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ENVIRONMENTAL AND SOCIO-ECONOMIC IMPACTS OF CEMENT PRODUCTION: A CASE OF MANRESA COMMUNITY, HARARE ZIMBABWE.

BY

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DEDICATION

This dissertation is dedicated to my parents, Lazarus and Teddie Kanyoka who made me to breeze through their words of inspiration and drive for perseverance echoing in my ears.

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Behind every successful person, there is good mentorship, guidance and support, thus, I would like to express my heartfelt gratitude to my project supervisor Dr L. Mujuru, who mentored, guided and supported me throughout the project writing endeavour. Successfully, she provided all the inspiration and strength in times of need hence the project came to light. Without her support and guidance this project would never come to this standard level, for that reason, I owe her a world of gratitude.

It is my radiant sentiment to place on record my best regards, deepest sense of gratitude to Lafarge employees and Manresa community who helped in provision and collection of data. Not forgetting my lecturers who equipped me with necessary information to sail through my career and project writing. I thank my parents for being my source of support and guidance in this education journey.

Above all, I would like to thank Jehovah for the divine protection and wisdom throughout my academic journey. For without his wisdom and protection this project would never see the light.

ABSTRACT

Cement production has become an important industry worldwide, due to increasing demands for infrastructural development. However, environmental and socio-economic impacts of cement production on nearby communities has raised concerns worldwide. A study was done to assess environmental and socio-economic impacts of cement production at Lafarge in Manresa community of Harare, Zimbabwe. Data was collected using questionnaires, key-informant interviews and field observations. Results showed that, cement production at Lafarge had a variety of environmental and socio-economic effects to land use change (40%), and the reduction in air and water quality (20%). These cement production processes also affected the health and well-being of Manresa community. Socio-economic challenges included health issues, cultural interference and land use conflicts. On the other hand, the cement production process created jobs, improved health service provision and infrastructural development.

There are a variety of measures taken to curb the destruction of environment in the surrounding community and these include, rules and regulation to facilitate sustainable utilisation of resources and business operation, working with environmental organisations such as Environmental Management Agency which help in protecting the environment, maintenance of equipment, monitoring and auditing and educating employees on safe operations. However, lack of funds to implement long term measures hinders the progress to meet the targets.

There is a need for strategic policy interventions, collaboration between industries and stakeholders and implementation of long term sustainable strategies to mitigate the negative effects while enhancing positive impact.

Contents

CHAPTER 1: INTRODUCTION

Development projects, mainly those linked to infrastructure development are linked to production of cement which is a basic ingredient in the construction industry. Production of cement is known to have adverse impacts to both the environment and people. When coupled with water, cement is a non-metallic, inorganic material that solidifies and hardens. The formation of calcium silicate hydrates as a result of the interaction between water and the cement`s component parts during mixing is the main source of this hydraulic hardening (Stajanča and Eštoková, 2012). Cement has become one of the most crucial materials for economic growth, being an essential elements of concrete for building and civil engineering works. Due to the substantial physical development occurring around the world, its demand as a fundamental component of construction has increased. More than 3 billion tons of cement were produced worldwide in 2010 (Arachchige et al., 2019). The increased output levels have primarily been blamed for pollution and other environmental issues (Ali et al., 2015).

The consumption of cement grew globally, from 3 billion metric tonnes in 2010 (Mazvimavi and Twomlow, 2009) to 4.8 billion metric tonnes in 2022 (Sahoo et al., 2022) which has caused a sharp increase in the cement production. The production of cement has however, come with several environmental and social challenges.

Diverse commercial operations degrade environmental components such as water, air, land, and vegetation. Generally, the major environmental problems connected with cement manufacturing are pollutant emissions and energy consumption (Al Smadi et al., 2009). Environmental impacts of cement industry could be defined as the negative impact on water, air, and land caused by various activities ranging from raw material mining (lime stone, dolomite, and sand.) to crushing, grinding, and other processes developed in a cement plant. Noise, visual blight, vibration, soil deterioration, and agricultural health are also anaesthetic impacts. Various commercial operations degrade environmental components such as water, air, land, and vegetation. Emissions are the primary environmental problems connected with cement production (Al Smadi et al., 2009).

Sulphur dioxide, nitrogen oxides, and gray dust are among the environmental pollutants connected with cent manufacturing (Zimwara et al. 2012). According to Devi et al. (2017), 5% of all greenhouse gases emission occurred in the cement industry alone in 2007 only. However, air pollution from cement production has been a significant cause of concern in terms of natural ecosystem sustainability. There are other environmental problems associated with cement production apart from which include, degradation, destruction of the natural ecosystem and socio-economic problems.

Africa needs more cement to build its infrastructure, because rapid infrastructure development is a goal in many developing countries and cement demand is closely tied to economic growth (Devi et al., 2017). Through infrastructural development, which leads to economic growth, the cement industry has created variety of jobs worldwide. The cement business greatly raises living standards around the world by creating direct job opportunities and several cascading economic benefits for adjacent industries. Cement output increased globally as a result of increased demand. For every person in the globe, on average, 1 ton of cement is made each year (Devi et al., 2017). Despite being widely used and profitable, the cement business poses numerous problems for both the local community and its residents.

Cement production, has a wide variety of socioeconomic effects on the neighbouring areas(Akande and Idris, 2005). It also has some consequences, such as the loss of animal refuge, the disruption of customary values, and even the relocation of local people. These negative consequences produced social friction, strained links between family members and community life, and sometimes resulted in economic disparities, as seen in Bangladesh, where peasants were moved from their farming land, which was their main source of income (Hilson, 2002). Mineral exploitation for cement manufacturing, according to Akande and Idris (2005), can change neighbouring communities if used responsibly. This can be achieved through creating more jobs and construction of new roads, schools, clinics and homes as in Nigeria`s Obajana region. Additionally, it draws a variety of commercial opportunities that will change the course of many lives.

