BINDURA UNIVERSITY OF SCIENCE EDUCATION

FACULTY OF SCIENCE EDUCATION

EXAMINING IMPACT OF CEMENT PRODUCTION TO THE ENVIRONMENT: A CASE OF KHAYA ZIMBABWE CEMENT COMPANY IN ARCTURUS ROAD HARARE

BY

CHARI GERALD

B223015B

SUPERVISED BY: DR ZEZEKWA

A RESEARCH PROJECT SUBMITTED TO THE DEPARTMENT OF SCIENCE AND MATHEMATICS EDUCATIONIN IN PARTIAL FULFILLMENT OF THE REQUIREMENTS OF THE BACHELOR OF SCIENCE EDUCATION HONOURS DEGREE IN CHEMISTRY

YEAR 2024

BINDURA UNIVERSITY OF SCIENCE EDUCATION

Approval Form

The undersigned certify that they have supervised, read and recommend to Bindura University for acceptance of dissertation entitled:EXAMINING IMPACT OF CEMENT PRODUCTION TO THE ENVIRONMENT: A CASE OF KHAYAH ZIMBABWE CEMENT COMPANY IN ARCTURUS ROAD HARARE (B223015B) in partial fulfilment of the requirements for the Bachelor of Science Education Honours Degree in Chemistry

(Signature of Supervisor) Date 04./……06./2024

(Signature of the Chairperson) Date

……/……/……/……

BINDURA UNIVERSITY OF SCIENCE EDUCATION

Release Form

Permission is hereby granted to Bindura University to produce single copies of this project and to lend or sell such copies for private, scholarly or scientific research purpose only. The author reserves other publication rights and neither the project nor the extensive extracts from it may be printed or otherwise without the authors written permission,

Student's name Gerald Chari

Signature ……G.CHARI……

Date .....31...../..05...../....24.....

Dedications

This research is dedicated to my family for the support and love they offered me throughout the duration of this programme. May God bless you abundantly my dear family.

Acknowledgements

Firstly, I would like to give thanks to God almighty for giving me the courage to progress well with this project. Secondly, I would like to give thanks to Dr Zezekwa who assisted me

throughout the research. Also, I wish to extend my thanks to Dr Trinoswho provided more insight on how to conduct research. Lastly,I would like to thank my family for the moral support she gave me even at times I did not feel like participating.

Contents

CHAPTER 1

1.0 INTRODUCTION

This research investigates the environmental impact of cement production by Khayah Cement Company in the Eastview community of Harare. The motivation for this study arises from the recognition that significant levels of fugitive dust emissions occur during cement production, leading to adverse effects on the environment. Therefore, the researcher aims to examine the impact of cement dust on the environment and identify potential mitigation measures to minimize the effects of dust emissions. This chapter encompasses the following sections: background of the study, problem statement, research aim, research objectives, research question, and the significance of the study.

1.1 Background of the study

The demand for cement production has increased due to urbanization and modernization, as it is a crucial component for housing and infrastructure development. Khayah Zimbabwe Cement Company (KZCC) has played a significant role in social and economic development through job creation, revenue generation, and infrastructure development. However, since its establishment in 1956, concerns have arisen regarding the adverse effects of cement production on the surrounding Eastview community and the environment. One major issue is the high levels of fugitive dust emissions, which pose threats to human health, crops, livestock, and indigenous forests.

The Environmental Management Agency (EMA) has received numerous complaints from residents of Eastview regarding serious air pollution caused by fugitive dust from KZCC's chimneys. Cement dust covers house roofs and vegetation, creating a grey-white appearance.

Hosam (2021) is of the view that fine cement dust particles in the air pose significant health risks, including heart problems, lung impairment, and aggravated pulmonary disease.

According to Torgal (2011) cement production processes also release greenhouse gases such as carbon monoxide and carbon dioxide, which contribute to global warming, acid rain, and climate change. These environmental impacts adversely affect flora and fauna. Additionally, the emission of gases during cement production can result in offensive odours, further degrading air quality. The constant deposition of cement dust on various surfaces leads to soil pollution, causing soil depletion and reduced fertility. The calcium, alumina, and silica in the cement dust negatively affect soil fertility and hinder plant growth and agricultural productivity. These pollution levels contradict the Environmental Management Act, which ensures the right to live in a clean and healthy environment for present and future generations.

To address environmental concerns, international, regional, and national policies and strategies have been developed to improve the environmental performance of industries. According to Mehta & Monteiro (2005) the environmental impact of concrete, however, goes further than the large amount of CO2 released into the atmosphere through cement production. Cleaner production (CP) is one widely implemented strategy, aligned with international conventions and protocols like the Kyoto Protocol and the United Nations Framework Convention on Climate Change. These strategies aim to reduce greenhouse gas emissions and mitigate environmental damage.

While the aforementioned approaches have been effective, the researcher seeks to explore additional methods to mitigate the negative effects of dust emissions on the environment caused by cement production.

1.2 Problem statement

The production of cement by Khayah Zimbabwe Cement Company (KZCC) has significantly increased, reaching approximately 900 tonnes per week, with a focus on exporting to the Democratic Republic of Congo and Zambia in addition to serving the local market. However, this increased production has led to a rapid deterioration of the environmental conditions in the surrounding areas, resulting in an intensified greenhouse effect. Studies conducted by Akande and Idris (2017) have highlighted the various socio-economic impacts of cement production on nearby communities. Additionally, Hilson (2009) has observed that cement production is associated with pollution, land degradation, and the destruction of wildlife and crops. These negative consequences have prompted the researcher to undertake this study and seek viable solutions to address dust emissions in an economically and environmentally sustainable manner.

1.3 Research aim

The aim of this study was to examine the negative effects posed to the environment by cement production at Khayah Zimbabwe Cement Company

1.4 Research objectives

This study was guided by the following research objectives to:

1.4.1 Examine the effects of Khayah cement production on the environment in Eastview community

1.4.2 Assess the impact of cement production on the environment in Eastview community.

1.4.3 Explore strategies that can be used to minimize the negative effects of cement production to the environment

1.5 Research questions

This study was guided by the following research questions:

1.5.1 What are the effects of Khayah cement production on the environment in Eastview community?

1.5.2 In what way is pollution affecting the environment in Eastview Community?

1.5.3 How might these negative effects be mitigated?

1.6 Significance of the study

The significance of this study extends to various stakeholders, including:

1.6.1 Policy makers

This study fills a gap in the literature regarding the impact of cement production in Zimbabwe. By providing empirical evidence and effective strategies, it can inform policy and decision makers on sustainable practices in cement production.

1.6.2 Chemistry teachers

The study contributes to the understanding of waste management practices and their impact on sustainable development in cement industries. This knowledge can be incorporated into the teachings of Chemistry teachers, particularly in the section on Environmental Chemistry, enhancing their ability to educate A Level Chemistry learner.

1.6.3 Chemistry learners

A Level Chemistry learners can benefit from this study as it provides them with effective waste management strategies. This will enhance their understanding of Environmental Chemistry concepts, which are part of their Advanced Level syllabus.

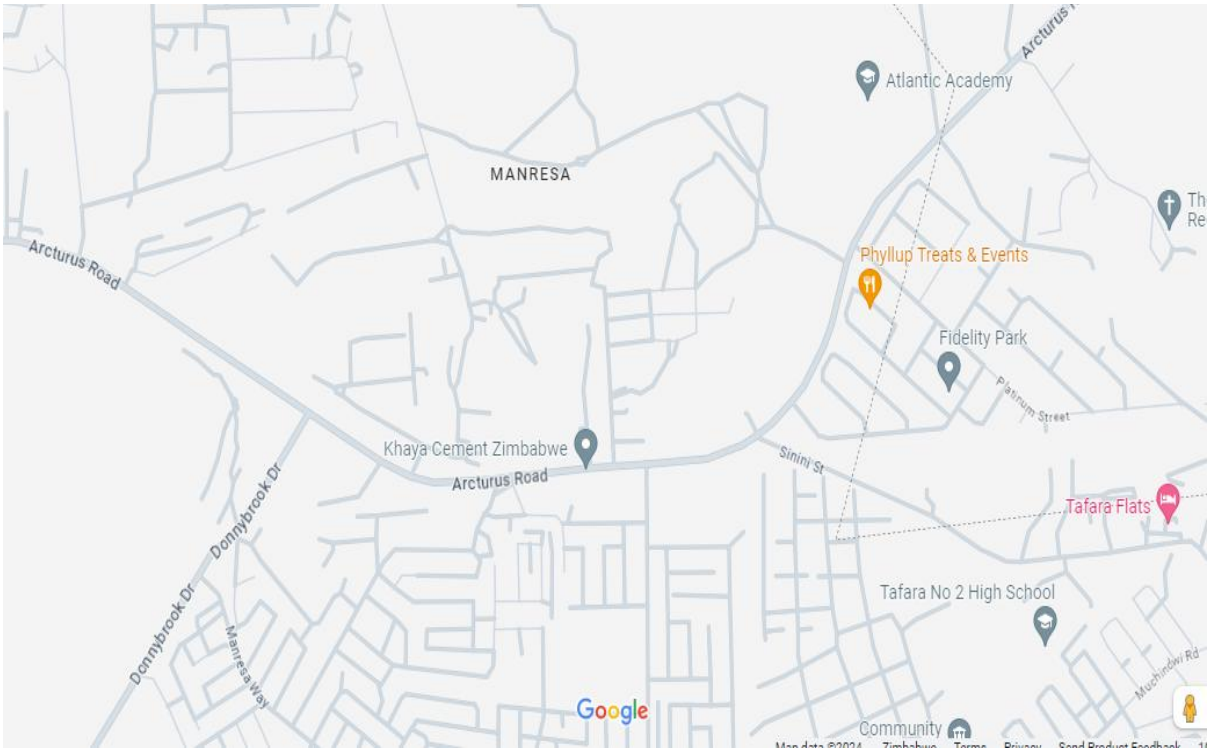
1.6.4 Other researchers

The information and findings of this study can serve as a valuable resource for future research and scientific development in the field of cement production and its environmental impact. Other researchers can build upon this study to further explore related issues and contribute to scientific knowledge. This study has the potential to generate valuable insights and practical recommendations that can benefit various stakeholders and contribute to sustainable practices in the cement industry.

1.7 Delimitation of the Study

There are numerous cements producing companies in Zimbabwe spread across various geographic locations namely Portland Holdings in Bulawayo, Khayah Private limited in Harare and Sino Zimbabwe Cement Company in Gweru. Out of these companies this study is only focusing on Khayah Zimbabwe Cement Company (KZCC) situated in Eastview along Arcturus road. Figure 1.1 below shows the areal map of the khayah Zimbabwe Cement plant and surrounding community.

Map showing location of khayah cement company



1.8 Limitations to the study

This study was not without its drawbacks. Initially, the research was undertaken within a restricted timeframe, which posed challenges to the large-scale collecting of information and the accompanying costs. I had trouble getting in touch with management because office workers were gatekeeping, making way for more important business matters. Organisational staff also struggled with maintaining secrecy because they were afraid to reveal information and needed approval from higher authority, which meant that most of the material would be classified as sensitive. To avoid this, questions were made simpler in order to obtain information that was not considered sensitive.

Some officials from the company did not want to be associated wit this project and they could not assist

1.9 Definition of key terms

Senderson (2002) asserts that environment is the sum total of all the living and non-living elements and their effects that influence human life

1.9.1 Pollution

According to Nagle et al (2007), pollution is the deterioration or unclean objectionable conditions in the quality of natural resources such as air, water and soil because of the action or presence of unwanted substances beyond a certain limit.

1.9.2 Atmosphere

Alston (2012) posit that atmosphere is a mixture of gases that surrounds the planet or the layers of gases surrounding a planet or other celestial body.

1.10 Summary of the chapter

This chapter has introduced the context in which the study is going to be carried out as well as justifying the fundamental problem under investigation. The study aims at examining the impact of cement production on the environment. The chapter is composed of the topic, introduction, background of the study, problem statement, significance of the study, research aim, research objectives, research questions, delimitation of the study, limitation of the study and a precise definition of terms is provided in this chapter. The next chapter is chapter 2 which is literature review.

Chapter 2: Literature Review

2.1 Introduction

The section provides an overview of the environmental impacts of cement manufacturing, discussing its influence on the environment and potential mitigation strategies. It explores the stages of cement production, starting with the extraction of raw materials like limestone and culminating in the milling process to produce cement. While cement is vital for construction, its production is energy-intensive, primarily fueled by coal, petroleum coke, or natural gas, emitting greenhouse gases such as carbon dioxide (Lopez, 2022). Additionally, the calcination process releases pollutants like sulphur dioxide and nitrogen oxides, contributing to air pollution and health issues (Singla & Stashwick, 2022). Dust and particulate matter generated during grinding and milling also pose environmental and health risks.

The production of cement, essential for construction worldwide, poses significant environmental challenges due to resource depletion and pollution. Quarrying for raw materials leads to habitat destruction, erosion, and biodiversity loss, exacerbating land and water degradation (Al-Otaibi et al., 2018). Cement manufacturing is a major emitter of carbon dioxide and other pollutants, contributing to climate change and local air pollution (Singla & Stashwick, 2022). The industry's high-water consumption and wastewater discharge further threaten ecosystems and human health. Addressing these issues is crucial for sustainable development and aligning with global environmental goals like the Paris Agreement and Sustainable Development Goals(Iacobuţă et al., 2022).

Khaya Cement Company, a prominent player in Zimbabwe's cement industry, exemplifies the challenges and opportunities within the sector. Like other cement producers, the company faces environmental concerns associated with quarrying and manufacturing processes. Balancing economic growth with environmental sustainability requires implementing mitigation strategies to minimise resource consumption, emissions, and habitat disruption (Cohen, 2020). By embracing sustainable practices and technology, companies like Khaya Cement can contribute to a more environmentally responsible cement industry, crucial for meeting future construction needs while safeguarding ecosystems and communities.

