EFFECTS OF QUARRYING ACTIVITIES ON THE ENVIRONMENT IN NAIROBI COUNTY: A CASE STUDY OF EMBAKASI DISTRICT.

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DECLARATION

This research project is my original work and has not been submitted or presented for examination in any other university, either in part or as a whole.

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Recommendation/approval

This research project has been submitted for examination with our recommendation and approval as university supervisors:

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DEDICATION

I dedicate this research project to my children Malaika and Leon, my husband Richard and my late parents. To them, I say may God almighty bless you abundantly.

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I would like to take this opportunity to express my gratitude to the Almighty God and all the people whose contributions have made this work a success.

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May God bless you all.

ABSTRACT

Quarrying is an activity where stones are dug for the purpose of being used in building, making roads through cutting, digging or blasting. Quarrying is a huge supporter of local economic development: as the use of extracted material enhances trade, creating jobs for most people who depend on this for their livelihoods aside from other economic activities.

Quarrying is a short-term activity with long term effects it comes along with the promises of wealth and jobs but it brings high environmental costs. The main aim of the study was to unearth impacts that quarrying activities has on health of the quarry workers and people living next to the quarries as well as physical environment.

The general objective of the study was**:** to examine the effect of quarrying activities to the environment. Specifically, the study examined the effects of quarrying activities on the natural and human environments. The null hypothesis that was tested was to find out if there was a relationship between quarrying activity and the environment which included both the physical and human environment.

Questionnaires and interview were used as tools of data collection. The questionnaires were administered to quarry workers, quarry owners and people living next to the quarries to gather the information required. The effects of quarrying on the environment that included the landscape were observed. Stratified random sampling was done to get the target population of 189, which was used to gather data.

The information collected was analyzed using SPPS for cross tabulation and to generate frequencies and statistical graphs for the interpretation of data. Through Chi square test it was established that there was a relationship between the quarrying activity and the health of both the quarry workers and area residents. The findings of the study indicated that the workers did not have protective gears which are a requirement in their profession. This increases the effects to the health of the quarry workers.

The findings showed that regardless of the important role that quarrying activities played in the economic growth; it resulted into negative effects to the environment

such as land degradation. Other quarry workers were not provided by the protective gear that they need as they carry out their duties and as result they are exposed to dangers which affect them. This shows that most of the quarry companies do not adhere to the set environmental legislation such as the Occupational Safety and Health Act 2007. Results shows that the quarries produce a lot of dust and noise and this affects the quarry workers and people living close to them. The area was mainly a grazing land and farm land before the location of the quarries, when the quarrying companies were established a lot of vegetation has been lost. The several quarries that have been abandoned act as dumping site where people damp waste from other construction sites and waste from the nearby house hold. The vegetation has been affected due to dust accumulation which hinders growth.

Future interventions should be taken by the Government of Kenya to ensure that the laws governing the quarrying and mining industries are observed through enhanced surveillance. Licenses of the quarry owners who do not adhere to the set laws should be revoked. Compliance monitoring visits to quarry sites should be undertaken routinely so as to minimize the negative effects of quarrying operations on humans and the environment. Further research on more advanced methods that can reduce the effects of the quarrying activity on the environment should be carried out. Research should be carried out to identify the effects of the waste being dumped in the abandoned quarries on the health of the people living in the surrounding area.

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ABBREVIATIONS

AIDS	Acquired Immune Deficiency
DOD	Department of Defence
EIA	Environmental Impact assessment
K.R.A	.Kayole Resident Association
KNBS	Kenya National Bureau of Statistics
MEMR	Ministry of Environment and Mineral Resources
MERN	Mining and Environment Research Network
NEMA	National Environment Management Authority
SPSS	Statistical Package for Social Science
WSSD	World Summit on Sustainable Development

CHAPTER ONE
INTRODUCTION

1.1 Background of the study

Within the last decade, environmental concerns have gained prominence throughout the world. Several international protocols have been established by the global community to deal with the emerging environmental issues. In Kenya, these global changes coincided with the enactment of the Environmental Management and Coordination Act (1999) the law that governs environmental issues in the country. The Act established the National Environment Management Authority (NEMA) which, among other functions, monitors and evaluates development activities to ensure there is no threat to environmental stability. Activities, such as quarrying in urban areas become significant in this respect.

Quarrying is a huge supporter of local economic development; it enhances trade, creating jobs for people annually, creating new habitats sometimes new roads are built, first to transport the machines and then extracted materials which are then left to be used by residents. Most people in quarrying regions wholly depend on these quarrying for their livelihoods aside from other economic activities.