In Zimbabwe, two cement manufacturing firms control the industry, one in Matabeleland South province (PPC) and the other in Harare (Lafarge Cement Zimbabwe Limited). Other tiny incoming businesses, on the other hand, are trying to venture into cement production. In order to maximise earnings, these businesses are required to follow environmental regulations imposed by the Environmental Management Agency. This is to encourage resource sustainability while also reducing the environmental impacts connected with cement production. However, despite the efforts put in place to deal with environmental and socioeconomic effects of cement production, differ by location, the environment and the community continue to face challenges arising from cement production. This research focuses on the environmental and socioeconomic consequences of Lafarge cement production to Manresa community.

Problem statement

Cement demand is directly associated with environmental problems such as noise, air and land pollution, land degradation and ecosystem destabilisation. Kusena et al, (2012) concentrated on socio-economic effects of cement manufacturing on Hozheri community in Gweru, but all environmental effects were left out. A study by Al Smadi et al., (2009), assessed air pollutants from cement industry, while Sahoo et al., (2022) gave an evaluation of methods for cement industry to reduce emission and conserve energy. These studies did not assess measures that can be taken to reduce all environmental impacts in cement production. There is limited documentation on environmental and socio-economic impacts of cement production in Harare. Thus this study therefore, identifies environmental and socio-economic impacts arising from cement production and the efforts by cement industry to curb or reduce these impacts in Manresa Park, Harare.

Significance of the study

Results of this study will help to expose impacts of cement production to responsible authorities (such as Environmental Management Agency (EMA)) for monitoring and law enforcement purposes. In addition, the results of the study will help interested groups such as Non-Governmental Organisations with relevant information so that they give help when needed especially in form of educating stakeholders.

Aim of the study

To assess environmental and socio-economic impacts and effectiveness of measures to protect natural environment from impacts of cement production.

Objectives

- To identify environmental impacts of cement production at Lafarge cement in Manresa Park.
- To identify socio-economic impacts of cement production to the Manresa Park community.

- To assess effectiveness of the measures to combat environmental destruction.

Research Questions

- What are the environmental impacts associated with cement production in Manresa Park?
- What are the socio-economic impacts of cement production to the Manresa Park community?
- What are the measures put in place to combat the destruction of environment in Manresa Park from cement production and to what extent are these measures successful?

CHAPTER 2: LITERATURE REVIEW

2.1 Introduction

Cement is a very important ingredient in construction and this makes it a high demand product in the market. According to Stajan`ca and Etoková (2012), cement is an inorganic, non-metallic, finely powdered powder that when combined with water sets and hardens into a paste. The main cause of this hydraulic hardening is the production of calcium silicate hydrates, which are produced when water and cement components are mixed together. It is a crucial building component material utilized for housing and infrastructure development as well as a driver of economic growth (Devi et al., 2017).

Cement production have both negative and positive socio-economic and environmental impacts. It is determined by a number of variables, including the cement plant's location, the volume of its output, the technology employed, and last but not least, the regulatory framework in place. There are several steps that can be taken to stop cement from destroying the environment.

2.2 Environmental impacts of cement production

Cement production has several environmental impacts due to the "high volume process" nature of cement production, which requires supplies of raw materials, thermal fuels, and electrical power. The primary environmental effects of cement manufacturing in general include, Gaseous atmospheric emissions of carbon dioxide, Nitrogen oxide, Sulphur dioxide, Volatile Organic Compounds (VOCs) and others.

2.2.1 Air pollution from gaseous emissions

When calcium carbonate is cooked in a rotary kiln it produces clinker, a component of cement, which releases carbon dioxide (Conneely et al., 2001). Specifically, during calcination, at temperatures of 600-900°C, during the conversion of carbonates to oxides, carbon dioxide is emitted as a by-product. Carbon dioxide can reduce the amount of oxygen in the atmosphere leading to warming of the ground and it cause wilting of plants and skin diseases to humans (Karstensen, 2008).

Other materials such as sulphur oxides and nitrogen oxides are produced by the drying and kilning operations as additional air pollutants. The amount of sulphur dioxide produced varies from plant to plant and is derived from the sulphur compounds in the ores and the burned fuel (Al Smadi et al., 2009). When fuel is burned in rotary cement kilns, nitrogen from the fuel and incoming combustion air combine to create nitrogen oxides. The kind of fuel, nitrogen concentration, and combustion temperature are only a few of the variables that affect the quantity of emissions produced (Arachchige et al., 2019).

Additionally, a group of chemicals known as volatile organic carbon compounds (VOCs) are released into the atmosphere directly as a result of evaporation or another sort of volatilization. Stored solvents, gasoline, other industrial chemicals, and industrial activities like cement manufacture are also potential sources of these compounds (Devi et al., 2017). Another significant source of VOC release into the surrounding air is incomplete combustion of a variety of fuels. Toxicology, potential involvement in smog-causing photochemical reactions in the atmosphere, and potential involvement in the "greenhouse effect" and ensuing global warming are the main negative impacts of VOCs (Woodard, 2001).

2.2.2 Land degradation from cement production

One of the most significant effects of cement manufacture through raw material extraction is land degradation, particularly in places where quarrying occurs. Drilling, blasting, digging, handling, loading, hauling, crushing, screening, stockpiling, and storing are all part of quarry operations. This negatively impacts the ecosystem and biodiversity as it leads to land clearance, destruction of the soil profile and disturbance of the ecosystem processes (Zimwara et al., 2012). Overexploitation of resources also results from this operations as the extracted mineral depletes. Spills from quarrying equipment pollutes both water and ground, thus some organisms will be affected reducing microbial activity. Some of these effects are further explained below,

- Soil erosion

Quarry sites often involve the removal of top soil and vegetation to access the much needed minerals, this results in soil erosion and loss of fertile soils. The resultant is long term impacts on biodiversity and ecosystem, in some cases it makes it difficult for both flora and fauna to make a living (Conneely et al., 2001).

- Habitat destruction

Operations at a quarry site destroys and fragment habitats exposing flora and fauna to externalities, this may threaten the survival of native species. Adding on that, noise, dust and other disturbances associated with quarrying activities drives away wildlife and disrupt natural processes for example, photosynthesis is mostly affected by dust which reduces the leaf`s surface area (Shen et al., 2014).