2.2 Environmental effects of cement production

Cement production is a vital component of modern construction, but its environmental impact is a growing concern. The process of manufacturing cement involves significant energy consumption, releases substantial amounts of carbon dioxide, and generates various pollutants, contributing to air and water pollution. Furthermore, the extraction of raw materials, such as limestone and clay, can lead to habitat destruction and landscape alteration. Understanding the environmental effects of cement production is crucial for developing sustainable practices to mitigate its adverse impacts on ecosystems and human health.

2.2.1 Overview of cement production process

Cement production involves a series of complex steps, starting with the quarrying of raw materials like limestone and clay, which are then crushed and ground to form a raw meal (GasdiaCochrane, 2023). This mixture undergoes high-temperature treatment in a kiln to produce clinker, a crucial component of cement, through a process called calcination (Vikström, 2021). The resulting clinker is cooled, ground into a fine powder, and combined with additives like gypsum to create Portland cement (Vikström, 2021). This final product undergoes further

grinding and is then stored or transported for distribution (Vikström, 2021). However, the energy-intensive nature of cement production, reliance on raw material extraction, and emissions of greenhouse gases highlight its significant environmental impact, necessitating sustainable practices within the industry.

Understanding the complexities of cement production is paramount for evaluating its environmental footprint and implementing eco-friendly measures. From raw material extraction to clinker formation and cement grinding, each stage contributes to energy consumption and emissions of pollutants (Antunes et al., 2021; Samira et al., 2012). By comprehensively assessing the processes involved and exploring sustainable alternatives, the industry can mitigate its environmental impact and move towards more eco-conscious practices, essential for combating climate change and promoting environmental stewardship.

2.2.2 Energy consumption and greenhouse gas emissions

Cement production significantly impacts the environment through its high energy consumption and greenhouse gas emissions, primarily from the combustion of fossil fuels like coal and natural gas in kilns (Samira et al., 2012. This process releases carbon dioxide and other pollutants, contributing to air pollution and climate change. Understanding these impacts is crucial for assessing the industry's environmental footprint and developing strategies to mitigate its carbon emissions.

Efforts to reduce energy consumption and greenhouse gas emissions in cement manufacturing focus on enhancing energy efficiency and transitioning to alternative fuels and renewable energy sources. Technological advancements, such as preheaters and waste heat recovery systems, improve energy efficiency, while exploring alternative fuels like biomass offers both environmental and economic benefits (Alessandra et al., 2021). Integration of renewable energy

sources like solar and wind power also presents opportunities for reducing reliance on fossil fuels (Marouani et al., 2023). However, challenges such as technological barriers and regulatory constraints hinder widespread adoption, necessitating coordinated efforts to incentivise investment in clean technologies and establish supportive frameworks for sustainable cement production (AlJaber et al., 2023; Barbhuiya et al., 2024; Geng et al., 2023; Nuushuun, 2023).

2.2.3 Air pollution

Air pollution stemming from cement production is a significant environmental concern, with particulate matter (PM), sulfur dioxide (SO2), and nitrogen oxides (NOx) being prominent pollutants emitted during various stages of the cement manufacturing process (Etim et al., 2021). Particulate matter, consisting of fine particles and dust, is released during raw material processing, clinker production, and cement grinding (Nuushuun, 2023). These particles, often small enough to be inhaled deeply into the lungs, can pose serious health risks to nearby communities, leading to respiratory issues such as asthma and bronchitis (Manisalidis et al., 2020). Furthermore, particulate matter can contribute to haze and reduced visibility, impacting air quality and aesthetic values in surrounding areas (Agustine et al., 2018). Research indicates that the size and composition of particulate matter emitted from cement plants vary based on factors such as raw material composition, kiln type, and combustion conditions, highlighting the complexity of addressing this aspect of air pollution in cement production (Ciobanu et al., 2021; Etim et al., 2021; Liu et al., 2019).

Sulphur dioxide (SO2) emissions in cement production primarily result from the combustion of fossil fuels, such as coal and petroleum coke, used to power kilns and other cement plant operations (Nakomcic-Smaragdakis et al.,2016). SO2 is a highly reactive gas that can react with other compounds in the atmosphere to form sulphate aerosols, contributing to acid rain and fine

particulate matter (Chinyama, 2011). Exposure to elevated levels of SO2 can lead to respiratory problems, cardiovascular issues, and damage to vegetation(Manisalidis et al., 2020). Despite advancements in emission control technologies, SO2 emissions remain a significant concern in regions where cement plants rely heavily on Sulphur-containing fuels (Sayed, 2008). Effective monitoring and mitigation strategies are essential to minimise the environmental impact of SO2 emissions from cement production, particularly in areas with stringent air quality regulations or sensitive ecosystems.

Nitrogen oxides (NOx), including nitric oxide (NO) and nitrogen dioxide (NO2), are another class of pollutants emitted during cement manufacturing, primarily from high-temperature combustion processes in kilns and preheaters. NOx emissions contribute to the formation of ground-level ozone and secondary particulate matter, exacerbating air quality issues and posing health risks to nearby communities(Manisalidis et al., 2020). Additionally, nitrogen oxides can react with other atmospheric pollutants to form nitric acid, contributing to acid rain and ecosystem degradation (Menezes & Popowicz, 2022; Prakash et al., 2023). Mitigating NOx emissions from cement plants requires the implementation of advanced combustion technologies, such as selective catalytic reduction (SCR) and selective non-catalytic reduction (SNCR), as well as optimizing operating conditions to minimize nitrogen oxide formation (Ji-Hyeon et al., 2022). Research efforts continue to focus on developing more efficient and cost-effective strategies for reducing NOx emissions from cement production, aiming to mitigate its adverse effects on human health and the environment.

2.2.4 Water pollution

Water pollution stemming from cement production is a significant environmental concern due to wastewater discharge and contamination of nearby water bodies. Throughout the cement

production process, including quarrying, grinding, blending, and clinkerisation, substantial volumes of wastewater containing suspended solids, heavy metals, and chemical additives are generated, posing threats to aquatic ecosystems and human health (Arachchige et al., 2019; Panagoda et al., 2023). Studies have identified elevated levels of pollutants like heavy metals and organic compounds in cement plant wastewater, which persist in the environment, accumulate in sediments, and potentially enter the food chain, highlighting the widespread nature of this issue (Tanabe et al., 2019).

The contamination of water bodies by cement production wastewater has been extensively documented globally, with direct discharge and indirect pathways like runoff and leaching contributing to ecosystem damage and risks to human health (Akhtar et al., 2021; Bashir et al., 2020). Mitigating this pollution requires a multifaceted approach involving technological innovations, regulatory measures, and corporate responsibility initiatives. Strategies such as minimising wastewater generation, improving treatment technologies, implementing stringent environmental regulations, and engaging with local communities are essential to address water pollution effectively (Silva, 2023). By adopting sustainable practices and investing in pollution prevention measures, cement companies can reduce their environmental impact and contribute to the conservation of water resources.

2.2.5 Land degradation

Land degradation, particularly stemming from quarrying and habitat destruction, stands as a significant environmental challenge intertwined with cement production. Quarrying, crucial for obtaining raw materials like limestone and clay, involves extensive excavation, altering landscapes and ecosystems profoundly. Studies reveal the detrimental impacts of quarrying, including soil erosion, biodiversity loss, and habitat disruption. For instance, research by Kafu &

Mlaba, 2024 highlights how quarrying linked to cement production can fragment and destroy habitats, leading to declines in species diversity Additionally, vegetation and topsoil removal during quarrying exacerbate soil erosion, compromising soil fertility and ecosystem viability for plant and animal life (deVilleneuve et al., 2023).

Habitat destruction from cement production operations poses a substantial threat to biodiversity and ecosystem integrity, especially as cement plants often operate near ecologically sensitive areas. Research by Mathews et al. (2014) underscores the adverse effects of habitat destruction, emphasizing the loss of critical habitat for numerous species. Converting natural landscapes into industrial sites not only reduces biodiversity but also disrupts vital ecological processes like pollination and nutrient cycling (Kremen, 2020). Efforts to address these issues necessitate a comprehensive approach integrating environmental conservation principles with sustainable land management practices. Strategies such as quarry rehabilitation, reforestation, and habitat restoration can help mitigate the adverse impacts of cement production on land degradation and biodiversity loss (Salgueiro et al., 2020). Collaborative efforts among industry stakeholders, environmental organizations, and local communities are vital for developing and implementing effective mitigation strategies that balance cement production needs with natural resource preservation and biodiversity conservation.

2.2.6 Health impacts on humans and wildlife

Cement production is linked to various health impacts on humans and wildlife due to pollutant release and ecosystem alterations. Particulate matter (PM) emitted during cement production, including PM2.5 and respirable dust, poses significant health risks to nearby communities, leading to respiratory diseases such as asthma and lung cancer (Manisalidis et al., 2020). Studies conducted in cement-producing regions have highlighted elevated levels of respiratory symptoms

and diseases among residents living near cement plants. Additionally, pollutants discharged during cement production, such as Sulphur dioxide (SO2) and nitrogen oxides (NOx), contribute to acid rain formation, disrupting aquatic ecosystems and posing risks to wildlife (Zuhara & Isaifan, 2018). Heavy metals released during production processes can bio-accumulate in wildlife tissues, threatening both aquatic and terrestrial species (Tchounwou et al., 2012), while quarrying activities lead to habitat destruction and fragmentation, impacting biodiversity and ecosystem resilience (Ozcan et al., 2012).

2.3. Mitigation strategies for negative environmental effects

Mitigation strategies for negative environmental effects are crucial endeavours aimed at minimizing the adverse impacts of human activities on the environment. With the growing recognition of climate change, habitat destruction, pollution, and resource depletion, these strategies are essential for preserving biodiversity, safeguarding ecosystems, and ensuring the sustainability of natural resources. From implementing renewable energy sources to promoting sustainable land use practices and advocating for conservation efforts, mitigation strategies offer a pathway towards fostering a harmonious relationship between human societies and the environment they inhabit.

2.3.1Technological innovations for cleaner production techniques

Technological innovations play a crucial role in mitigating the environmental impact of cement production by enabling cleaner and more sustainable production techniques. One such innovation is the use of alternative fuels and raw materials in cement kilns, which reduces the reliance on fossil fuels and minimizes greenhouse gas emissions (Aranda-Usón et al., 2013). Studies have shown that replacing traditional fuels with alternative fuels such as biomass, municipal solid waste, and tires can significantly lower carbon dioxide emissions and reduce the environmental

footprint of cement production (Chatziaras et al., 2014). Additionally, the integration of advanced combustion technologies, such as precalciner kilns and fluidised bed combustors, enhances energy efficiency and reduces air pollution by optimizing the combustion process and minimizing emissions of particulate matter and nitrogen oxides (Martin, et al., 2011).

Another promising innovation in cement production is the development of carbon capture and storage (CCS) technologies, which capture carbon dioxide emissions from cement plants and store them underground to prevent their release into the atmosphere (Plaza et al., 2020). CCS has the potential to significantly reduce carbon dioxide emissions from cement production, making it a key strategy for achieving carbon neutrality in the industry. Research efforts have focused on improving the efficiency and cost-effectiveness of CCS technologies, as well as identifying suitable geological storage sites for long-term carbon sequestration (Yasemi et al., 2023). By capturing and storing carbon dioxide emissions, CCS not only helps mitigate climate change but also reduces other environmental impacts associated with cement production, such as air pollution and acidification of water bodies.

Furthermore, advancements in materials science and process engineering have led to the development of innovative cement formulations and production processes that minimise environmental impact while maintaining product quality and performance. For example, the use of supplementary cementitious materials such as fly ash, slag, and silica fume as partial replacements for Portland cement clinker reduces the carbon footprint of cement production and enhances the durability and strength of concrete (Yaseen et al., 2024). Additionally, research into alternative binders and additives, such as geopolymers and nano materials, holds promise for further reducing the environmental footprint of cement production by decreasing energy consumption and resource depletion (Krishna et al., 2021). By embracing these technological

innovations, the cement industry can transition towards more sustainable and environmentally responsible production practices, contributing to global efforts to combat climate change and protect the planet's natural resources.

2.3.2 Regulatory frameworks and environmental policies

Regulatory frameworks and environmental policies play a pivotal role in mitigating the environmental impact of cement production in Zimbabwe. The country, like many others, has recognized the importance of balancing industrial development with environmental conservation. Zimbabwe's regulatory framework includes legislation, policies, and guidelines aimed at regulating the cement industry's activities to minimise negative environmental externalities. The Environmental Management Act of 2002 serves as the cornerstone legislation governing environmental management in the country, providing a legal basis for regulating and monitoring industrial activities, including cement production. Additionally, the National Environmental Policy of 2013 outlines the government's commitment to sustainable development and the protection of natural resources, emphasizing the need for industries to operate in an environmentally responsible manner.

In the context of cement production, regulatory frameworks in Zimbabwe focus on various aspects, including air quality, water management, waste disposal, and land use planning. The Environmental Impact Assessment (EIA) regulations require cement companies to conduct comprehensive assessments of the potential environmental impacts of their operations before commencement (Machaka, 2014). This process ensures that environmental considerations are integrated into decision-making processes, allowing for the identification of potential risks and the implementation of mitigation measures. Furthermore, the Environmental Management Agency (EMA) oversees compliance with environmental regulations and issues permits for

industrial activities, including cement production, based on environmental impact assessments and adherence to set standards (Gumindoga et al., 2021).

Despite the existence of regulatory frameworks and environmental policies, challenges remain in their implementation and enforcement, particularly in developing countries like Zimbabwe. Limited resources, institutional capacity, and technical expertise pose significant barriers to effective environmental governance in the cement industry (Howes et al., 2017). Furthermore, issues such as corruption, lack of public participation, and inadequate monitoring and enforcement mechanisms undermine the efficacy of regulatory frameworks (Moji et al. 2022). As a result, there is a need for strengthened collaboration between government agencies, industry stakeholders, and civil society to address these challenges and ensure the effective implementation of environmental policies. Additionally, capacity-building initiatives, public awareness campaigns, and investment in monitoring technologies are essential to enhance regulatory compliance and promote sustainable practices within the cement industry in Zimbabwe (Matamanda et al., 2022).

