, protect downstream waste-to-feed loops, and maintain the recycling value of both streams.

Chemical storage procedures were found to have a significant, high-risk behavioral vulnerability despite these favorable metrics. Just 14.2% of interviewees accurately said they don't keep hazardous cleaning products or volatile chemicals in exposed areas or at uncontrolled temperatures. Conversely, data indicates that a startling 85.8% of workers actively participate in inappropriate chemical storage.

The daily sanitation cycles (Clean-in-Place or CIP systems) at a brewing facility mostly rely on concentrated, extremely corrosive chemicals, particularly nitric or phosphoric acids for inorganic scale removal and caustic soda (Sodium Hydroxide, NaOH) for organic removal. Severe chemical dangers, such as toxic vapor emissions, structural corrosion, or exothermic reactions in the event of unintentional mixing, are introduced when these volatile, incompatible compounds are stored in open, temperature-unregulated spaces (Niskanen & Louhelainen, 1997).

This operational failure stands in sharp contrast to the 93.3% of workers who claimed to know that inhaling Ammonia (NH3) from refrigeration leaks can cause fatal asphyxiation. According to Karanika-Murray and Weyman (2013), the enormous discrepancy between theoretical understanding and practical application is known as the knowledge-do gap. Employees are aware of the disastrous effects of a major chemical failure, such as an ammonia leak, but they frequently overlook the small, daily risks connected to improper chemical storage and housekeeping.

This cohort of temporary contractors may be a major factor in the fact that 25.8% of the workers acknowledged not wearing the necessary PPE (goggles, respirators, and earplugs) during their whole shift. The institutionalization of consistent safety standards is necessary to close this gap, guaranteeing that contractors receive the same strict behavioural audits and safety rewards as full-time employees.

CHAPTER 6: CONCLUSION AND RECOMMENDATIONS

6.1: CONCLUSION

In conclusion, the Delta workforce demonstrated fair knowledge, positive attitude and positive practices towards the sources and impacts of industrial pollution on the environment and occupational safety and health. Most respondents had poor knowledge, only 39.2% respondents identified clean-stream fermentation carbon dioxide (CO2) venting as a driver of climate change, and 60.8% failed to recognize that discharging untreated brewery effluent rich in residual sugars, soluble starches, and spent yeasts depletes aquatic dissolved oxygen, causing localized eutrophication and asphyxiation (Olajire, 2012). Furthermore, while 80.8% recognize that loud noise causes hearing loss, 65% are unfamiliar with Noise-Induced Hearing Loss (NIHL) as a progressive, systemic pathology. This is a critical vulnerability given the high-decibel bottling lines in the packaging sector (Gyamfi et al., 2016). This diagnostic blindness is reinforced by an institutional lack of legal awareness; only 26.7% could identify the Environmental Management Act [Chapter 20:27], forcing the facility into a reactive compliance posture (Mapfumo & Muroyiwa, 2021).

With an encouraging overall score of 75.9%, the facility's Safety Attitudes (Section 5.2) demonstrated a strong desire for safety compliance and broad support (97.5%) for unmonitored ISO 14001 and ISO 45001 frameworks. This demonstrates that employees have a moral inclination toward appropriate operational behavior (Zwetsloot et al., 2017). Under operational output pressures, however, this ethical alignment falters: 57.5% of the workers acknowledged that they would voluntarily disregard leaks, circumvent safety procedures, or turn off mechanical interlocks in order to maintain production speeds. In Reason's (1997) Swiss Cheese Model of accidents, this emphasis on output above protection develops latent conditions for systemic failure. Peer-to-peer reporting accountability is hindered by social friction (Conchie & Donald, 2009) and a young demographic profile (41.7% aged 18–25) that encourages risk-taking (Salminen, 2004).