- Water and air pollution

Quarry operations contaminates both ground and surface water sources by introducing heavy metals, sediments and chemicals making it unusable. This can harm aquatic and make water unsafe for wildlife health by algal blooms (Chen et al., 2010). Large amounts of dust and gases are produced which harm the nearby residents and animals. These also cause eye irritation to both wildlife and people, respiratory problems also results from these gases and dust for example asthma.

- Climate change

Greenhouse gases which are emitted during quarrying contribute to climate change by depleting the ozone layer which will result in global warming (Benhelal et al., 2013). For example the use of heavy machinery in quarrying may generate greenhouse gases which contribute to global warming.

Overall, land degradation in cement quarry sites have significant long-lasting impacts, therefore it is important to minimise them by adopting sustainable quarrying practices, proper waste disposal and other by-products and most importantly , restoring the land to its natural state.

2.2.3 Dust emission from cement production

Dust emission is another environmental impact primarily coming from the cement mills, clinker cooler, kiln system, and raw mills. The fact that hot exhaust gas or exhaust air is passing through pulverized material to create an intricately dispersed combination of gas and particles is a common characteristic of these processes. The type of particles produced is dependent on the source material, such as raw materials that have partially undergone calcination, clinker, or cement (Karstensen, 2008). Dust emissions have been connected to breathing issues like asthma and impaired visual which causes death of animals in road accidents. Reduced photosynthesis in trees is another impact of dust emission as the leaf surface area will be reduced by dust trapped by the leaf.

Chlorosis, or the yellowing of plants as a result of chlorophyll loss, is a result of dust emission. Necrosis is the term for the drooping of leaves brought on by a lack of chlorophyll. Chlorosis and necrosis occur due to exposure to pollutants like Sulphur oxide, Nitrogen oxide among others (Abdul-Wahab, 2006). This will lead to permanent death of some species, thus there is imbalance in the ecosystem and species richness will be reduced.

In some cases, a bad odour may occasionally be a direct effect of the gases released during the manufacture of cement. Additionally, the process of making cement directly produces foul odours during the ignition of the rotary kiln since it poses a threat to the lives of plants and animals as they develop a breathing and sight problems.

2.3 Socio-economic impacts of cement production

Cement production has a range of socio-economic impacts, both positive and negative. These impacts are complex and depend on a range of factors including location, scale of production and the regulatory environment among others. Some of the key impacts are those of economic growth and development, employment creation and cultural shifts (Kusena et al., 2012).

Cement manufacturing causes a host community's economic growth as it offers the necessary basic building materials for infrastructural expansion and improvement, such as road rehabilitation, educational and healthcare facilities, as well as water and energy supply, it is viewed as a key driver of economic growth (Stajanča and Eštoková, 2012). One of the most important advances a cement company can do to encourage successful operations is the improvement of road networks.

Instead of importing labour, the local people, particularly those impacted by company operations are employed (Modak and Biswas, 1999). This is one of the advantages a local cement industry may provide. Direct and indirect employment is generated by cement production in the manufacturing and construction industries. These opportunities are meant to benefit both the local and external people (Mazvimavi and Twomlow, 2009).

Cement production however, interferes with the cultural norms of the local community, negatively impacting the indigenous people with strong cultural ties with their land and natural resources. Processes such as quarrying of limestone will disturb some protected sites for example, damaging the ancestral graves of the locals. The sacredness of the location will be lessened in this situation. The Lafarge Cement Company's operations were obstructing the traditional temple on the ridge where ceremonies were performed in Deo Badeyogi, Nigeria, (Hilson, 2002).

Moreover, there is cultural erosion with increased social immorality cases for example increased prostitution involving employees. This will result in breaking down of families, exposing children to inadequate parental care. Two cases of impregnated school children who ultimately dropped from school were also noted in Gweru where Sino cement is located (Kusena et al., 2012).

2.4 Measures to combat environmental destruction from cement production

Reduced fuel use, especially from fossil fuels, which are the most air-polluting sources, can greatly help reduce greenhouse gas and solid particle emissions globally (Benhelal et al., 2013). Saving fuel and energy can also help prevent the depletion of fossil fuels and allow future generations to benefit from these priceless resources in the same way that we do. Several strategies, including process modification, process integration, plant optimization, maintenance, insulation, energy recovery, and the use of alternative fuels like biomass and waste materials, have helped to attain this goal.

Cement industries have also been adopting measures to improve their energy efficiency such as the use of recent technologies, efficient equipment, optimising their processes and implementation of waste heat recovery systems to reduce heat loss. High heat losses might result from issues including kiln seal leakage, cooler inefficiency, fuel fineness, inappropriate air and fuel ratio, and low air stream temperature (Karstensen, 2008). Therefore, optimization techniques should be used to reduce fuel usage, pollutant emissions, and ultimately, the cement industry's costs

Cement plants are increasingly using recycled materials such as fly ash and slag in their products so as to reduce resource exploitation. They are exploring at ways to recycle concrete and other building materials to reduce waste and conserve resources. In the case of fly ash, the by-product not only helps to minimize the amount of raw materials and energy needed in the process, but it also has the potential to increase the durability of concrete by substituting some of the clinker. In this instance, the organic component is burned and serves as a thermal energy source while the mineral component is incorporated into the process and provides input as a raw material and additive (Benhelal et al., 2013). Another example of a material that can be used as a component of feed is slag from blast furnaces. Alumina-silicates, calcium-alumina-silicates, and silicates are all non-metallic by-products of the iron and steel manufacturing process (Ibid).

Mining of raw minerals to make cement can have negative environmental impacts such as soil erosion and deforestation. To mitigate these impacts, cement companies are adopting sustainable mining practices such as afforestation, land restoration and technological advancement to save the environment by replacing outdated equipment with advanced ones to reduce spillages.

The environmental effects of cement manufacture, such as land degradation, emission standards, and requirements for environmental safety, are regulated by governments all over the world. In Zimbabwe, the government established a number of laws through the parliament to protect the environment. The following environmental rights are guaranteed to every Zimbabwean person by section 4 of the Environmental Management Act (EMA), Chapter 20:27, 2002 (Manzungu, 2001).