2.3.3 Lack of enforcement of environmental regulations

The lack of enforcement of environmental regulations represents a significant challenge in mitigating the adverse impacts of cement production on the environment. Despite the existence of environmental laws and regulations governing industrial activities, including cement manufacturing, enforcement mechanisms may be weak or ineffective in many regions. Several studies have highlighted instances where cement companies, including those in Zimbabwe, have been found to operate in non-compliance with environmental regulations, leading to increased pollution and environmental degradation (Kusena et al., 2012). For instance, a study by Smith et al. (2019) found that in Zimbabwe, many cement factories often bypassed environmental

standards due to lax enforcement by regulatory authorities, resulting in significant air, water, and soil pollution in surrounding communities (Kusena et al., 2012). This lack of enforcement not only undermines environmental protection efforts but also poses serious risks to public health and ecosystems.

In addition to regulatory enforcement challenges, corruption and regulatory capture further exacerbate the situation, hindering effective environmental governance in the cement industry (Tu et al., 2020). Studies have documented instances where regulatory agencies tasked with overseeing environmental compliance may be susceptible to corruption or undue influence from industry stakeholders, compromising their ability to enforce regulations impartially (Tu et al., 2020). For example, research by Santos et al., 2022 and Xia et al., 2024 identified instances of regulatory capture in the cement industry in various countries, where industry lobbying and political connections influenced regulatory decision-making, often to the detriment of environmental protection. In Zimbabwe, similar concerns have been raised regarding the relationship between regulatory agencies and cement companies, raising questions about the integrity and effectiveness of environmental enforcement mechanisms (Mubonderi, 2023).

Moreover, the lack of public participation and transparency in the regulatory process further undermines efforts to enforce environmental regulations in the cement industry (Azevedo, 2017). Many communities affected by cement production activities may lack awareness of their rights or avenues for meaningful engagement in decision-making processes related to environmental permits, monitoring, and enforcement (Brewer, 2009). This lack of transparency and public participation not only limits accountability but also perpetuates a cycle of environmental injustice, disproportionately impacting marginalized communities. Research by Brown and Jones (2018) underscores the importance of community involvement in environmental governance,

highlighting the role of civil society organizations and grassroots movements in advocating for stronger regulatory enforcement and promoting environmental justice (Bullard & Johnson, 2000; Gemmill-Herren & Bamidele-Izu, 2002). In the context of the Khaya Cement Company in Eastview, Zimbabwe, addressing these governance challenges requires strengthening regulatory capacity, promoting transparency and accountability, and fostering meaningful engagement with affected communities to ensure effective enforcement of environmental regulations and safeguard environmental sustainability (Murombo, 2016)

2.3.4 Technological limitations in implementing cleaner production methods

Technological limitations pose significant challenges to the implementation of cleaner production methods in cement production, influencing both the feasibility and effectiveness of environmental mitigation strategies. One major obstacle lies in the inherent complexity and scale of cement manufacturing processes, which often involve high temperature reactions and large-scale industrial equipment (Telschow et al., 2012). Traditional cement production relies heavily on energy-intensive processes, such as clinker production in rotary kilns, which emit substantial amounts of greenhouse gases and particulate matter (Schneider et al., 2011). Despite advancements in technology, implementing cleaner production methods requires overcoming technical barriers related to process efficiency, resource utilization, and emissions control(Neto et al., 2022). For instance, while alternative fuels and raw materials can reduce carbon emissions and resource consumption, their use may require modifications to existing equipment and infrastructure, posing logistical challenges and investment costs for cement producers.

Moreover, the diversity of cement production facilities worldwide presents a further challenge in implementing standardized cleaner production technologies. Cement plants vary significantly in terms of age, size, and geographical location, each presenting unique technical constraints and

opportunities for environmental improvement. Retrofitting older facilities with advanced emission control systems or transitioning to alternative cement production processes may be economically and technically unfeasible for some companies(Hills et al., 2016). Additionally, the availability of skilled personnel and technical expertise plays a crucial role in adopting and optimizing cleaner production technologies. Small and medium-sized cement producers, in particular, may lack the resources and technical know-how to invest in cleaner production methods, hindering their ability to meet environmental regulations and sustainability targets Rizos, et al., 2016).

Despite these challenges, ongoing research and development efforts in the cement industry aim to address technological limitations and promote the adoption of cleaner production methods. Innovative approaches, such as carbon capture and utilization (CCU) technologies, offer promising opportunities to reduce carbon dioxide emissions from cement production by capturing and repurposing CO2 for beneficial use. Furthermore, advancements in process optimization, digitalization, and automation hold potential for improving energy efficiency and reducing environmental impacts across the cement manufacturing value chain (Peng et al., 2023). However, successful implementation of cleaner production technologies requires a collaborative approach involving industry stakeholders, policymakers, researchers, and technology providers to overcome technological barriers, drive innovation, and achieve sustainable development goals in the cement sector.

2.3.5 Political and social resistance to change

Political and social resistance to change in cement production in Zimbabwe is a critical aspect that warrants attention within the literature. Zimbabwe's political landscape, marked by historical legacies and contemporary dynamics, plays a significant role in shaping attitudes towards

industrial development and environmental regulation (Ndlovu-Gatsheni, 2003). Political interests, including those of government officials, industry stakeholders, and influential individuals, often intersect with economic considerations, creating barriers to implementing sustainable practices in cement production(Rich Dorman & Rich Dorman, 2016). Moreover, political instability and governance challenges in Zimbabwe may exacerbate environmental degradation by prioritizing short-term economic gains over long-term sustainability objectives(Rich Dorman & Rich Dorman, 2016). This complex interplay between politics and environmental management underscores the importance of examining the political dimensions of resistance to change in the cement industry.

Social resistance to change in cement production in Zimbabwe is also influenced by various socio-cultural factors, including community perceptions, values, and livelihood concerns (Kusena et al., 2102). Local communities living near cement plants may resist changes to production practices due to fears of economic disruption, displacement, or adverse health impacts. Additionally, historical experiences of environmental injustice, such as unequal distribution of environmental burdens and benefits, can foster distrust between communities and cement companies, leading to heightened resistance to change. Social movements, civil society organizations, and grassroots activists often mobilize to challenge environmentally harmful practices in the cement industry, amplifying voices of dissent and advocating for greater accountability and transparency in decision-making processes.

2.3.6 Collaboration between government, industry, and community stakeholders

In Zimbabwe, as in many other countries, collaboration between government, industry, and community stakeholders plays a crucial role in achieving sustainable cement production. The cement industry is a significant contributor to the national economy, providing essential building

materials for infrastructure development and construction projects. However, the environmental impact of cement production, including air and water pollution, land degradation, and resource depletion, necessitates a coordinated approach among stakeholders to mitigate adverse effects while fostering economic growth (Mohamad et al.,2021). Government involvement is vital in establishing regulatory frameworks, setting environmental standards, and monitoring compliance to ensure that cement companies operate in an environmentally responsible manner. By working closely with industry stakeholders, the government can promote the adoption of cleaner production technologies, encourage investment in sustainable practices, and enforce environmental regulations effectively (Kumar et al., 2023).

Industry engagement is equally important in driving sustainable cement production initiatives in Zimbabwe. Cement companies have a vested interest in reducing their environmental footprint to enhance their reputation, comply with regulatory requirements, and meet the growing demand for environmentally friendly products. Through innovation, research, and development, cement manufacturers can explore alternative raw materials, improve energy efficiency, and minimize waste generation throughout the production process (Abdul-Wahab et al., 2021). Collaboration with government agencies, research institutions, and environmental NGOs can provide industry stakeholders with access to expertise, funding opportunities, and best practices for sustainable manufacturing. Moreover, industry-led initiatives such as corporate social responsibility programs, stakeholder engagement forums, and transparency in reporting environmental performance can foster trust and collaboration with local communities affected by cement production activities.

Community engagement and participation are essential elements of sustainable cement production efforts in Zimbabwe. Local communities residing near cement plants are directly

impacted by environmental pollution, noise, traffic, and other disturbances associated with industrial operations. Therefore, fostering dialogue, building trust, and addressing community concerns are critical for achieving social license to operate and maintaining harmonious relationships between cement companies and neighboring communities. Through consultation processes, community members can voice their concerns, provide feedback on environmental management practices, and participate in decision-making regarding land use planning, resource allocation, and environmental mitigation measures (Aranda-Usón et al., 2013). Collaboration between government, industry, and community stakeholders can facilitate the development of inclusive policies, programs, and initiatives that balance economic development with environmental protection and social equity, ultimately leading to more sustainable cement production practices (Favretto et al., 2021).

2.3.7 Investment in research and development for greener technologies

Investment in research and development (R&D) for greener technologies is increasingly recognized as a crucial approach to mitigating the environmental impact of cement production worldwide, including in Zimbabwe. Various studies have highlighted the potential of greener technologies to reduce carbon emissions, minimize resource depletion, and enhance overall sustainability within the cement industry. For instance, research by Bourtsalas et al., 2018 demonstrated the feasibility of utilizing alternative fuels such as biomass and waste-derived fuels in cement kilns, which not only reduces reliance on fossil fuels but also decreases greenhouse gas emissions. Similarly, advancements in alternative raw materials, such as fly ash and slag, have been shown to decrease the carbon intensity of cement production while simultaneously addressing waste management challenges (Althoey et al., 2023). These studies underscore the

importance of R&D investments in fostering innovation and driving the adoption of greener technologies to promote sustainable cement production practices in Zimbabwe.

In the Zimbabwean context, there is a growing recognition of the need to invest in R&D for greener technologies to address environmental challenges associated with cement production. With the government's increasing emphasis on sustainable development and climate action, there is an opportunity to leverage R&D investments to enhance the environmental performance of the cement industry. For instance, research initiatives focused on optimizing energy efficiency in cement manufacturing processes have the potential to reduce both energy consumption and carbon emissions. Furthermore, collaborations between academia, industry stakeholders, and government agencies can facilitate knowledge exchange and technology transfer, thereby accelerating the adoption of greener technologies across the cement sector (Mbohwa et al., 2018). By prioritizing R&D investments in greener technologies, Zimbabwe can position itself as a leader in sustainable cement production within the region while simultaneously contributing to global efforts to mitigate climate change and environmental degradation.

However, despite the potential benefits of investing in R&D for greener technologies, several challenges and barriers need to be addressed to realize their full potential in Zimbabwe's cement industry. Limited funding and resources for research and innovation, coupled with a lack of incentives for technology adoption, pose significant obstacles to progress in this area. Additionally, technological limitations and the need for skilled personnel to implement and maintain greener technologies may hinder their widespread adoption. Furthermore, regulatory frameworks and policy support are essential to create an enabling environment for R&D investments and incentivize industry players to prioritize sustainability in cement production (Misi and Chikowore, 2019). Addressing these challenges will require concerted efforts from

government, industry, and other stakeholders to mobilize resources, build capacity, and foster a culture of innovation to drive sustainable development in Zimbabwe's cement sector.

2.3.8 Education and awareness programs for sustainable consumption and production

In Zimbabwe, as in many developing nations, the cement industry plays a pivotal role in infrastructure development, but its growth has been accompanied by environmental challenges. Education and awareness programs focused on sustainable consumption and production practices are crucial to mitigating the adverse impacts of cement production on the environment. These programs aim to inform stakeholders, including industry players, policymakers, communities, and consumers, about the environmental consequences of cement manufacturing and promote more sustainable alternatives. By raising awareness about the environmental footprint of cement production and advocating for responsible consumption patterns, these programs can help drive the adoption of cleaner technologies, enhance regulatory frameworks, and foster a culture of environmental stewardship in cement sector (Montalvo, 2008).

Various initiatives have been undertaken to promote education and awareness on sustainable consumption and production in Zimbabwe's cement industry. These efforts often involve collaboration between government agencies, non-governmental organizations (NGOs), academic institutions, and industry stakeholders. For instance, the Environmental Management Agency (EMA) of Zimbabwe has implemented public awareness campaigns, workshops, and educational materials targeting cement producers, construction companies, and local communities (Macheka & Hardman, 2021). These initiatives aim to educate stakeholders about the environmental impacts of cement production, raise awareness about sustainable construction practices, and promote the use of alternative materials such as fly ash and slag in cement production. By

engaging with stakeholders at multiple levels, these programs seek to foster a holistic approach to sustainability in Zimbabwe's cement industry.

Despite these efforts, challenges remain in effectively implementing education and awareness programs for sustainable consumption and production in Zimbabwe's cement sector. Limited resources, inadequate infrastructure, and socio-economic disparities pose significant barriers to widespread adoption of sustainable practices. Furthermore, there is a need for greater coordination and collaboration among stakeholders to ensure the success of education and awareness initiatives. Addressing these challenges requires sustained commitment from government, industry, civil society, and the international community to prioritize environmental sustainability in Zimbabwe's cement industry. By investing in education, raising awareness, and promoting sustainable consumption and production practices, Zimbabwe can mitigate the environmental impact of cement production and move towards a more sustainable future.

2. 4 Chapter summary

This chapter focused on reviewing the literature in relation to the production of cement, the effects of cement production to the environment, the effects of cement production on wildlife and human health and the strategies to mitigate the effects of cement production to the environment. The literature reviewed that although cement plays a crucial role in economic development of any country it also has negative effects in its production. The next chapter presents research methods of the study

Chapter 3: Research Methodology

3.0 Introduction

The methodology chapter serves as the backbone of a research study, providing a comprehensive overview of the methods and techniques employed to address the research questions and objectives (Goundar, 2012; Jilcha, 2020). This chapter outlines the research paradigm, research approach, research design, entry into research sites, selection of participants, data collection procedures, and analytical approaches utilized to generate and analyses data, trustworthiness and ethical considerations.

3.1 Research paradigm

A paradigm refers to a set of beliefs, values, assumptions, and practices that guide the way researchers conceptualize, conduct, and interpret their studies (Kivunja & Kuyini 2017). It serves as a framework or lens through which researchers view the world, formulate research questions, select methodologies, and interpret findings (Abdul & Alharthi, 2016). Paradigms provide researchers with a foundational understanding of how knowledge is generated, organized, and validated within a particular discipline or field of study (Kivunja & Kuyini 2017). Different paradigms may emphasize different ontological (beliefs about the nature of reality), epistemological (beliefs about the nature of knowledge), and methodological (approaches to inquiry and data collection) perspectives (Held, 2019).