Active Practices (Section 5.3) received an excellent score of 73.0% on the factory floor, which was bolstered by successful source-segregation of glass cullet and spent organic grains (73.3%) and high attendance for pre-shift toolbox discussions (92.5%). However, there is a significant knowledge-do gap (Karanika-Murray & Weyman, 2013).A disturbing

85.8% actively participate in hazardous chemical storage practices, despite the fact that 93.3% are aware of the catastrophic risk of acute ammonia (NH3) refrigerant leaks.

6.2: RECOMMENDATIONS

To improve the attitude and practices of the Delta workforce towards the sources and impacts of industrial pollution on the environment and occupational safety and health, the employer can:

1. Carry out training programs focused on industrial waste management, legal standards and industrial epidemiology.
2. Carry out on job induction and toolbox talks for every shift
3. Introduce a peer to peer safety observation program, SHE Taskforce, which rewards teams for identifying near misses, unsafe conditions, PPE compliance and hazards at the workplace.

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APPENDICES

APPENDIX 1: RESEARCH QUESTIONNAIRE

RESEARCH QUESTIONNAIRE

My name is Caleb Mashoko, I am a fourth-year student at Bindura University of Science Education pursuing an honors degree in Safety Health and Environmental Management. As part of my research project, I am doing an **ASSESSMENT OF WORKER'S KNOWLEDGE, ATTITUDES AND PRACTICES TOWARDS THE SOURCES AND IMPACTS OF POLLUTION ON THE ENVIRONMENT AND OCCUPATIONAL SAFETY AND HEALTH AT DELTA BEVERAGES, SOUTHERTON PLANT.** Your answers will help guide the study and advance knowledge of industrial pollution control. You are free to stop participating at any moment without penalty. Please be truthful when answering any questions. I appreciate you taking the time to participate.

INSTRUCTIONS TO RESPONDENTS

- *Tick all the appropriate boxes*
- *Do not write your name on any part of the paper.*

SECTION A: SOCIO-DEMOGRAPHIC CHARACTERISTICS

1. Gender: Male ☐ Female ☐
2. Age (years): 18-25 ☐ 26-34 ☐ 35-40 ☐ 41-49 ☐ 50+ ☐
3. Highest Education Level: Primary ☐ Secondary ☐ Tertiary ☐
4. Category: Employee ☐ Contractor ☐
5. Please indicate your department: Engineering ☐ Packaging ☐ Brewing ☐
6. Are you aware that brewery effluent (wastewater) can deplete Oxygen in local rivers if not treated? Yes ☐ No ☐
7. Have you received any trainings on the sources and impacts of industrial pollution Yes ☐ No ☐

SECTION B: KNOWLEDGE OF POLLUTION ON THE ENVIRONMENT AND OCCUPATIONAL SAFETY AND HEALTH

Number	Knowledge	Answers
1.	Does discharging untreated brewery effluent (wastewater) into the city drainage system deplete oxygen levels in local rivers?	Yes ☐ No ☐ Don't know ☐
2.	Permanent hearing loss may result from prolonged exposure to industrial machinery noise levels higher than 85 decibels (dB).	Yes ☐ No ☐ Don't know ☐
3.	Carbon Dioxide (CO2) released during fermentation is a greenhouse gas that contributes to global climate change.	Yes ☐ No ☐ Don't know ☐
4.	Mixing organic waste (like spent yeast or grain) with inorganic waste (like plastic or glass) prevents effective recycling.	Yes ☐ No ☐ Don't know ☐ ☐
5.	Inhaling high concentrations of Ammonia (NH3) from a refrigeration leak can cause severe respiratory damage or asphyxiation.	Yes ☐ No ☐ Don't know ☐
6.	Environmental pollution and workplace hazards cannot always be detected using human sense organs (e.g., odourless gases, microscopic particles).	Yes ☐ No ☐ Don't know ☐
7.	A worker operating high-speed machinery while fatigued or under stress poses an increased risk of workplace accidents.	Yes ☐ No ☐ Don't know ☐
8.	Keeping workstation floors clean and dry minimizes the risk of slips, trips, and chemical wash-down accidents.	Yes ☐ No ☐ Don't know ☐