1. The right to live in a healthy, clean environment;

2. Availability of environmental information;

3. The right to conserve the environment for the benefit of current and future generations; and

4. The right to participate in the execution of laws and regulations that stop pollution, environmental deterioration, and sustainable management;

CHAPTER 3: METHODS AND MATERIALS

3.1 Description of the study area

This research was done at Lafarge Cement Company which is in Manresa Park in Harare east, about 16.093 kilometres from the Harare Central Business District. Manresa is located between latitudes -17.81917º S, longitudes 31.1975º E and 1601 metres altitude. It is close to Mabvuku and Tafara high density suburbs.

The agro-ecological area IIa, where Manresa is located, has mean maximum temperature of 26.0 ºC and mean minimum temperature of 13 ºC (Mazvimavi and Twomlow, 2009). Natural region IIa receive rainfall between 700 mm to 1000 mm falling from November to March and suitable crops to grow are maize, tobacco and wheat. The estimated elevation is 1.601 metres above sea level. Soils in Manresa are typically heavy textured red clay loams with humic soils found in valley bottoms which are good and suitable for intensive farming (Ovincent et al., 1960). Beef, dairy, pig and poultry production are main types of livestock production found in this area (Mugandani et al., 2012). The estimate population for Manresa is 1420 households. Manresa Park is a low residential area which is dominated by new inhabitants that most of them come in the last 10 years and some are still coming.

The dominant tree species in this region are *Piliostigma thonningii* and *Bauhinia petersiana*. Associated species include *Faurea,* c*ombretum molle*, *Uapaca kirkiana*, *Pterocarpus angolensis, Albizia antunesiana*, *Strychnos spinosa* and *Parinari curatelifolia* (Geist, 1999).

Founded in 1954 in Zimbabwe, Lafarge Cement limited is a supplier of essential construction products. Formerly known as Circle Cement, the company is a subsidiary of the Lafarge Group (France), which offers composite and masonry cement aggregates such as washed sand, quarter stones, crusher run and gravel. The company also offers specialised products which include, agricultural lime, colorbrite and snolime. The company has an estimated 525 employees.

Lafarge cement Zimbabwe limited is located in Harare East, 16 kilometres along Acturus Road located between latitude -17.8216º S and longitude -31.1996º E, at 1601 metres above sea level. Lafarge cement premises covers an estimated area of 2.7 square-kilometres (Zimwara et al., 2012). The company has three working sites namely quarry site just near Chikurubi Prison, the Production plant site and lastly the sales site which is near Woman University in Africa. Observations will be done at the quarry site (Chikurubi), the production Plant site (Lafarge) and the nearby community to the plant (Manresa).

3.2. Research Design

The research followed a life cycle assessment (LCA) of cement production to identify the sources of environmental impacts. LCA is a system analysis method which is applied to large complex systems and their interaction (Modak and Biswas, 1999). The inclusion of every stage of the process or product's life cycle was fundamental to this analysis as it helped to identify the sources of the environmental impacts. The processes under assessment are raw material extraction, transportation, milling, clinkering and cement grinding. This lifecycle assessment does not include the packing and storage process as the main focus was mainly on the production processes.

3.3. Data collection

A life cycle assessment of cement production was used to identify the sources of impacts from each and every stage of cement production. The lifecycle starts from the extraction of the main raw material which is limestone extraction, transportation, milling of the limestone, clinkering, cement milling and finally packaging and storing. This LCA however, does not include packing and storage of the product as the study mainly focused much on the production processes. Environmental aspects at each stage were identified by closely looking at the raw materials used, the mixing process and the end product. At every stage of the production process, inputs, processes and outputs were identified and all the end products with negative impacts to the environment were recorded. By assessing the mixtures of raw materials with additives and identifying the reactions and its outputs at each stage of the cement production, the LCA helped to identifying the exact process and stage at which there is emission or other environmental aspects which damage the environment. Three areas were visited on foot for direct observation to gather more information on impacts of cement production. The observation will be aided by a check list of environmental impacts (appendix 1). Photographic images of degraded and affected areas as a result of Lafarge cement production processes were captured.

3.4. Assessment of socioeconomic impacts

A comprehensive descriptive survey methodology helped to gather both qualitative and quantitative data. This was done with the aid of a questionnaire (appendix 2). About 10% of the households, or 142 households were chosen through cluster sampling for questionnaire administration. The population was divided into clusters which were based on the longevity stay of households in Manresa Park (from those that came last year, 3 years ago, 5years ago and above 10 years in the area) and each cluster had 35 people. This was to reduce bias since the area is dominated by new inhabitants (below 5 years in the area) with little knowledge about Lafarge cement unlike those who stayed in this area for 5 years and above who have a better experience with company. The categories formulated reflected different understanding and perceptions among the inhabitants who stayed in Manresa Park for different years.

Key-informant interviews were used to gather data from purposively selected key informants who included the Safety, Health and Environmental (SHE) officer for the company, Plant Assistant and Sister-in-charge at Cimas clinic. The SHE officer provided information on how the company activities were affecting the environment, local community's views on the prevailing situation, remedial actions and information on the last audits by EMA. The safety healthy and environmental officer again provided information on how they are dealing with impacts of cement to the natural environment and people in the Manresa Park community.

Plant assistant provided information on pollutants and their sources. The clinic provided information on trends and prevalence of diseases in the surrounding communities linking them to cement production.

3.5. Data analysis

Quantitative and qualitative data were coded into SPSS V21.0 processed and presented as graphs and tables. Descriptive statistics were used to describe impacts of cement production processes results.

CHAPTER 4: RESULTS

4.1 Environmental impacts of cement production processes in Manresa Park

Cement production at Lafarge Cement Zimbabwe in Manresa Park has a variety of impacts which include both positive and negative. Figure 1 shows environmental impacts of cement production in Manresa Park.