This study is located within constructivism paradigm which believes that reality is socially constructed, subjective, may change, and is multiple (Brau, 2020). Using the constructivism

paradigm to examine the impact of cement production on the environment, specifically focusing on Khaya Cement Company in Eastview, offers a unique and insightful perspective. Constructivism emphasizes the subjective construction of knowledge and understanding through social interactions and interpretations of experiences (Brau, 2020). Constructivism offers a meticulous perspective on understanding the environmental impact of cement production in Eastview, acknowledging the subjective interpretation of environmental issues. Through this paradigm, researchers can ferret into how individuals and communities construct their understanding of the environment based on their unique experiences, values, and social contexts (Adom & Ankrah, 2016). By employing methods such as interviews, focus groups, and participatory approaches, diverse perspectives, local knowledge, and community narratives regarding environmental degradation, health concerns, and socio-economic implications can be uncovered (Duea et al., 2022). Furthermore, constructivism underscores the importance of contextualizing environmental practices within socio-cultural and historical contexts (Watson, 2024). This lens allows researchers to examine how historical factors, political dynamics, and socio-economic conditions shape environmental practices and policies related to cement production in Eastview. By engaging stakeholders as active participants in the research process, constructivism promotes participatory engagement and knowledge co-creation (Boaz et al., 2018). Through collaborative efforts with community members, local organizations, and industry stakeholders, solutions to environmental challenges associated with cement production can be developed. Additionally, constructivism emphasizes reflexivity and acknowledges the multiple realities and subjective interpretations within a given context (Mills et al., 2006, Mogashoa, 2014). Researchers critically reflect on their biases, assumptions, and positionalities, navigating complexities and uncertainties inherent in studying environmental issues. This

inclusive and metric approach fosters a deeper understanding of the impact of cement production on the environment in Eastview, paving the way for more effective and sustainable environmental management practices.

3.2 Research approach

A research approach refers to the overarching strategy or method that researchers use to investigate a particular topic or question (Grover, 2015). It outlines the general framework within which research is conducted, including the theoretical perspective, data collection methods, data analysis techniques, and overall design of the study. This study is located within qualitative research approach.

Utilizing a qualitative research design to examine the impact of cement production on the environment, specifically focusing on Khaya Cement Company in Eastview, offers a nuanced understanding of the complex interactions and contextual factors at play. Qualitative methods such as interviews, focus groups, and observations allow researchers to explore deeply into the experiences, perceptions, and perspectives of various stakeholders, including community members, environmental activists, company employees, and regulatory authorities (Almeida et al., 2017). Through these qualitative approaches, researchers can uncover the diverse range of environmental concerns, social dynamics, and economic implications associated with cement production in Eastview. By engaging with stakeholders in open-ended discussions and exploring their lived experiences, researchers can capture rich, contextualized data that goes beyond mere quantification of environmental parameters, providing insights into the underlying causes, motivations, and implications of cement production on the local ecosystem and community well-being (Aschehoug et al., 2012).

Moreover, qualitative research facilitates the exploration of complex, multifaceted phenomena in their natural settings, allowing researchers to uncover emergent themes, patterns, and contradictions that may not be apparent through quantitative methods alone (Busetto et al., 2020; Cleland, 2017; Cropley, 2023). Through in-depth interviews with community members, for example, researchers can elucidate the ways in which cement production impacts daily life, livelihoods, and social cohesion in Eastview. Additionally, qualitative methods enable researchers to adopt a reflexive stance, acknowledging their own subjectivity and biases while actively engaging with the voices and perspectives of participants (Olmos-Vega et al., 2023). This reflexive approach enhances the trustworthiness and credibility of the research findings, fostering transparency and accountability in the research process. Overall, by embracing a qualitative research design, this study can offer holistic insights into the environmental, social, and economic dimensions of cement production in Eastview, facilitating informed decision-making and promoting sustainable development initiatives.

3.4 Research design

Research design refers to the overall strategy or plan used to investigate a particular research question or hypothesis (Thakur, 2021). It outlines the structure and methodology of a study, including how data will be collected, analyzed, and interpreted. This study is rooted with a phenomenology research design.

Phenomenology IS a valuable research design for examining the negative effects posed to the environment by cement production at Khayah Zimbabwe Cement Company. This approach aims to explore and understand the lived experiences of individuals affected by the environmental impacts of cement production in the local community. Researchers can conduct in-depth interviews with community members, workers, and other stakeholders to gather rich, detailed

descriptions of their experiences, perceptions, and concerns regarding the environmental consequences of cement production (Zikargae et al., 2022). By focusing on the lived experiences and perspectives of these individuals, phenomenology allows for a deeper understanding of the complex relationships between cement production activities and environmental degradation in the local context (Neubauer et al., 2019).

Furthermore, phenomenology emphasizes the subjective experiences and meanings people attach to their experiences, providing insights into the social, cultural, and environmental factors influencing perceptions of environmental impacts (Neubauer et al., 2019). Through this qualitative approach, researchers can uncover hidden insights, patterns, and themes that may not be captured through quantitative methods alone. By engaging directly with the community and stakeholders, phenomenology enables researchers to develop a holistic understanding of the environmental challenges faced by the community due to cement production at Khayah Zimbabwe Cement Company. This in-depth understanding can inform strategies for sustainable development and environmental management to mitigate the negative effects of cement production on the local environment (Ekincioğlu et al., 2013).

3.5 Entry into the research site

Any research done where human participants are involved, ethical issues need to be considered. Doing research ethically means protecting human participants; conducting research in such a way that serves the interests of individuals, groups and the society looking at issues such as management of risk, protection of confidentiality, and informed consent (Smith, 2003).

Ethical issues that need attention include copyright, informed consent, confidentiality and authority to conduct research in particular geographical settings. Authority to undertake this study started at the Bindura University of Science Education., then the Eastview community

thorough community leaders and the Khaya Company through its management. Below is a description of how I sought participation consent from Bindura University of Science Education, until I collected the data needed in the study. At Bindura University of Science Education, I obtained an introductory letter from the Faculty of Science Education chair of research unit (see appendix 1). I took my introductory letter and my request to conduct my study in Eastview (see Appendix 2) community leaders. The request for research authority letter contained details of the study. This authority to undertake research was then taken to Khaya Cement Company for the purpose of obtaining research authority at organizational level. This was granted (see appendix 3). From this level I constructed a consent form that sought to ask for informed consent from the participants (see appendix 6). The consent letter highlighted the purpose of the study, ethical consideration that promote confidentiality, right to withdrawal at any point during the study. The consent form also highlighted the time to be taken interviewing the participant, the mode of capturing data that will be audio. The emphasis was placed on the using data collected only for research purposes and nothing else. The upcoming section is going to the data collection procedures applied in this study.

3. 6 Selection of participants

Selecting participants for a study on the effects of Khayah cement production on the environment in the Eastview community involved several steps to ensure the sample represents the population of interest and provides meaningful data for analysis.

In qualitative research, selecting participants involves purposefully choosing individuals who can provide rich and diverse perspectives relevant to the research questions (Palinkas et al., 2015). For the study on the effects of Khayah cement production on the environment in the Eastview community, participants include 10 residents living in close proximity to the cement production

site, 2 environmental activists (from EMA), and 2 chemistry teachers from nearby school. The goal is to gather insights from various stakeholders who can offer firsthand experiences, knowledge, and opinions regarding the environmental impacts of cement production in the community.

Similarly, for the inquiry into pollution affecting the environment in Eastview Community, participants encompass a wide range of individuals and groups affected by pollution, including 10 residents, 4 healthcare professionals, 5 educators, and 4 local business owners, involving diverse perspectives, the research can capture the multifaceted nature of pollution and its implications for different aspects of the community, such as public health, economic development, and social well-being. This breadth of input is essential for gaining a comprehensive understanding of the complex dynamics at play.

When considering how to mitigate the negative effects identified through the research, participant selection becomes particularly critical. In addition to including individuals and organizations directly impacted by the environmental challenges in Eastview, I include 10 community activists, 2 EMA officials, and 2 urban planners. These participants can contribute valuable insights into potential strategies and interventions for addressing environmental degradation and promoting sustainability in the community. By engaging with a diverse array of stakeholders, the research can foster collaboration and dialogue aimed at identifying feasible and effective solutions to mitigate the identified negative effects.

3.7 Data collection method

The data collection method employed in this study is grounded in qualitative research methodologies, emphasizing depth and context in understanding human experiences and

perspectives. Through structured interviews with diverse participant groups, the study seeks to explore the complex environmental challenges associated with Khayah cement production in the Eastview community. This qualitative approach allows for the capture of rich, detailed narratives, providing valuable insights into the multifaceted implications of cement production on the environment and the community. The collected qualitative data serves as a foundation for identifying patterns, common themes, and unique perspectives, contributing to a comprehensive analysis of the study's focus.

3.7.1 Data collection instruments

The development of the interview guide for this study on the effects of Khayah cement production on the environment in the Eastview community was informed by a rigorous research process. Initially, a thorough literature search was conducted to identify existing studies and gaps in knowledge regarding the environmental impacts of cement production. This literature review helped shape the focus of the interview guide by highlighting key areas of concern and potential topics for exploration. The interview questions were meticulously crafted to be relevant to the study's objectives and tailored to the diverse participant groups involved. For instance, a sample question posed to the local residents might be, "Can you describe any noticeable changes in the local environment since the commencement of cement production in Eastview?" For environmental activists, a question could be, "What are your primary concerns regarding the environmental impact of Khayah cement production, and what mitigation measures do you recommend?" These questions aimed to elicit detailed narratives and professional insights, facilitating both qualitative and quantitative data collection to provide a holistic understanding of the environmental challenges faced by the community.

3.7. 2 Data collection process

To investigate the effects of Khayah cement production on the environment in the Eastview community, a comprehensive data collection procedure was implemented, involving structured interviews with various participant groups.

The participant selection process aimed to capture diverse perspectives on the environmental impacts of cement production. Ten residents directly affected by the cement production were selected to provide firsthand experiences and observations. Additionally, two environmental activists affiliated with the Environmental Management Agency (EMA) and two chemistry teachers were included to offer professional insights and organizational perspectives, respectively.

Interview questions were meticulously crafted to address key topics, such as environmental pollution, public health, economic implications, and social well-being. The questions were tailored to the roles and expertise of each participant group, ensuring clarity and relevance. A combination of open-ended and close-ended questions was utilized to facilitate detailed narratives and quantitative data collection, providing a holistic understanding of the issues at hand.

Individual interviews were scheduled with each participant, accommodating their preferences for face-to-face, virtual, or phone interviews based on availability and comfort. The interviews were conducted in a confidential and comfortable setting to encourage candid and insightful responses. Participants were assured of confidentiality and anonymity to promote honesty.

With participants' consent, the interviews were recorded to ensure accurate data capture. The recorded data were transcribed and analyzed meticulously to identify patterns, common themes,

and unique insights. Qualitative data from open-ended questions provided rich narratives, while quantitative data from close-ended questions offered measurable insights.

3.8 Data analysis

Following the comprehensive data collection through structured interviews with diverse participant groups in the Eastview community, a systematic data analysis procedure was adopted to interpret the gathered information. The recorded interviews were transcribed verbatim to maintain the integrity of the data. Utilizing a qualitative content analysis approach, the transcriptions were reviewed to identify recurring themes, patterns, and unique insights related to environmental pollution, public health concerns, economic implications, and social well-being. Open-ended responses from participants provided rich qualitative narratives that were coded and categorized to capture the depth and nuances of their experiences and perspectives. Concurrently, quantitative data from close-ended questions were analyzed using descriptive and inferential statistical methods to derive measurable insights and correlations. The combination of qualitative and quantitative analyses facilitated a holistic understanding of the environmental impacts of Khayah cement production on the Eastview community, informing the development of targeted strategies for mitigation and improvement.

3. 9 Trustworthiness

Trustworthiness in this study was ensured through various strategies encompassing dependability, credibility, confirmability, and transferability. Dependability was established by maintaining consistency in the data collection process and adhering to the structured interview protocol across all participant groups (Forero et al., 2018). Credibility was achieved by selecting a diverse range of participants, including residents, environmental activists, and cement company representatives, and crafting interview questions tailored to their roles and expertise, ensuring the

data's relevance and authenticity (Forero et al., 2018). Confirmability was maintained through meticulous data recording, transcription, and analysis, allowing for the traceability and verification of findings (Johnson et al., 2020). Lastly, transferability was addressed by providing detailed descriptions of the research context, participant selection criteria, and data collection procedures, enabling the findings to be applied or compared in similar contexts beyond the Eastview community (Shenton, 2004).

3.10 Ethical considerations

Ethical considerations are paramount in rigorous research, shaping the integrity and credibility of the study (Enago Academy, 2019). Ethics should not be relegated to a mere procedural formality but should be integrated seamlessly into every stage of the research process (Žukauskas et al., 2018). In the investigation of the effects of Khayah cement production on the environment in the Eastview community, ethical principles were diligently upheld. The participant selection process prioritized voluntary participation, ensuring that individuals willingly chose to share their experiences and insights. Confidentiality and anonymity were maintained throughout the data collection process, safeguarding participants' privacy and encouraging open dialogue. Furthermore, participants were informed of their right to withdraw from the study at any point without facing negative consequences, upholding the principle of autonomy. Adhering to the ethical principle of "primum non nocere" or "first do no harm," care was taken to minimize potential risks and ensure that the research process did not cause harm or distress to the participants. These ethical considerations were not merely checkboxes to be ticked but were integral to the research design and implementation, demonstrating a genuine commitment to ethical research practices.