9.	Fugitive atmospheric emissions (steam, gas leaks) within the plant can compromise indoor air quality and worker respiratory health.	Yes ☐ No ☐ Don't know ☐
10.	Reusing industrial chemical containers for domestic or non-designated purposes presents a high toxic risk.	Yes ☐ No ☐ Don't know ☐
11.	Consistently wearing earplugs, safety boots, and goggles can significantly reduce the risk of chronic occupational injuries.	Yes ☐ No ☐ Don't know ☐
12.	The legal guidelines for factory environmental management in Zimbabwe are primarily governed by the Environmental Management Act [Chapter 20:27].	Yes ☐ No ☐ Don't know ☐
13.	Full-time employees, short-term contractors, and administrative staff face the exact same level of daily risk regarding floor-level chemical spills.	Yes ☐ No ☐ Don't know ☐
14.	Chronic diseases like Noise-Induced Hearing Loss (NIHL) can be transmitted or exacerbated by poor workplace ergonomics and safety environments.	Yes ☐ No ☐ Don't know ☐
15.	Basic workplace safety training (such as initial induction) completely eliminates the risk of future operational accidents.	Yes ☐ No ☐ Don't know ☐

SECTION C: ATTITUDES

Number	Attitudes	Answers
16.	Different waste bins must be used strictly for sorting glass, plastics, and organic brewery residues.	Yes ☐ No ☐ Don't know ☐
17.	It is unsafe to operate a production line without wearing the full required Personal Protective Equipment (PPE) for even a short period.	Yes ☐ No ☐ Don't know ☐
18.	Is it important to report a minor chemical or water leak immediately, even if it does not interfere with production targets?	Yes ☐ No ☐ Don't know ☐
19.	Is industrial pollution an inevitable by-product of a large factory that individual workers cannot control?	Yes ☐ No ☐ Don't know ☐
20.	Achieving maximum production speed should replace stopping a machine to address a minor environmental safety hazard.	Yes ☐ No ☐ Don't know ☐
21.	Regular monitoring of environmental pollution metrics throughout a shift is needless for general plant operators.	Yes ☐ No ☐ Don't know ☐
22.	Should one follow international standards, like ISO 14001 or ISO 45001 even when supervisors are not actively watching?	Yes ☐ No ☐ Don't know ☐
23.	Bypassing safety guards on machinery to clear a product jam quickly should not be done under any circumstances.	Yes ☐ No ☐ Don't know ☐
24.	Excessive ambient noise on the packaging line could permanently damage a worker's long-term health and personal life.	Yes ☐ No ☐ Don't know ☐

Number	Attitudes	Answers
25.	Workers who notice a breakdown in safety protocols by a colleague should report it to management to prevent accidents.	Yes ☐ No ☐ Don't know ☐

SECTION D: PRACTICES

Number	Practices	Answers
26.	Do you clean up or report small chemical/oil spills at your workstation before starting a different task?	Yes ☐ No ☐
27.	Do you check safety valves, seals, or emergency shut-offs that need no active maintenance before your shift begins?	Yes ☐ No ☐
28.	Do you wear your required personal protective equipment (earplugs, respirator, and goggles) during your full shift?	Yes ☐ No ☐
29.	Do you cover or isolate malfunctioning, leaking, or hazardous machinery until a maintenance technician arrives?	Yes ☐ No ☐
30.	Do you use the same general waste bin for disposing of recyclable materials like cullet or plastic wraps?	Yes ☐ No ☐
31.	Do you store volatile chemicals or hazardous cleaning agents at unregulated temperatures or in open spaces?	Yes ☐ No ☐

32.	Do you use proper neutralizing agents and water after chemical handling to safely wash down the floor surfaces?	Yes ☐ No ☐
33.	Do you check environmental safety signs and equipment hazard symbols when working with unfamiliar tools?	Yes ☐ No ☐
34.	Do you participate in safety "Toolbox Talks" or environmental brief meetings before your factory shift begins?	Yes ☐ No ☐