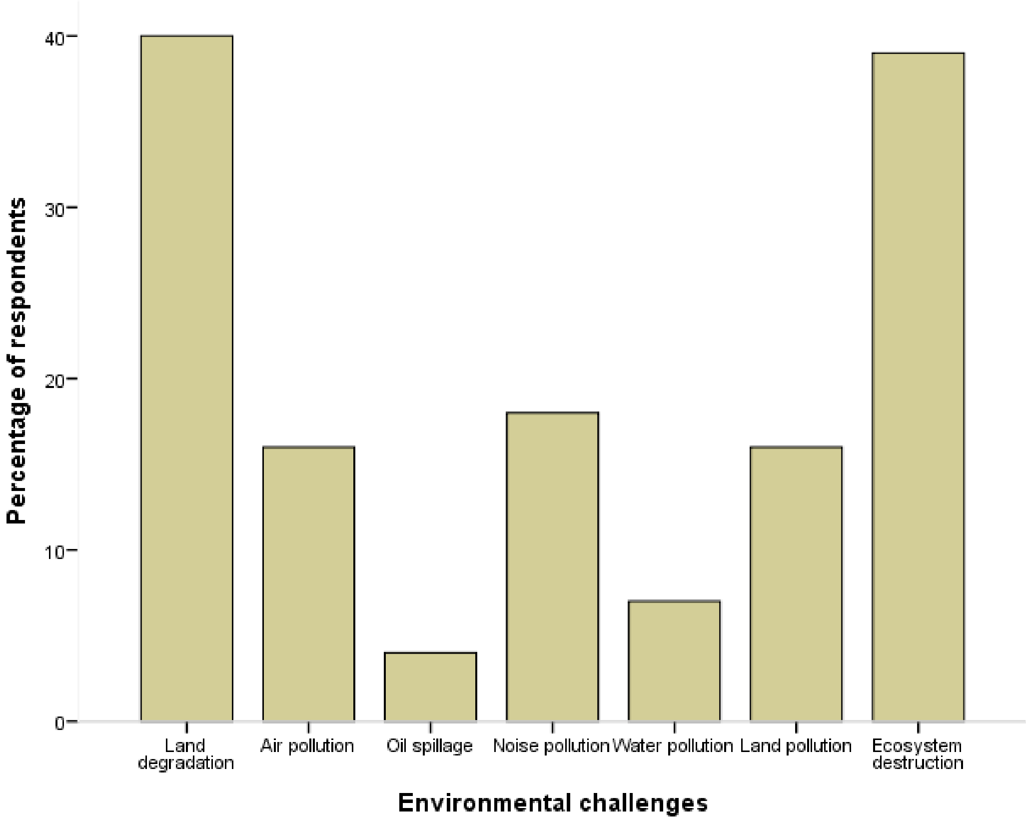

Figure 1. Environmental impacts of cement production in Manresa Park.

Two quarry pits where limestone is extracted for cement production cause land degradation and ecosystem destruction (Appendix 3i). The use of heavy equipment during blasting and crushing of limestone and their transportation produce a lot of noise which mostly affect the wildlife and surrounding community.

Land pollution is another environmental impact linked cement production at Lafarge resulting from improper disposal of unused material. Some of the materials disposed have negative impacts on the environment and these include oils, chemicals among others. Appendix 3ii shows dumped scrap polluting the land.

Air pollution is another impact of cement production at Lafarge Cement Zimbabwe, the quality of air is easily compromised by emission of dust and other form of air contamination. From the extraction of raw materials to the final grinding and packing of cement, dust is produced at every stage. Both fugitive and brown dust are produced and they are all dangerous to the environment as they cause chlorosis and necrosis to plants.

4.3 Socio-economic benefits of cement production in Manresa Park

Cement production industry has both positive and negative socio-economic impacts. The positive impacts shown in Figure 2 include road rehabilitation identified by 85% of the respondents, followed by employment creation with 30%, health service improvement identified by 15% and lastly 10% of the respondents found no benefits.

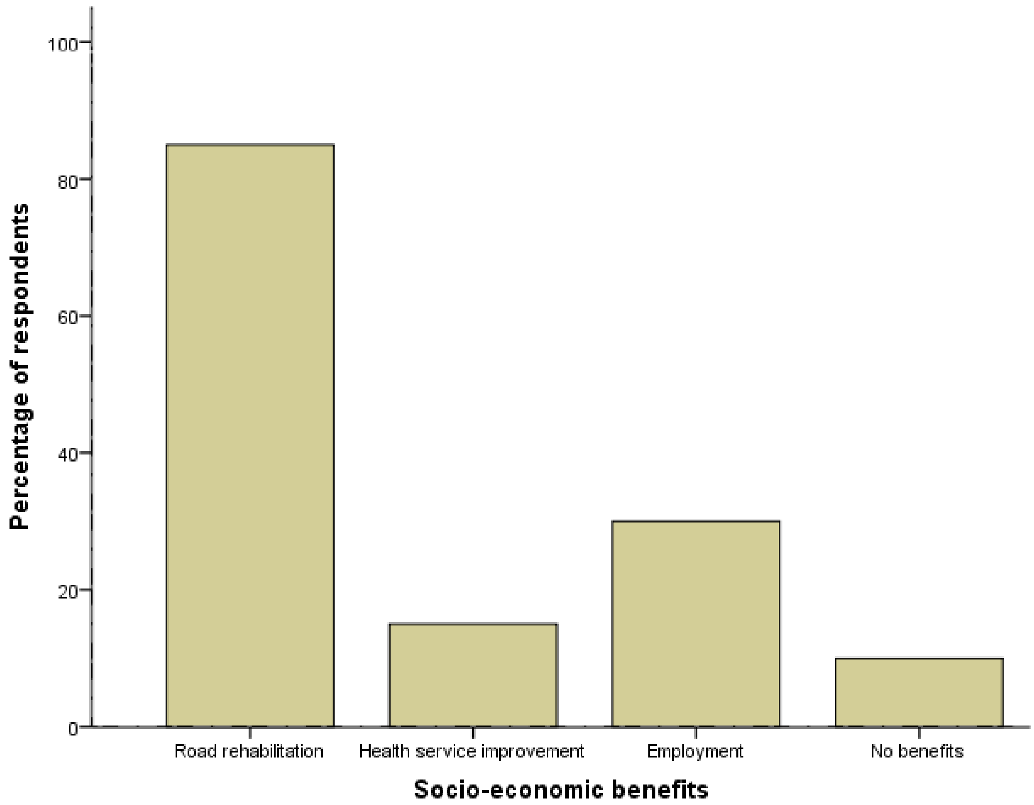

Figure 2. Socio-economic benefits from Lafarge Cement production in Manresa community.