3. 11 Limitations of the study

While the structured data collection procedure provided valuable insights into the environmental impacts of Khayah cement production in the Eastview community, there were inherent limitations that could have affected data quality. One potential limitation was the reliance on self-reported information, which may be subject to biases or inaccuracies. To mitigate this, interview questions were designed to encourage participants to provide detailed and honest responses, and the confidential setting was maintained to foster openness. Additionally, the limited sample size, particularly the small number of environmental activists and chemistry teachers, may not fully represent the diversity of perspectives on the issue. To address this, efforts were made to select participants with varying backgrounds and expertise to capture a broad range of insights. Despite these limitations, the data collection process was conducted systematically, adhering to rigorous methodological standards, to ensure the reliability and validity of the findings. In the subsequent chapter, the analysis of the gathered data will be presented, offering a nuanced understanding of the environmental implications of cement production in Eastview and informing strategies for mitigation and improvement.

3. 12 Chapter summary

This chapter presented an overview of the research methodology used to gather data from a sample size of21 participants. These encompass a wide range of individuals and groups affected by pollution, including 10 residents, 1 health personal,5 educators, and 4 local business owners and an environmental activist. The chapter also looked at that data is to be collected using interviews.

Chapter 4: DATA PRESENTATION, ANALYIS AND INTERPRETATION

4.0 Introduction

Chapter 4 digs into the findings and discussions centered around the environmental impacts of Khayah cement production on the Eastview community. Through structured interviews with residents, environmental activists, and a chemistry teacher, this study aims to comprehensively understand the ramifications of cement production on the local environment. The chapter explores demographics, experiences, perceptions, regulatory compliance, and potential solutions, offering insights into the multifaceted challenges faced by the community.

4.1 Theme 1 Findings from Research Question 1: Environmental impacts of khayah Cement Production on the Eastview Community

The purpose of this study was to understand the environmental impacts of Khayah cement production on the Eastview community. Participants from various backgrounds, including residents, environmental activists, and a chemistry teacher, shared their observations, concerns, and suggestions for mitigating these impacts. The findings are based on interviews conducted using a structured guide that covered demographics, experiences, perceptions, regulations, and potential solutions.

4.1.1 Demographics and background

Participants included residents, an environmental activist, and a chemistry teacher, all of whom have lived near the cement production site for periods ranging from 5 to 10 years. This diverse group provided a comprehensive perspective on the environmental impacts of the cement production.

4.1. 2 Experience and observations

Participants consistently reported noticeable dust accumulation on buildings, plants, roofs, and other surfaces. This dust was often described as grey and pervasive. There were frequent mentions of deteriorating air quality, noise pollution, and water contamination, attributed directly to the cement production. Several respondents noted changes in the local vegetation, such as plants appearing dusty, grey, and shorter than usual. One environmental activist also highlighted impacts on animals and land. This supported by the following excerpts:

> *“Since the cement production began, I have noticed that buildings and plants appear dusty and grey, and the plants are shorter than usual." (Chemistry teacher, resident for 5 years)*
>
> *"There is visible dust accumulation on vegetation, roofs, and other surfaces. The roofs and plants nearby have turned grey." (Environmental activist, resident for 6 years)*
>
> *"There is dust in the windows of houses and on parked cars." (Resident for 10 years)*
>
> *"The community is experiencing social isolation and disruption of traditional ways of life due to the environmental changes." (Resident for 5 years)*
>
> *"Plants, animals, land, and water bodies are affected." (Environmental activist, resident for 6 years)*

"Continuous exposure may lead to chronic diseases such as TB." (Resident for 6 years)

Many participants reported an increase in respiratory diseases, such as coughing, sneezing, and chest pains. There was also mention of high rates of respiratory-associated diseases and flu. Additionally, participants observed a decline in the quality of life, citing health problems and social isolation. One participant mentioned concerns about chronic diseases like tuberculosis due to continuous exposure to pollutants.

4.1.3 Perceptions and concerns

A significant concern regarding the cement plant was its proximity to residential areas, which was seen as a major factor contributing to environmental and health issues. Participants were particularly worried about various forms of pollution, including dust, particulate matter, noise pollution, and water pollution.

The community is experiencing health declines and disruptions to their traditional ways of life, with social isolation and displacement also being significant issues. Tgis is supported in the following excerpts:

"The closeness of the cement plant to the residential area is a primary concern. There was neglect in the distance of plants to residential areas." (Chemistry teacher, resident for 5 years)

4.1.4 Regulations and compliance

Most participants were aware of environmental regulations or the existence of environmental impact assessments. However, they felt these regulations were not adequately enforced. There was a general consensus that regulations were not being adequately enforced. Participants noted

neglect in maintaining appropriate distances between the plant and residential areas, and inadequate action to reduce dust levels. This is substantiated by the following excerpts

> *"Environmental impact assessments and regulations are not being adequately enforced since people in the area are greatly affected." (Resident for 5 years)*

> *"There is some level of breaching the regulations, and they should ensure the health and safety of workers and the environment." (Environmental activist, resident for 6 years)*

4.1.5 Suggestions and solutions

Participants emphasized the need for strict enforcement of environmental laws and adherence to international standards for regulatory compliance. Suggestions for improving technology and practices included implementing dust collectors, carbon capture and storage technologies, and other dust suppression measures. There was also a call for more community involvement and engagement from the cement company to address environmental concerns effectively. However, participants believed that the community had little power to influence the cement company due to its elite status. They suggested that the company should monitor air quality and be responsive to community concerns. This was supported by the following excerpts:

> *"The government must enforce laws as per world standards, and the company must bear the health bills of the affected community members." (Chemistry teacher, resident for 5 years)*

> *"Community engagement, regulatory compliance, and implementing carbon capture and storage technologies to reduce carbon emissions and dust suppression are needed." (Resident for 5 years)*

"Install dust collectors, and the company should monitor air quality and allow residents to raise an alarm if there is a breach." (Environmental activist, resident for 6 years) "EMA and the government must enforce the law, and the company must adhere to international standards." (Resident for 10 years)

4.1.6 Additional insights

Some participants highlighted the necessity for the company to bear the healthcare costs of affected community members. Another suggested shutting down the company if it fails to comply with environmental standards.

4.2 Findings and analysis from research question 2

The interviews conducted with various stakeholders in the Eastview Community reveal significant insights into the impact of pollution on personal experiences, health, education, and the local economy. These perspectives help to paint a comprehensive picture of the community's struggles and highlight urgent areas for intervention.

4.2.1 Personal experience and observations

Interviewees consistently reported pervasive pollution affecting the entire community. Descriptions of dusty environments, grey roofs, and discoloration of painted walls and plants underscore the visible impact of pollution.

Respondents frequently mentioned respiratory issues such as congested noses, sneezing, and increased cases of flu. One participant highlighted waking up with a congested nose, while another noted the rising prevalence of airborne diseases.

Over the years, residents observed a decline in air quality and changes in the environment, such as vegetation covered in cement dust and water bodies turning grey. The general consensus is

that pollution levels have increased, significantly altering the community's environment. This is supported by the following excepts.

"The outlook of the environs indicates pollution of the whole community."

"Daily we enable dusty, pollutants from the plants."

"Environment no longer has clear air."

"Release of cement dust and particulate matter affecting air quality and human health."

"Pollution is affecting water quality and dusty conditions are resulting in respiratory diseases."

"Surfaces are always dusty despite regular cleaning."

"Usually wake up with a congested nose and sneezing."

"Roofs and painted walls have changed color."

4.2.3 Health implications

Healthcare professionals in the community pointed out an increase in respiratory conditions, including symptoms indicative of lung malfunction and a higher risk of tuberculosis. This correlation between pollution and health issues underscores the urgent need for medical and environmental intervention. This is substantiated by the following excerpts:

"Pollution."

"High risk of respiratory symptoms and lung malfunction."

"Tuberculosis."

4.2.4 Educational perspective

Educators have responded by incorporating environmental awareness into their curricula. This includes introducing environmental chemistry, integrating environmental topics into various subjects, hands-on activities, and field trips. Pollution has created significant educational challenges, such as decreased school attendance due to health issues and the loss of students whose parents have died from pollution-related diseases. Limited resources and lack of technology also hinder effective environmental education. This supported by the following excerpts:

> *"Introduce environmental chemistry into the curriculum with special emphasis on case studies."*

> *"Lack of awareness, limited resources, limited access to technology, and lack of role models."*

4.2.5 Economic impact

Local business owners reported economic challenges stemming from pollution, such as dusty products that deter customers and a preference for purchasing goods from cleaner areas. Additionally, pollution has driven some residents to relocate to less polluted suburbs, further impacting local businesses.

Despite these challenges, some business owners see potential opportunities for innovation in pollution control measures, which could both improve community health and create new economic opportunities. This supported in the following excerpts:

> *"Customers prefer to buy hardware materials in the city as our products are always dusty and look older."*

"Many are relocating to clean suburbs."

4.2.6 Scientific insights

Environmental scientists identified air pollution from industrial emissions and machinery as the primary concerns. They highlighted the need for mitigation strategies such as installing filters on emission stacks to trap dust and gases. Recommendations included practical solutions like greenhouse farming to protect crops from cement dust and promoting natural remedies to clear dust from residents' bodies. This is supported by the following excerpts:

"Air pollution is most dominant due to emissions; noise levels may also be a challenge from the machinery being used."

"Filters on emission stacks to trap the dust and gases produced."

"Greenhouse farming to reduce the amount of cement on crops."

4.2.7 Pressing issues and suggested solutions

A recurrent suggestion across interviews was the relocation of polluting industrial plants to distant areas to reduce their impact on the community. This was seen as a critical step to improving air quality and overall community health.

Interviewees proposed several community-based initiatives, including cleanup campaigns, educational programs about pollution dangers, and collaborative efforts requiring government support to make impactful changes.

"The decision has to be made to relocate the plant to a distant place."

"Suggestions are but need government support to effect crucial decisions."

"The best solution might be to relocate people so that the area will be left for production only."

"High levels of air pollution."

"Need to drink natural remedies that help clear the dust in the body."

"The plant should be relocated to other places."

"Community to carry out clean-up campaigns and educate the society about the dangers of pollution."

The findings from these interviews paint a stark picture of the impact of pollution on the Eastview Community, highlighting significant health, educational, and economic challenges. The most pressing issues identified include the need for cleaner air, better health interventions, and educational resources to combat the effects of pollution. Moving forward, a combination of community-based initiatives, innovative business solutions, and government

support will be essential in addressing these challenges effectively. Relocating polluting industries, enhancing environmental education, and implementing practical mitigation strategies such as emission filters and greenhouse farming can create a healthier and more sustainable environment for the Eastview Community.

Moreover, fostering community engagement through cleanup campaigns and awareness programs can empower residents to take proactive steps in combating pollution. Collaboration between local businesses, educational institutions, healthcare professionals, and environmental scientists is crucial in developing comprehensive solutions that address the multifaceted impacts

of pollution. Through these combined efforts, the Eastview Community can move towards a future where the well-being of its residents and the environment are safeguarded.

4.3 Finding from Research Question 3

The purpose of this interview is to gain insights into the environmental challenges faced by Eastview and to gather suggestions for promoting sustainability in the region. By interviewing residents, experts, and organizational representatives, we aim to identify the root causes of these environmental issues and explore potential solutions. Confidentiality is assured, and participants' responses will be used solely for research purposes.

4.3.1 Environmental challenges observed in Eastview

Participants consistently reported several environmental challenges in Eastview, including air, water, and noise pollution. Dust from industrial activities, particularly cement production, was frequently mentioned as a major contributor to air pollution. This was highlighted by statements such as, "Surfaces are always dusty, air pollution, land pollution and noise" and "Change in air quality due to air pollution."

4.3.2 Impact on community and organizations

The impact of these environmental challenges is profound. One respondent noted, "People are breathing contaminated air risking their lives to respiratory diseases and drinking contaminated water that may cause diseases over time." Another participant emphasized the broader community impact, stating, "Quality of air being inhaled by residents decreased" and "Dust on crops causing stunted growth," indicating the negative effects on both human health and agriculture.

4.3.3 Root causes of environmental issues

Several root causes were identified, with a significant focus on industrial activities. Participants pointed to "Emissions from the cement plant, sewer bursts and poor garbage

disposal" as primary culprits. The proximity of residential areas to industrial sites was also noted, with one participant stating, "Operation of the cement company near residential areas" as a critical issue.

4.3.4 Strategies and interventions

Participants proposed various strategies to mitigate environmental challenges in Eastview. A common suggestion was the implementation of advanced technologies to reduce industrial emissions. For instance, one respondent recommended, "Company needs to implement technologies that suppress dust particles," while another suggested, "Company needs to use new technologies that absorb dust from the production."

Enhancing waste management practices was also highlighted. One participant mentioned, "City council to improve waste collection and repair the damaged sewer pipes," emphasizing the role of municipal services in addressing pollution. Additionally, there were calls for increased regulatory measures, with one suggestion being, "Government to enforce laws" related to environmental protection.

4.3.5 Successful environmental initiatives

When asked about replicable environmental initiatives, some participants were unsure, stating, "I don’t know of any." However, others pointed to specific examples, such as "Production of asbestos in Zvishavane" and "Cleaner production techniques (find ways to trap dust and use it for other processes)." These responses indicate a need for greater awareness and documentation of successful environmental projects that could be adapted for Eastview.

4.3.6 Role of residents, organizations, and authorities

Collaboration emerged as a key theme in implementing solutions. Participants emphasized the need for collective action, stating, "The need to work together" and "Collaboration between all stakeholders." This includes roles for residents, organizations, and authorities in fostering a sustainable community.

4.3.7 Recommendations for mitigating environmental degradation

Experts provided targeted recommendations for mitigating environmental issues. One suggestion was, "People should avoid deforestation as it takes up excess carbon dioxide produced," highlighting the importance of maintaining green spaces. Another expert advised, "Company needs to install dust absorbers to reduce emission of dust in the atmosphere," underscoring the need for technological upgrades in industrial practices.

4.3.8 Urban planning and sustainability

Urban planning was identified as a critical factor in creating sustainable communities. One expert recommended, "Zoning will help in separating residential areas from industrial areas," advocating for better spatial planning to reduce residents' exposure to pollutants. Another suggestion was, "Town planning should not allocate such companies areas with residential homes," reinforcing the need for strategic planning decisions.

4.3.9 Role of community activism

Community activism was seen as vital for raising awareness and mobilizing action. One participant noted, "It helps in raising conscious citizens who may even sponsor resources to reduce waste disposal," while another suggested, "Conduct anti-pollution campaigns," highlighting the potential of grassroots movements in driving environmental change.

4.3.10 Fostering collaboration

To effectively address environmental challenges, participants called for enhanced collaboration between stakeholders. One suggestion was, "Residents to form groups that can lead meetings with the government," indicating the need for organized community efforts. Another participant proposed, "Maybe EMMA and private organizations can use their persuasive role to bring all the parties together," pointing to the role of advocacy groups in facilitating cooperation.

4.3.11 Existing partnerships and initiatives

There were mixed responses regarding existing partnerships. Some participants were unaware of any, stating, "No," while others mentioned initiatives like the "Support ideas of Kyoto protocol 2008. EMA to monitor environment." This indicates both a lack of awareness and the potential for leveraging existing frameworks for environmental sustainability.

4.3.12 Resources and support needed

Finally, participants identified key resources and support required to implement solutions. These included "Manpower, money and government intervention," and specific calls for government action, such as, "Minister of finance to allocate a budget towards reducing environmental degradation." These responses underscore the need for both financial and institutional support to drive effective environmental interventions.

4.4 Chapter summary

Chapter 4 presents a detailed analysis of the environmental impacts of Khayah cement production on the Eastview community. Through interviews with diverse stakeholders, including residents, activists, and educators, the study unveils a grim reality of pollution-induced health problems, economic strains, and educational setbacks. Participants consistently reported dust accumulation, deteriorating air quality, and water contamination, attributing these issues directly

to cement production activities. Despite awareness of environmental regulations, there's a consensus that enforcement is lacking. Recommendations include stricter regulatory enforcement, technological upgrades in dust suppression, and greater community engagement. The chapter underscores the urgent need for collaborative efforts between stakeholders and governmental support to mitigate pollution and safeguard the well-being of the Eastview community.

Chapter 5 Summary, Conclusions and Recommendations

5.0 Introduction

Chapter 1 sets the stage for an in-depth exploration of the environmental impact of cement production by Khayah Cement Company in the Eastview community of Harare. Motivated by concerns over fugitive dust emissions and their adverse effects on the environment, the researcher aims to examine the impact of cement dust and identify mitigation measures. It provides a thorough background on cement production, highlighting its importance in development alongside the environmental challenges it poses. The problem statement underscores the urgent need to address the escalating environmental degradation caused by increased cement production, supported by scholarly evidence on the socio-economic and environmental impacts. Research objectives and questions guide the study towards understanding the effects of cement production and exploring strategies for mitigation. The significance of the study is underscored, targeting policymakers, educators, learners, and researchers, while delimitations and limitations provide context for the study's scope and potential challenges. Overall, this chapter lays a solid foundation for the subsequent literature review and empirical investigation.

Chapter 2 delves into the multifaceted environmental impacts of cement production, outlining its energy-intensive processes, greenhouse gas emissions, and pollution generation. It explores the stages of cement manufacturing, highlighting the significant environmental challenges posed by quarrying, clinker production, and cement grinding. The chapter underscores the detrimental effects of cement production on air quality, water resources, land degradation, and human health, emphasizing the need for robust mitigation strategies. Technological innovations, regulatory frameworks, and community engagement emerge as key avenues for mitigating environmental impacts and promoting sustainability within the cement industry. However, challenges such as technological limitations, regulatory enforcement, and political and social resistance to change present formidable obstacles to implementing cleaner production methods. The chapter advocates for collaborative efforts between government, industry, and community stakeholders to address these challenges and foster a more environmentally responsible approach to cement production in Zimbabwe.

Chapter 3 of the research methodology outlines the comprehensive framework employed to investigate the environmental impact of cement production in Eastview, focusing on Khaya Cement Company. Grounded in the constructivist paradigm, the study aims to understand how individuals and communities construct their understanding of the environment, emphasizing participatory engagement and reflexivity. Employing a qualitative research approach, the study utilizes methods such as interviews and focus groups to explore diverse perspectives and uncover underlying causes of environmental degradation. The research design adopts phenomenology, aiming to understand the lived experiences of those affected by cement production. Ethical considerations are paramount throughout the study, with careful attention to participant consent, confidentiality, and protection from harm. The data collection process involves structured

interviews with various stakeholders, ensuring a holistic understanding of the environmental challenges faced by the community. Trustworthiness is maintained through strategies such as dependability, credibility, confirmability, and transferability. Despite inherent limitations, including reliance on self-reported information and a limited sample size, the study adheres to rigorous methodological standards to ensure the reliability and validity of the findings, paving the way for informed decision-making and sustainable development initiatives in Eastview.

Chapter 4 delves into the extensive findings and discussions surrounding the environmental repercussions of Khayah cement production on the Eastview community. By conducting structured interviews with residents, environmental advocates, and a chemistry teacher, the study aims to grasp the full scope of cement production's impact on the local environment. The chapter scrutinizes various aspects, including demographics, experiences, perceptions, regulatory compliance, and potential solutions. It reveals a concerning pattern of dust accumulation, declining air quality, noise pollution, and water contamination directly linked to cement production, as reported by participants with diverse backgrounds. Despite awareness of environmental regulations, there's a prevailing sentiment of inadequate enforcement, leading to a call for stricter measures. Recommendations include technological advancements in dust suppression, community involvement, and governmental support. Ultimately, collaborative efforts are deemed crucial in addressing the multifaceted challenges posed by cement production and safeguarding the well-being of the Eastview community.

5.1 Conclusions

The section on the environmental impacts of Khayah cement production on the Eastview community unveiled a range of concerns voiced by residents, environmental activists, and a chemistry teacher. Participants reported noticeable dust accumulation, deteriorating air quality,

noise pollution, and water contamination attributed directly to cement production. Additionally, there was a consensus among participants regarding the decline in the quality of life due to health problems, social isolation, and disruptions to traditional ways of life. Despite awareness of environmental regulations, participants felt that enforcement was lacking, leading to significant environmental and health issues in the community.

The interviews with stakeholders in the Eastview community revealed widespread pollution affecting personal experiences, health, education, and the local economy. Residents consistently reported respiratory issues, declining air quality, and changes in the environment due to pollution. Healthcare professionals noted an increase in respiratory conditions, while educators highlighted educational challenges resulting from pollution-related health issues. Local businesses faced economic strains due to pollution, impacting consumer preferences and driving some residents to relocate to less polluted areas.

Participants consistently reported environmental challenges in Eastview, including air, water, and noise pollution, with industrial activities, particularly cement production, identified as primary contributors. The impacts of pollution on human health and agriculture were profound, highlighting the urgent need for intervention. Root causes of environmental issues included emissions from industrial plants, sewer bursts, and poor waste management practices. Participants proposed various strategies, including advanced technologies, enhanced waste management, and increased regulatory measures, to mitigate environmental challenges and promote sustainability.

5.2 Recommendations

There is a clear need for enhanced enforcement of environmental regulations to ensure the health and safety of community members, which includes rigorous monitoring and penalties for non-

compliance to discourage environmental violations. Implementing advanced technologies such as dust collectors and carbon capture and storage systems can help mitigate pollution from cement production, while fostering community engagement and involvement in decision-making processes can empower residents to address environmental concerns effectively. A key recommendation is the relocation of polluting industrial plants, such as cement production facilities, to distant areas to minimize their impact on the community, which could significantly improve air quality and overall community health. Community-based initiatives, including cleanup campaigns and educational programs, require support from governmental bodies to make meaningful changes, thus government support is essential for funding and implementing initiatives aimed at combating pollution and fostering a healthier environment in the community. Implementing advanced technologies to reduce industrial emissions and enhancing waste management practices can help mitigate environmental degradation in Eastview, along with increased regulatory measures enforced by governmental authorities to ensure compliance with environmental protection laws. Collaboration among stakeholders, including residents, organizations, and authorities, is vital for implementing effective solutions, and encouraging community activism through anti-pollution campaigns and organized efforts can raise awareness and mobilize action towards environmental sustainability in Eastview.

References

N. LOPEZ(2022). Climate-friendly cement? California takes on a high-carbon industry. Cal Matters annual reader survey

V. Singla & S. Stashwick (2022). Cut Carbon and Toxic Pollution, Make Cement Clean and Green

Expert Blog

Al-Otaibi, F. S., Ajarem, J. S., Abdel-Maksoud, M. A., Maodaa, S., Allam, A. A., Al-Basher, G. I.&Mahmoud, A. M. 2018. Stone quarrying induces organ dysfunction and oxidative stress in meriones libycus. Toxicology and industrial health 34: 679-692

Cohen, S. (2020). Economic Growth and Environmental Sustainability. News from the Columbia Climate School.

M. Gasdia-Cochrane. (2023) The Cement Manufacturing Process. Thermo Fischer Scientific

Vikström, A. (2021). Separate Calcination in Cement Clinker Production, A laboratory scale study on how an electrified separate calcination step affects the phase composition of cement clinker

Antunes, M., Santos, R. L., Pereira, J., Rocha, P., Horta, R. B., & Colaço, R. (2021). Alternative Clinker Technologies for Reducing Carbon Emissions in Cement Industry: A Critical Review. *Materials (Basel, Switzerland)*, *15*(1), 209. https://doi.org/10.3390/ma15010209

Telschow, Samira & Frandsen, Flemming & Theisen, Kirsten & Dam-Johansen, Kim. (2012). Cement Formation—A Success Story in a Black Box: High Temperature Phase Formation of Portland Cement Clinker. Industrial & Engineering Chemistry Research. 51. 10983–11004. 10.1021/ie300674j.

Cantini, Alessandra & Leoni, Leonardo & De Carlo, Filippo & Salvio, Marcello & Martini, Chiara & Martini, Fabrizio. (2021). Technological Energy Efficiency Improvements in Cement Industries. Sustainability. 13. 10.3390/su13073810.

Marouani, Ismail, Tawfik Guesmi, Badr M. Alshammari, Khalid Alqunun, Ahmed Alzamil, Mansoor Alturki, and Hsan Hadj Abdallah. 2023. "Integration of Renewable-Energy-Based Green Hydrogen into the Energy Future" *Processes* 11, no. 9: 2685. https://doi.org/10.3390/pr11092685

AlJaber, A.; Martinez-Vazquez, P.; Baniotopoulos, C. Barriers and Enablers to the Adoption of Circular Economy Concept in the Building Sector: A Systematic Literature Review. *Buildings* 2023, *13*, 2778. https://doi.org/10.3390/buildings13112778

Geng, Jun, Yi Huang, Xiang Li, and Yun Zhang. 2023. "Overcoming Barriers to the Adoption of Recycled Construction Materials: A Comprehensive PEST Analysis and Tailored Strategies" *Sustainability* 15, no. 19: 14635. https://doi.org/10.3390/su151914635

Barbhuiya, Salim & Kanavaris, Fragkoulis & Das, Bibhuti & Idrees, Maria. (2024). Decarbonizing cement and concrete production: Strategies, challenges and pathways for sustainable development. Journal of Building Engineering. 86. 108861. 10.1016/j.jobe.2024.108861.

Etim, Mmemek-Abasi, Kunle Babaremu, Justin Lazarus, and David Omole. 2021. "Health Risk and Environmental Assessment of Cement Production in Nigeria" *Atmosphere* 12, no. 9: 1111. https://doi.org/10.3390/atmos12091111

Gboe, Nuushuun. (2023). Innovative Environmental Protection Technologies to reduce Air Pollution from Cement Manufacturing Industry in Liberia. Technium Sustainability. 4. 13-30. 10.47577/sustainability.v4i.9592.

Manisalidis, I., Stavropoulou, E., Stavropoulos, A., & Bezirtzoglou, E. (2020). Environmental and Health Impacts of Air Pollution: A Review. *Frontiers in public health*, *8*, 14. https://doi.org/10.3389/fpubh.2020.00014

Agustine, I & Yulinawati, Hernani & Gunawan, D & Suswantoro, E. (2018). Potential impact of particulate matter less than 10 micron (PM 10) to ambient air quality of Jakarta and Palembang. IOP Conference Series: Earth and Environmental Science. 106. 012057. 10.1088/1755-1315/106/1/012057.

Ciobanu, C., Istrate, I. A., Tudor, P., & Voicu, G. (2021). Dust Emission Monitoring in Cement Plant Mills: A Case Study in Romania. *International journal of environmental research and public health*, *18*(17), 9096. https://doi.org/10.3390/ijerph18179096

Liu, Hexin & Yang, Fuxin & Du, Yongle & Ruan, Renhui & Tan, Houzhang & Xiao, Jiafan & Zhang, Sicong. (2019). Field measurements on particle size distributions and emission characteristics of PM10 in a cement plant of China. Atmospheric Pollution Research. 10. 10.1016/j.apr.2019.04.003.

Nakomcic-Smaragdakis, Branka & Cepic, Zoran & Živančev, Nevena & Dorić, Jovan & Radovanovic, Ljiljana. (2016). Use of scrap tires in cement production and their impact on

nitrogen and sulfur oxides emissions. Energy Sources, Part A: Recovery, Utilization, and Environmental Effects. 38. 485-493. 10.1080/15567036.2013.787473.

Chinyama P.M., M. (2011). Alternative Fuels in Cement Manufacturing. InTech. doi: 10.5772/22319

Horkoss, Sayed. (2008). Reducing the SO2 emission from a cement kiln. International journal of Natural and Social Science.

Menezes, F., & Popowicz, G. M. (2022). Acid Rain and Flue Gas: Quantum Chemical Hydrolysis of NO_2. *Chemphyschem : a European journal of chemical physics and physical chemistry*, *23*(21), e202200395. https://doi.org/10.1002/cphc.202200395

Prakash, J., Agrawal, S. B., & Agrawal, M. (2023). Global Trends of Acidity in Rainfall and Its Impact on Plants and Soil. *Journal of soil science and plant nutrition*, *23*(1), 398–419. https://doi.org/10.1007/s42729-022-01051-z

Kim, Ji-Hyeon & Kim, Jin-Ho & Kim, Hyo & Kim, Hyun-Ji & Kang, Suk-Hwan & Ryu, Jae-Hong & Shim, Soon-Seop. (2022). Reduction of NOx Emission from the Cement Industry in South Korea: A Review. Atmosphere. 13. 121. 10.3390/atmos13010121.