Road rehabilitation eased transport problems for most residents in Harare east linking with Harare central business district. Respondents wished if Lafarge could continue with the good work for the other roads.

Despite a spike in unemployment rates in Zimbabwe, Lafarge has played a pivotal role of employing both qualified and unqualified personnel thus reducing unemployment and raising the standards of living of the local people.

An improvement in health service provision in Manresa community was through the Cimas hospital meant for Lafarge employees that was now accessible to any beneficiary of Cimas in the community. This eliminated the problem associated with proximity to a health service provision and transport cost to nearby clinics or hospitals.

However, respondents also identified socio-economic challenges (figure 3) such as land conflicts (30%), disease spread (13%), cultural challenges (7%) and others had no challenges associated with Cement Company. The spread of disease such as cholera have high chances including other communicable diseases due to the increased population of employees. Respondents were also concerned about the sand harvesting by in Chishawasha area, instead of the area used for residential stands. Lafarge has a great relationship with cultural beliefs of residents but is challenged by immoral behaviour such as prostitution by some employees.

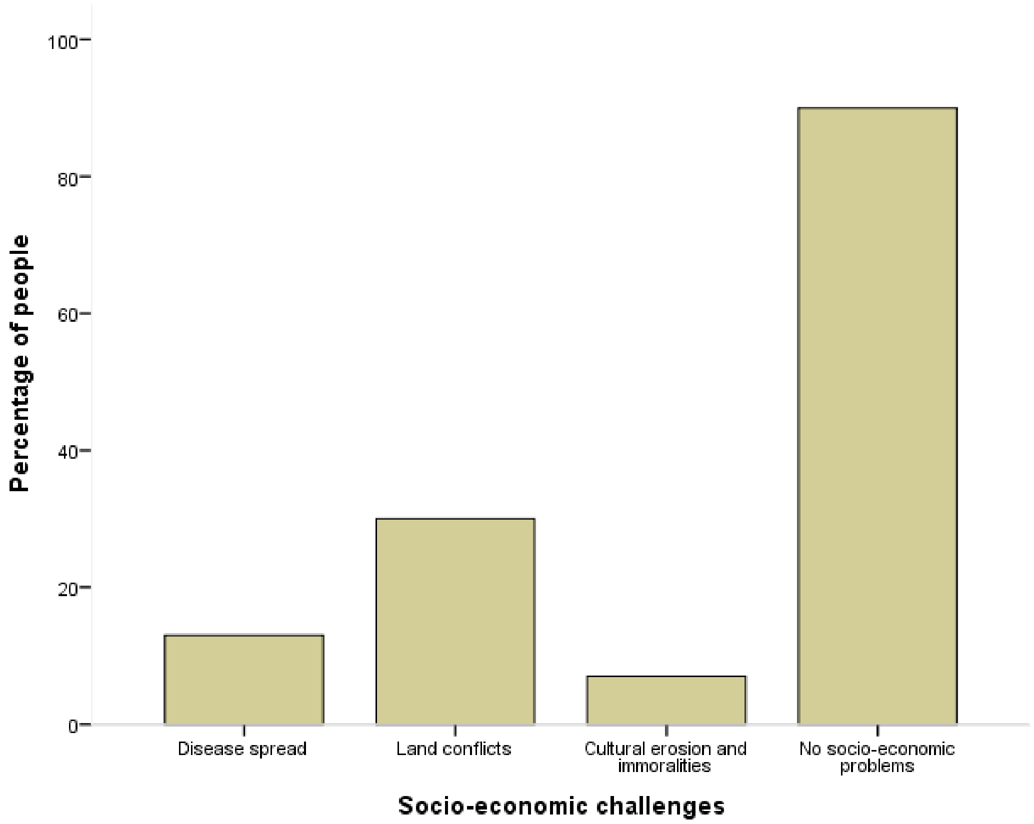

Figure 3. Socio-economic challenges caused by Lafarge cement production in Manresa Community

Cement production is a high air polluting industry with very high chances of respiratory problems to communities in the vicinity. Despite high chances of respiratory diseases in cement industries, Lafarge has managed to contain respiratory related diseases, such as coughs and chest problems that were identified by 20% of the respondents. Other common disease were tuberculosis (17%) and sexually transmitted infection, in form of HIV (3%).

4.5. Measures used by Lafarge to combat environmental destruction

Long and short term measures to deal with environmental problems from Lafarge cement production operations are shown in figure 4. Some of the measures to safeguard the environment and people include employee awareness and commitment to environmental conservation and safety.

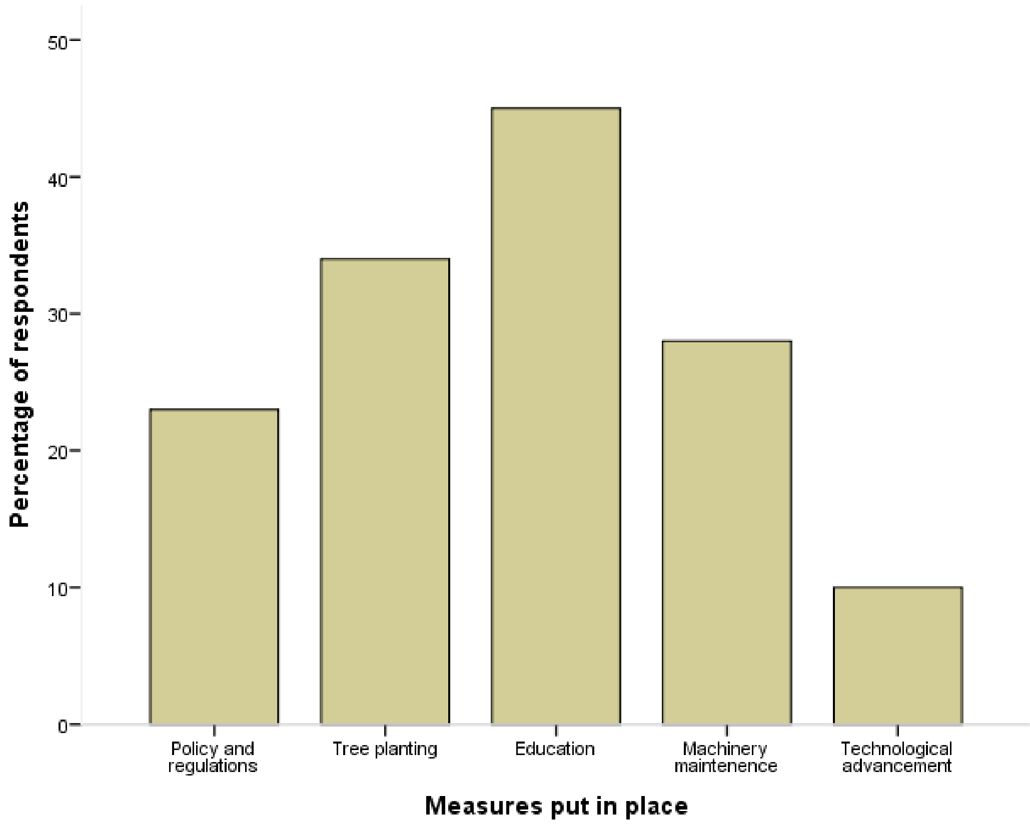

Figure 4. Measures put in place to combat destruction of environment from cement production processes at Lafarge.

These rules observed are summed up by a statement which says “living by these rules is a condition of employment” meaning every employee is obliged to follow these rules and failure will put the job at risk. They are guided by the International Organisation for Standardisation (ISO) 14001 of 2015 and ISO 45001 of 2018 and Environmental Management Act Chapter 20:27 of 2002. In the Lafarge premises, no one is allowed to kill or take any animal without the approval from the Wildlife Authorities. Snake catchers are trained every year to reduce killing of snakes and those found killing snakes will be sued. Up to date there are no incidence of snake bites as employees are well informed of snake infested areas, and regular fumigation are done. In addition to this, Lafarge engaged in fast growing tree planting programs to try and restore degraded environment and the tree species mainly grown are *Eucalyptus grandis and Pinus spp*. Periodic awareness meetings and campaigns are done with all employees to remind them of main goal of the industry which is to conduct business in a safe and sustainable way with zero harm.

Both internal and external periodic monitoring and audits are done to check the compliance and competence of staff, equipment and employees. The previous audits recorded an improvement in dealing with environmental impacts. Introduction of fumigation programs in snake infested areas, introduction of signs and notice boards for awareness are some of the improvements.

Dust suppression is another measure which is being used daily at Lafarge cement plant. Bulk water tanks move around the plant spraying water to suppress dust to reduce the spread and fast movement of dust.

Dust plants are used to reduce emission at the plant by sucking dust and re-divert it into the processing machine. These dust plants are installed at every critical point where emission is mostly present. At Lafarge there are eight working dust plants, four of them are in milling house, two at the pre-heater section while the remaining two are at packing plant. These dust plants are designed to capture 3.8 tonnes per six hours. The dust plants are designed to capture and store dust then dispose it in a good way that it does not affect both the environment people. These plants are maintained periodically to sustainable day-to-day running of the business.

Lafarge embarked on tree planting in degraded areas to restore the natural state and reduce erosion of loose material. This is a long-term measure which they put in place to conserve the environment for the coming years. It is their rule that, every employee must plant his or her tree on the date set by the leadership. Fast growing tree species such as *Eucalyptus grandis* and *Pinus spp* are the most planted trees.

Equipment and machinery maintenance is another measure which Lafarge takes serious of, to reduce spillages and improper working of their machines. Periodic maintenance are done to ensure smooth and sustainable daily business.

Despite having a clear roadmap of measures to combat the destruction of environment from their operations, Lafarge faced a variety of challenges including poor technology, brain drain, lack of funds and poor polices. These challenges are hindering progress in adopting and implementing new and effective measures for sustainable production processes.

CHAPTER 5: DISCUSSION

5.1. Environmental impacts of cement production processes in Manresa Park.

A number of environmental impacts were recorded including land degradation which was most dominant (figure 1). The environmental impacts at Lafarge destroy the aesthetic value of the environment, ecosystem processes and the natural state of the land. According to (Kusena et al., 2012) cement manufacturing deteriorates almost every part of the environment and has negative effects on human health. Appendix 3i shows an image of degraded environment by limestone quarrying activities at Lafarge quarry site.

Appendix 3ii shows scattered dumped different materials polluting the ground at Lafarge cement plant. Land pollution degrades the natural state of the environment and it also affect the growth and health of flora and fauna, the microbial activity can also be compromised (Stajanča and Eštoková, 2012). This concurs with Arachchige et al., (2019), who indicated that, land pollution from cement industries destroyed the aesthetic value of the environment and it also compromised ecosystem operations.

Furthermore, air pollution was another environmental impact of the cement industry. The nature of the particulates generated is directly linked to the raw materials being used (Karstensen, 2008). Air pollution has a variety of health and environmental impacts which ranges from respiratory infections such as chest pains, coughs, tuberculosis and can stimulate asthma and other respiratory problems (Karstensen, 2008). Air pollution affects the growth and quality of plants and it also affect fertilization by causing sterility to pollen grains. This was supported by, Abdul-Wahab (2006), who added that, chlorosis and necrosis occur due to exposure to pollutants like nitrogen oxide, sulphur dioxide and sometimes dust. Air pollution`s biggest problem is global warming which lead to climate change. Gaseous emission have local and global environmental impact resulting in global warming, depletion of the ozone, acid rain, biodiversity loss and lastly reduced productivity of crops (Devi et al., 2017). Due to the use of heavy equipment, blasting and quarrying processes, noise pollution becomes an issue of concern in areas around cement industries. Noise pollution also has a great impact on human hearing ability. According to Devi et al. (2017), noise pollution is very dangerous to human and animal hearing ability, that it causes accidents in roads.