Panagoda, Sanuja & Ranasinghe, Hansa & Perera, Vishwa & Sandunika, Irukshi & Tilanka, Gemal & Alwis, Saneeka & Dilka, Shashini. (2023). Cement Manufacturing Process and Its Environmental Impact. 43. 161-168.

Arachchige, Udara & devasurendra, Janeesha & Chathumini, Limasha & Alagiyawanna, Kalani & Dassanayake, Nadeesha & Balasuriya, Chanaka. (2019). Environmental Pollution by Cement Industry. International Journal of Research. 6. 631-635.

Tanabe, L. K., Carvalho, S., Dasari, V., Nasif, A., O'Toole, K. A., & Berumen, M. L. (2022). Potential effects of heavy metal pollution from a cement factory near Saudi Arabia's largest green turtle rookery. *Environmental monitoring and assessment*, *194*(6), 450. https://doi.org/10.1007/s10661-022-10063-2

Bashir, I., Lone, F. A., Bhat, R. A., Mir, S. A., Dar, Z. A., & Dar, S. A. (2020). Concerns and Threats of Contamination on Aquatic Ecosystems. *Bioremediation and Biotechnology: Sustainable Approaches to Pollution Degradation*, 1–26. https://doi.org/10.1007/978-3-030-35691-0_1

Akhtar, Naseem, Muhammad Izzuddin Syakir Ishak, Showkat Ahmad Bhawani, and Khalid Umar. 2021. "Various Natural and Anthropogenic Factors Responsible for Water Quality Degradation: A Review" *Water* 13, no. 19: 2660. https://doi.org/10.3390/w13192660

Silva, Jorge Alejandro. 2023. "Wastewater Treatment and Reuse for Sustainable Water Resources Management: A Systematic Literature Review" *Sustainability* 15, no. 14: 10940. https://doi.org/10.3390/su151410940

Kafu, Babalwa & Mlaba, Sanelisiwe. (2024). Assessing the Impact of Quarrying as an Environmental Ethic Crisis: A Case Study of Limestone Mining in a Rural Community.. 10.20944/preprints202401.1691.v1.

deVilleneuve, Stephanie & Kelly, Austin & Miyanaka, Noriki & Shanmuhasundaram, Thiruvikram & Murphree, Parker & Wyatt, Briana. (2023). Impacts of vegetation and topsoil removal on soil erosion, soil moisture, and infiltration. Agrosystems Geosciences & Environment. 6. 10.1002/agg2.20402.

Matthews, Tom & Cottee-Jones, H Eden W & Whittaker, Robert. (2014). Habitat fragmentation and the species-area relationship: A focus on total species richness obscures the impact of habitat loss on habitat specialists. Diversity and Distributions. 20. 10.1111/ddi.12227.

Kremen C. (2020). Ecological intensification and diversification approaches to maintain biodiversity, ecosystem services and food production in a changing world. *Emerging topics in life sciences*, *4*(2), 229–240. https://doi.org/10.1042/ETLS20190205

Salgueiro, Pedro & Prach, Karel & Branquinho, Cristina & Mira, Antonio. (2020). Enhancing Biodiversity and Ecosystem Services in Quarry Restoration – Challenges, Strategies and Practice. Restoration Ecology. 28. 10.1111/rec.13160.

Zuhara, Shifa & Isaifan, Rima. (2018). The Impact of Criteria Air Pollutants on Soil and Water: A Review. Journal of Environmental Science and Pollution Research. 4. 278-284. 10.30799/jespr.133.18040205.

Tchounwou, P. B., Yedjou, C. G., Patlolla, A. K., & Sutton, D. J. (2012). Heavy metal toxicity and the environment. *Experientia supplementum (2012)*, *101*, 133–164. https://doi.org/10.1007/978-3-7643-8340-4_6

Ozcan, Orkan & Musaoglu, Nebiye & Seker, Dursun. (2012). Environmental impact analysis of quarrying activities established on and near a river bed by using remotely sensed data. Fresenius Environmental Bulletin. 21. 3147-3153.

Aranda-Usón, Alfonso & López-Sabirón, Ana & Ferreira Ferreira, German & Llera-Sastresa, Eva. (2013). Uses of Alternative Fuels and Raw Materials in the Cement Industry as Sustainable Waste Management Options. Renewable and Sustainable Energy Reviews. 23. 242–260. 10.1016/j.rser.2013.02.024.

Chatziaras, N. & Psomopoulos, Constantinos & Themelis, Nickolas. (2014). Use of alternative fuels in cement industry.

Martin, Nathan & Worrell, Ernst & Price, Lynn. (2011). Energy Efficiency and Carbon Dioxide Emissions Reduction Opportunities in the U.S. Cement Industry. Environ. Energy Technol. Div. Rep.. 10.2172/751775.

Plaza, Marta G., Sergio Martínez, and Fernando Rubiera. 2020. "CO_2 Capture, Use, and Storage in the Cement Industry: State of the Art and Expectations" *Energies* 13, no. 21: 5692. https://doi.org/10.3390/en13215692

Yasemi, Sara, Yasin Khalili, Ali Sanati, and Mohammadreza Bagheri. 2023. "Carbon Capture and Storage: Application in the Oil and Gas Industry" *Sustainability* 15, no. 19: 14486. https://doi.org/10.3390/su151914486

Yaseen, N., Alcivar-Bastidas, S., Irfan-Ul-Hassan, M., Petroche, D. M., Qazi, A. U., & Ramirez, A. D. (2024). Concrete incorporating supplementary cementitious materials: Temporal evolution of compressive strength and environmental life cycle assessment. *Heliyon*, *10*(3), e25056. https://doi.org/10.1016/j.heliyon.2024.e25056

Krishna, R S & Mishra, Jyotirmoy & Zribi, Mayessa & Adeniyi, Funmilayo Itunu & Saha, Suman & Baklouti, Samir & Shaikh, Faiz & Gökçe, H. Süleyman. (2021). A review on developments of environmentally friendly geopolymer technology. Materialia. 20. 101212. 10.1016/j.mtla.2021.101212.

Machaka, Rowan. (2014). Environmental Impact Assessment System Evaluation Conference Report, Zimbabwe.

Gumindoga, Webster & Shekede, Munyaradzi & Mabiza, Collin & Kupika, Olga & Kabo-bah, Amos Tiereyangn. (2021). Journal of Environmental Management in Zimbabwe(JEMZ) Vol1(1)(2021).

Howes, Michael, Liana Wortley, Ruth Potts, Aysin Dedekorkut-Howes, Silvia Serrao-Neumann, Julie Davidson, Timothy Smith, and Patrick Nunn. 2017. "Environmental Sustainability: A Case of Policy Implementation Failure?" *Sustainability* 9, no. 2: 165. https://doi.org/10.3390/su9020165

Moji, L., Nhede, N.T. & Masiya, T., 2022, 'Factors impeding the implementation of oversight mechanisms in South African municipalities', *Journal of Local Government Research and Innovation* 3(0), a94. https://doi.org/10.4102/jolgri.v3i0.94

Matamanda, Abraham & Chirisa, Innocent & Rammile, Siphokazi & Marais, Mario. (2022). Towards Sustainable Policies for Housing and Technology in Zimbabwe. 10.1007/978-3-031-09098-1_6

Kusena, Winmore & Shoko, & Marambanyika, Thomas. (2012). Socio-economic impacts of cement production at Sino-Zimbabwe on Hozheri community, Gweru, Zimbabwe. Journal of Sustainable Development in Africa. 14. 94-103.

Tu, Y., Peng, B., Elahi, E., & Wu, W. (2020). Initiator or Intermediary? A Case Study on Network Relation of Environmental Regulatory Capture in China. *International journal of environmental research and public health*, *17*(24), 9152. https://doi.org/10.3390/ijerph17249152

Xia, Jun & Yao, Fiona & Yin, Xiaoli & Wang, Xinran & Lin, Zhouyu. (2024). How Do Political and Nonpolitical Ties Affect Corporate Regulatory Participation? A Regulatory Capture Perspective. Business & Society. 10.1177/00076503231219687

Santos, Filipe Duarte, Paulo Lopes Ferreira, and Jiesper Strandsbjerg Tristan Pedersen. 2022. "The Climate Change Challenge: A Review of the Barriers and Solutions to Deliver a Paris Solution" *Climate* 10, no. 5: 75. https://doi.org/10.3390/cli10050075

Azevedo M. J. (2017). The State of Health System(s) in Africa: Challenges and Opportunities. *Historical Perspectives on the State of Health and Health Systems in Africa, Volume II: The Modern Era*, 1–73. https://doi.org/10.1007/978-3-319-32564-4_1

Brewer, Jennifer. (2009). Public Participation in Environmental Assessment and Decision Making.

Gemmill-Herren, Barbara & Bamidele-Izu, Abimbola. (2002). The role of NGOs and Civil Society in Global Environmental Governance. Global Environmental Governance: Options and Opportunities.

Bullard, Robert & Johnson, Glenn. (2000). Environmental Justice: Grassroots Activism and Its Impact on Public Policy Decision Making. Journal of Social Issues. 56. 555 - 578. 10.1111/0022-4537.00184.

Murombo, Tumai. (2016). The Effectiveness of Initiatives to Promote Good Governance, Accountability and Transparency in the Extractives Sector in Zimbabwe. 60. 230-263. 10.1017/S0021855316000061.

Telschow, Samira & Frandsen, Flemming & Theisen, Kirsten & Dam-Johansen, Kim. (2012). Cement Formation—A Success Story in a Black Box: High Temperature Phase Formation of Portland Cement Clinker. Industrial & Engineering Chemistry Research. 51. 10983–11004. 10.1021/ie300674j.

Schneider, M. & Romer, Michael & Tschudin, M. & Bolio, Hugo. (2011). Sustainable Cement Production – Present and Future. Cement and Concrete Research. 41. 642-650. 10.1016/j.cemconres.2011.03.019.

Neto, Geraldo Cardoso de Oliveira, Roberto Rodrigues Leite, Wagner Cezar Lucato, Rosangela Maria Vanalle, Marlene Amorim, João Carlos Oliveira Matias, and Vikas Kumar. 2022. "Overcoming Barriers to the Implementation of Cleaner Production in Small Enterprises in the Mechanics Industry: Exploring Economic Gains and Contributions for Sustainable Development Goals" *Sustainability* 14, no. 5: 2944. https://doi.org/10.3390/su14052944

Rizos, Vasileios, Arno Behrens, Wytze Van der Gaast, Erwin Hofman, Anastasia Ioannou, Terri Kafyeke, Alexandros Flamos, Roberto Rinaldi, Sotiris Papadelis, Martin Hirschnitz-Garbers, and et al. 2016. "Implementation of Circular Economy Business Models by Small and Medium-Sized Enterprises (SMEs): Barriers and Enablers" *Sustainability* 8, no. 11: 1212. https://doi.org/10.3390/su8111212

Peng, Yixuan & Fayaz Ahmad, Sayed & Irshad, Muhammad & Al-Razgan, Muna & Ali, Yasser & Awwad, Emad. (2023). Impact of Digitalization on Process Optimization and Decision-Making towards Sustainability: The Moderating Role of Environmental Regulation. Sustainability. 15. 15156. 10.3390/su152015156.

Sabelo J. Ndlovu-Gatsheni (2003). Dynamics of the Zimbabwe Crisis in the 21st Century. GOVERNANCE, HUMAN RIGHTS, ACCORD

Rich Dorman, Sara, 'Understanding Zimbabwean Politics', *Understanding Zimbabwe: From Liberation to Authoritarianism* (2016; online edn, Oxford Academic, 21 Sept. 2017), https://doi.org/10.1093/oso/9780190634889.003.0001, accessed 9 Apr. 2024.

Mohamad, Nabilla & Muthusamy, Khairunisa & Embong, Rahimah & Kusbiantoro, Andri & Hashim, Mohd. (2021). Environmental impact of cement production and Solutions: A review. Materials Today: Proceedings. 48. 10.1016/j.matpr.2021.02.212.

Kumar, L., Naqvi, S. A., Deitch, M. J., Khalid, M. J., Naeem, K., Qayyum Amjad, A., Kumar, A., Gebremicael, T. G., & Arshad, M. (2023). Opportunities and constraints for cleaner production policy in the developing world: a case study of Sindh Region, Pakistan. *Environment, development and sustainability*, 1–44. Advance online publication. https://doi.org/10.1007/s10668-022-02889-0

Abdul-Wahab, S. A., Al-Dhamri, H., Ram, G., & Chatterjee, V. P. (2021). An overview of alternative raw materials used in cement and clinker manufacturing. *International Journal of Sustainable Engineering*, *14*(4), 743–760. https://doi.org/10.1080/19397038.2020.1822949

Aranda-Usón, Alfonso & López-Sabirón, Ana & Ferreira Ferreira, German & Llera-Sastresa, Eva. (2013). Uses of Alternative Fuels and Raw Materials in the Cement Industry as Sustainable Waste Management Options. Renewable and Sustainable Energy Reviews. 23. 242–260. 10.1016/j.rser.2013.02.024.

Favretto, N & Shackleton, Sheona & Sallu, Susannah & Gordon, C & Methner, N & Outa, G & Sola, Phosiso & Sikutshwa, L & Williams, Portia. (2021). Collaboration and Multi-Stakeholder Engagement in Landscape Governance and Management in Africa: Lessons from Practice.

Bourtsalas, Athanasios & Zhang, Jiao & Castaldi, Marco & Themelis, N.J.. (2018). Use of non-recycled plastics and paper as alternative fuel in cement production. Journal of Cleaner Production. 181. 8-16. 10.1016/j.jclepro.2018.01.214.