5.2 Socio-economic impacts of cement production in Manresa community.

Cement production has both positive and negative socio-economic impacts to the host community. Socio-economic benefits are most welcome to the community as the raise the standards of living through direct and indirect links. Figure 2 shows some of the benefits, the Manresa community is getting from the Lafarge Cement Company. This is supported by Akande and Idris (2005) who mentioned that, infrastructural developments such as road construction would ultimately trigger wide range of business activities due to accessibility to the area.

Industries are most welcome in societies as the locals will be expecting employment opportunities. This is supported by Modak and Biswas (1999) who added that, employment opportunities should benefit locals who are affected by any development initiative. Despite the spike in unemployment rates in Zimbabwe, Lafarge has played a significant role in creating both formal and informal employment. This creates a state of equilibrium between the formal and informal employees as the locals will be providing informal employees while formal ones will be from either of the two. In this study, 30% of the respondents were satisfied by employment creation at Lafarge.

Employee wellbeing and safety is the most prioritised thing at an industrial set up. However, Lafarge is not only concerned about its employees but the community as well. This was evidenced by inclusion of health services delivery to any member of the community under Cimas medical aid. This is supported by Kusena (2012), who added that the construction of a hospital or a clinic by an organisation shows they care about local people, employees and loss of production time due to illness of employees.

Despite having a bunch of positive impacts Lafarge is offering to the community, there are some negative impacts which are degrading the social wellbeing of the locals (Figure 3). Air pollution in form of dust, caused respiratory problems hence the need for drastic measures. This concurs with Kusena et al (2012) who showed serious health problem for communities around cement production sites in Hozheri community, in Gweru, Zimbabwe. Devi et al (2017) added that, it is well known that air pollution is hazardous to environment and human health.

5.3 Measures used by Lafarge to combat environmental destruction.

Different measures are put in place to reduce the environmental impacts at Lafarge (figure 4). Cement industry produces a variety of impacts which negatively affect both the environment and people, thus it is very important to take drastic measures to deal with the challenges before it affects the ordinary cities. Benhelal et al (2013) stressed importance of continuous monitoring to facilitate smooth and safe industrial operations. Maintaining of equipment also facilitate safe storage and handling of chemicals which might affect the environment and people. According to Benhelal et al (2013), it is obvious that a well-structured and regular maintenance program can highly result in plant performance improvement as well as fuel consumption and emissions reduction.

CHAPTER 6: CONCLUSION AND RECOMMENDATIONS.

6.1 Conclusion

Cement production in Manresa Park causes a variety of environmental impacts such as land degradation from quarry and sand harvesting, land pollution from dumping of useless material, air pollution from gaseous and dust emission, water pollution, ecosystem destruction and lastly oil spillages. There are positive and negative socio-economic impacts from cement production in Manresa. Positive impacts include infrastructural development, improved health service, and employment creation among others. Negative impacts caused by cement production in Manresa community include land conflicts, disease spread, cultural erosion and immorality.

However, Lafarge is fighting all negative impacts by implementing measures to curb further destruction of both the environment and human health. These measures include policy and regulations, tree planting in degraded areas, educating the employees, regular maintenance of machinery and equipment and lastly implementing advanced technologies. Despite having put all these measures in place, Lafarge is facing some setbacks in attaining the intended goals. These challenges are in form of financial capacity to implement long term measures, poor technology, brain drain, and poor policy implementation and follow up.

6.2 Recommendations

The following are some of the recommendations,

- Use of alternative renewable fuels for culcination process
- Working with environmental organisations to help protect the environment
- Community engagement and involvement in decision making such as community development, sustainable resource utilisation and protection
- Future studies should aim at covering all the communities around the cement industry which are being affected by the operations at the industry.

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APPENDICES

Appendix 1: Environmental impact checklist

1. Environmental degradation
2. Land pollution
3. Spillages
4. Dumps
5. Water pollution
6. Land clearance
7. Equipment dumping
8. Noise

Appendix 2: Questionnaire

SOCIOECONOMIC IMPACTS OF LAFARGE CEMENT PRODUCTION ON MANRESA COMMUNITY.

Questionnaire number……………. Date of interview…...../……../………

My Name is Leoford Kanyoka, a student at Bindura University who is studying Bachelors of Science Honours Degree in Natural Resource Management. Thank you for taking the time to complete this survey about the study, socio-economic and environmental impacts of Lafarge cement production on Manresa park community. The information gathered will be used solely for academic purposes and with the highest secrecy.

Your cooperation is highly appreciated

- Tick in appropriate box and fill in the details in spaces provided

Q1. Sex Male ☐ Female ☐

Q2. Are you a permanent resident of Manresa Park? Yes☐ No ☐

Q3. How many years have you been in Manresa Park?

1 year ☐ 2 years ☐ 5 years ☐ ≥10 years ☐

Q4. Are you the head of the household?

Yes ☐ No ☐

Q5. Have you ever been affected by Lafarge cement production?

Yes ☐ No☐

Q6. Are these environmental impacts present in your community due to cement processing at Lafarge?

1. Land degradation ☐
2. Air pollution ☐
3. Noise pollution ☐
4. Oil spillage ☐

5. Water pollution ☐
6. Ecosystem destruction ☐
7. Land pollution ☐

Q7. Is your community receiving the following benefits from Lafarge Cement Company?

1 Road rehabilitation ☐

2 Health service improvement ☐

3 Employment to community members ☐

4 No benefits ☐

Q8. Is Manresa community facing the following social challenges with Lafarge cement production processes?

1. disease spread ☐
2. Prostitution ☐
3. Workplace abuse ☐

Sexual harassment

Appendix 3

i. Limestone quarry pits (Eastern and Western pit).

ii. Dumped material polluting the land

iii. Bulk water tank spraying water to supress dust.