Althoey, Fadi & Ansari, Wajahat Sammer & Sufian, Muhammad & Deifalla, Ahmed. (2023). Advancements in low-carbon concrete as a construction material for the sustainable built environment. Developments in the Built Environment. 16. 100284. 10.1016/j.dibe.2023.100284.

Montalvo, Carlos. (2008). General wisdom concerning the factors affecting the adoption of cleaner technologies: a survey 1990-2007. Journal of Cleaner Production. 16. 10.1016/j.jclepro.2007.10.002.

Macheka, M. T., & Hardman, M. (2021). Environmental management and practises in Zimbabwe's Chivi district: A political ecology analysis. *Cogent Social Sciences*, *7*(1). https://doi.org/10.1080/23311886.2021.2000569

Hills, T., Leeson, D., Florin, N., & Fennell, P. (2016). Carbon Capture in the Cement Industry: Technologies, Progress, and Retrofitting. *Environmental Science & Technology*, *50*(1), 368-377. https://doi.org/10.1021/acs.est.5b03508

Iacobuţă, G. I., Brandi, C., Dzebo, A., & Elizalde Duron, S. D. (2022). Aligning climate and sustainable development finance through an SDG lens. The role of development assistance in implementing the Paris Agreement. *Global Environmental Change*, *74*, 102509. https://doi.org/https://doi.org/10.1016/j.gloenvcha.2022.102509

Rich Dorman, S., & Rich Dorman, S. (2016). 1Understanding Zimbabwean Politics. In *Understanding Zimbabwe: From Liberation to Authoritarianism* (pp. 0). Oxford University Press. https://doi.org/10.1093/oso/9780190634889.003.0001

Chapter 3 Refs-Gerald

Goundar, Sam. (2012). Chapter 3 - Research Methodology and Research Method.

Jilcha Sileyew, K. (2020). Research Design and Methodology. IntechOpen. doi: 10.5772/intechopen.85731

Kivunja, C. & A.B. Kuyini 2017. Understanding and Applying Research Paradigms in Educational Contexts. International Journal of Higher Education 6, 5: 26 - 41. Available at: https://files.eric.ed.gov/fulltext/EJ1154775.pdf (Accessed 08 November 2020.)

Abdul Rehman, Adil & Alharthi, Khalid. (2016). An introduction to research paradigms. 3.

Held, M. B. E. (2019). Decolonizing Research Paradigms in the Context of Settler Colonialism: An Unsettling, Mutual, and Collaborative Effort. International Journal of Qualitative Methods, 18. https://doi.org/10.1177/1609406918821574

Brau, B. (2020). Constructivism. In R. Kimmons & S. Caskurlu (Eds.), The Students' Guide to Learning Design and Research. EdTech Books. https://edtechbooks.org/studentguide/constructivism

Adom, Dickson & .com, Akwasi & Ankrah, Kusi. (2016). CONSTRUCTIVISM PHILOSOPHICAL PARADIGM: IMPLICATION FOR RESEARCH, TEACHING AND LEARNING. Global Journal of Arts Humanities and Social Sciences. 4. 1-9.

Duea, S. R., Zimmerman, E. B., Vaughn, L. M., Dias, S., & Harris, J. (2022). A Guide to Selecting Participatory Research Methods Based on Project and Partnership Goals. *Journal of participatory research methods*, *3*(1), 10.35844/001c.32605. https://doi.org/10.35844/001c.32605

Watson, Steven. (2024). A historical sociology of modern education, media and politics. 10.

Finnemore, Martha & Sikkink, Kathryn. (2001). TAKING STOCK: The Constructivist Research Program in International Relations and Comparative Politics. Annual Review of Political Science - ANNU REV POLIT SCI. 4. 391-416. 10.1146/annurev.polisci.4.1.391. 13140/RG.2.2.15415.70562.

Boaz, A., Hanney, S., Borst, R. *et al.* How to engage stakeholders in research: design principles to support improvement. *Health Res Policy Sys* 16, 60 (2018). https://doi.org/10.1186/s12961-018-0337-6

Mills, J., Bonner, A., & Francis, K. (2006). The Development of Constructivist Grounded Theory. International Journal of Qualitative Methods, 5(1), 25-35. https://doi.org/10.1177/160940690600500103

Mogashoa, Tebogo. (2014). Applicability of Constructivist Theory in Qualitative Educational Research.

Grover, Vijay. (2015). RESEARCH APPROACH: AN OVERVIEW. Golden Reserach Thoughts. 4. 1-8.

Almeida, Fernando & Faria, Daniel & Queirós, André. (2017). Strengths and Limitations of Qualitative and Quantitative Research Methods. European Journal of Education Studies. 3. 369-387. 10.5281/zenodo.887089.

Aschehoug, Silje & Boks, Casper & støren, Sigurd. (2012). Environmental information from stakeholders supporting product development. Journal of Cleaner Production. 31. 1-13. 10.1016/j.jclepro.2012.02.031.

Busetto, L., Wick, W. & Gumbinger, C. How to use and assess qualitative research methods. *Neurol. Res. Pract.* 2, 14 (2020). https://doi.org/10.1186/s42466-020-00059-z

Cropley, Arthur. (2023). Qualitative Research Methods: A Practice-Oriented Introduction.

Cleland J. A. (2017). The qualitative orientation in medical education research. *Korean journal of medical education*, *29*(2), 61–71. https://doi.org/10.3946/kjme.2017.53

Olmos-Vega, F. M., Stalmeijer, R. E., Varpio, L., & Kahlke, R. (2023). A practical guide to reflexivity in qualitative research: AMEE Guide No. 149. *Medical Teacher*, *45*(3), 241–251. https://doi.org/10.1080/0142159X.2022.2057287

Thakur, Harish. (2021). Research Design.

Zikargae, M. H., Woldearegay, A. G., & Skjerdal, T. (2022). Assessing the roles of stakeholders in community projects on environmental security and livelihood of impoverished rural society: A nongovernmental organization implementation strategy in focus. *Heliyon*, *8*(10). https://doi.org/10.1016/j.heliyon.2022.e10987

Neubauer, B. E., Witkop, C. T., & Varpio, L. (2019). How phenomenology can help us learn from the experiences of others. *Perspectives on medical education*, *8*(2), 90–97. https://doi.org/10.1007/s40037-019-0509-2

Ekincioğlu, Özgür & Gurgun, Asli & Engin, Yasin & Tarhan, Muhittin & Kumbaracibasi, Sezgi. (2013). Approaches for sustainable cement production – A case study from Turkey. Energy and Buildings. 66. 136-142. 10.1016/j.enbuild.2013.07.006.

Smith, D. (2003, January 1). Five principles for research ethics. *Monitor on Psychology*, *34*(1). https://www.apa.org/monitor/jan03/principles

Palinkas, L. A., Horwitz, S. M., Green, C. A., Wisdom, J. P., Duan, N., & Hoagwood, K. (2015). Purposeful Sampling for Qualitative Data Collection and Analysis in Mixed Method Implementation Research. *Administration and policy in mental health*, *42*(5), 533–544. https://doi.org/10.1007/s10488-013-0528-y

Forero, R., Nahidi, S., De Costa, J., Mohsin, M., Fitzgerald, G., Gibson, N., McCarthy, S., & Aboagye-Sarfo, P. (2018). Application of four-dimension criteria to assess rigour of qualitative research in emergency medicine. *BMC health services research*, *18*(1), 120. https://doi.org/10.1186/s12913-018-2915-2

Johnson, J. L., Adkins, D., & Chauvin, S. (2020). A Review of the Quality Indicators of Rigor in Qualitative Research. *American journal of pharmaceutical education*, *84*(1), 7120. https://doi.org/10.5688/ajpe7120

Shenton, Andrew. (2004). Strategies for Ensuring Trustworthiness in Qualitative Research Projects. Education for Information. 22. 63-75. 10.3233/EFI-2004-22201.

Enago Academy, "What Are the Ethical Considerations in Research Design?." Enago Academy. May 16, 2019. https://www.enago.com/academy/what-are-the-ethical-considerations-in-research-design/.

Žukauskas, P., Vveinhardt, J., & Andriukaitienė, R. (2018). Research Ethics. InTech. doi: 10.5772/intechopen.70629

APPENDIX A:

Interview Guide RQ1-Chari

Introduction:

- Welcome and thank the participant for their time.
- Explain the purpose of the study: to understand the environmental impacts of Khayah cement production on the Eastview community.
- Assure confidentiality and explain how the data will be used.

Section 1: Demographics and Background

- What is your role in relation to the cement production site? (e.g., resident, environmental activist, government official, etc.)
- How long have you been associated with or living near the cement production site?

Section 2: Experience and Observations

- Can you describe any noticeable changes in the environment since the cement production began?

- Have there been any health or quality of life changes you attribute to the cement production?

Section 3: Perceptions and Concerns

- What are your primary concerns regarding the environmental impacts of cement production?
- How do you feel the community has been affected by these environmental changes?

Section 4: Regulations and Compliance

- Are you aware of any environmental regulations that apply to the cement production site?
- Do you believe these regulations are being adequately enforced?

Section 5: Suggestions and Solutions

- What measures do you think could mitigate the environmental impacts of cement production?
- How do you think the community and the cement company could work together to address these concerns?

Closing:

- Is there anything else you would like to add that we haven't discussed?
- Thank the participant for their valuable insights and conclude the interview.

By following this structured interview guide, researchers can gather comprehensive data from various stakeholders, providing a holistic understanding of the environmental impacts of cement production in the Eastview community.

APPENDIX B: Interview Guide: RQ2

Introduction: Thank you for participating in this important research project aimed at understanding the impact of pollution on the Eastview Community. Your insights are invaluable to gaining a comprehensive understanding of this issue. Please note that all information provided will remain confidential and will be used solely for research purposes.

Section 1: Personal Experience and Observations

1. Can you describe any personal experiences or observations you've had regarding pollution in Eastview Community?

2. How do you believe pollution has affected your daily life and well-being?

3. Have you noticed any changes in the environment over the years that you attribute to pollution?

Section 2: Health Implications 4. As a healthcare professional, what health concerns have you observed or treated that you believe are related to pollution?

5. Are there any specific health conditions or symptoms that seem to be more prevalent in the Eastview Community compared to other areas?

Section 3: Economic Impact 6. As a local business owner, have you experienced any economic challenges or opportunities related to pollution?

7. Do you believe pollution has influenced consumer behavior or impacted the local economy in any way?

Section 4: Educational Perspective 8. As an educator, how do you incorporate environmental awareness and pollution education into your curriculum?

9. Have you noticed any educational challenges or opportunities arising from the issue of pollution in the community?

Section 5: Scientific Insights 10. As an environmental scientist, what specific pollution sources or factors do you believe are most concerning for the Eastview Community?

11. Are there any mitigation strategies or solutions you would recommend based on your scientific expertise?

Conclusion: 12. In your opinion, what are the most pressing issues related to pollution in Eastview Community that need immediate attention?

13. Do you have any suggestions for community-based initiatives or collaborative efforts to address these issues effectively?

Thank you for your time and valuable insights!

APPENDIX C:

Interview guide 3 RQ3

Introduction: Begin by introducing the purpose of the interview, emphasizing the importance of their insights in addressing environmental challenges and promoting sustainability in Eastview. Ensure confidentiality and assure participants that their responses will be used solely for research purposes.

Section 1: Understanding Environmental Challenges

1. Can you describe the environmental challenges you have observed or experienced in Eastview?

2. How have these challenges impacted you personally, your organization, or the community at large?

3. What do you believe are the root causes of these environmental issues?

Section 2: Potential Solutions and Interventions 4. Based on your experience and knowledge, what strategies or interventions do you think could effectively address these environmental challenges in Eastview?

5. Are there any successful examples of environmental initiatives or projects that could be replicated or adapted for Eastview?

6. How do you envision the role of local residents, organizations, and authorities in implementing these solutions?

Section 3: Expert Insights 7. As an expert in your field (e.g., environmental science, urban planning, sustainable development), what are your recommendations for mitigating environmental degradation in Eastview?

8. How can urban planning contribute to creating a more sustainable and resilient community?

9. What role can community activism play in raising awareness and mobilizing action towards environmental sustainability?

Section 4: Collaborative Efforts and Partnerships 10. How can collaboration between different stakeholders (residents, organizations, experts) be fostered to address environmental challenges effectively?

11. Are there any existing partnerships or initiatives that could be leveraged to support environmental sustainability efforts in Eastview?

12. What resources or support would be needed to implement the proposed solutions successfully?

Conclusion: Thank the participants for their valuable insights and feedback. Encourage them to share any additional thoughts or suggestions they might have and provide contact information for follow-up questions or clarifications.

This interview guide aims to facilitate a comprehensive discussion, capturing diverse perspectives and expertise to develop holistic strategies for mitigating environmental challenges in Eastview.

APPENDIX D

SAMED

P Bag 1020
BINDURA
ZIMBABWE

Tel: 0271 - 7531 ext 1038
Fax: 263 - 71 - 7616

BINDURA UNIVERSITY OF SCIENCE EDUCATION

Date: .....

TO WHOM IT MAY CONCERN

NAME: GERALD CHARI REGISTRATION NUMBER: B2230158

PROGRAMME: H.B.Sc.Ed.Chem PART: 2.2

This memo serves to confirm that the above is a bona fide student at Bindura University of Science Education in the Faculty of Science Education.

The student has to undertake research and thereafter present a Research Project in partial fulfillment of the HBSc.Ed (Chemistry) programme. The research topic is:

EXAMINING IMPACT OF CEMENT PRODUCTION TO THE ENVIRONMENT: A CASE STUDY OF KHAYAH ZIMBABWE CEMENT COMPANY IN ARCTURUS ROAD HARARE

In this regard, the department kindly requests your permission to allow the student to carry out his/her research in your institutions.

Your co-operation and assistance is greatly appreciated.

Thank you

BINDURA UNIVERSITY OF SCIENCE EDUCATION
DEPARTMENT OF EDUCATIONAL FOUNDATIONS
9 APR 2021
P. BAG 1020
BINDURA

Z. Ndemo (Dr.)
CHAIRPERSON - SAMED