Quarrying activities around Embakasi area in Nairobi have been going on since the 1950s when the place was sparsely inhabited. Today, the population of Embakasi area has grown tremendously and there is stiff competition between various land use practices in the area. Moreover, new residential areas have sprouted throughout the area further instilling pressure onto what used to be open space.

Embakasi division had a total of 19 quarries (Nema 2010) over the years. These quarries were established in the area as early as 1950s when the population sparse was about 7,747 people (Census report 1969). The population of the area has grown tremendously over the years to about 925,775 people (Census Report 2009- KNBS) and this makes the effects of the quarrying activity to be felt by many who live in the given area. Kayole Resident Association (KRA) in Nairobi effectively managed to relocate the huge stone crushing industry from their area, but not after the impact on their buildings and health (Kariuki 2002). Due to this most quarrying companies have

relocated to other areas leaving eight companies which are still operational. There is need to identify the effects on the environment with the continued presence of these quarries in the area.

Quarrying is a very important activity in human life as it helps in the development of infrastructure such as roads in a given area. The quarrying activities that are carried out by man affect our environment in one way or the other. Both physical and the biological environment are affected by these activities. The effect to the environment in most cases is usually negative that is: it cause harm to the environment. The study tried to identify how quarrying activities in Nairobi affects the environment and the people working in or living near the quarries.

1.2 Statement of research problem

Quarrying activities has led to development of infrastructure, created employment opportunities, growth of towns and has contributed to the establishment of various industries. Quarrying activities have also lead to environmental damage (Siachoono 2009). There are two reasons why land degradation generally results from mineral extraction: first is industrial development and secondly short term economic benefits such as reaching production goals and employment. The quarrying activity has affected the environment in both negative and positive ways. Scholars in different parts of the world have tried to carry out research in order to identify how this activity has impacted the environment ((Adekoya, 2003; Ajakaiye, 1985; Kibet, 2004)

The benefits of the quarrying activity should trickle down to the people living in the neighboring area; this can be in form of good roads and other infrastructure. According to (Aigbedion 2005) the benefits of quarrying include socio-economic development and growth due to internal revenue and/or foreign exchange earnings. This study attempts to establish the positive effects of quarrying on the environment in Embakasi. The study area is characterized with poor roads especially the one leading to the quarry site, contrary to what is expected due to the presence of the quarries in the area. There is need therefore to establish why that is the case.

Studies have been carried out by different scholars in relation to quarrying, Kibet (2004) carried out a research on environmental problems associated with sand mining.

He looked at how the sand mining affects the environment and the working conditions of the sand miners. Charles (2002) carried out a research about different types of mining that is used in the sand mining industries and mainly the effects of sand mining to the health of the workers, Mweni (2002) investigated extend of quarry worker welfare and Otieno (1998) researched on the quarrying in Kayole and its contribution to defects in adjacent residential building. These scholars have carried out research in Kangudo and Kayole areas which related to quarrying activity in different areas but this study focused on the effect of quarrying activity in Embakasi Division with special emphasis on its effects on the environment, both human and physical.

Quarrying activities in Nigeria has caused significant impact on the environment, the blasting rocks with explosives in order to extract material for processing gives rise to noise pollution, air pollution, damage to biodiversity and habitat destruction which affect the human environment of a particular area Okafor (2006). If a comparison is made between the two cases, is this the same case as the Embakasi area where several quarries are in operation?

There are several pieces of legislation that governs the quarrying industry for example The Occupational Safety and Health Act, 2007 and Environmental Management Co-ordination Act 1990. They give guidelines that are to be used in the mining industry such as the level of noise, the vibrations and protective clothing for the workers in different workplace. This study attempts to establish whether the relevant provisions of the Acts are observed in the study area.

The main focus of the study is to identify the effect of quarrying activity to the environment with emphasis to Embakasi District. The study intends to find out if the problems experienced in other areas where quarrying is taking place apply to the study area.

1.3 Research Questions

The research questions for the studies are:

- What are the effects of quarrying to the environment?

- Does the quarrying activity have any effect on the people living in the given area and quarry workers?
- What problems do people living next to the quarries experience due to their activities?
- What dangers/problems do the worker in the quarries experience?
- What are some of the measure being taken by the quarry owners to reduce the effects of quarrying to the environment?

1.4 Study Objectives

This states the main aim of the study in the given area.

To establish the effect of quarrying activities to the environment.

1.5 Specific Objectives

1. To examine the effects of quarrying on the natural environment.
2. To establish the effects of quarrying activities on the quarry workers and the area residents.
3. To establish if the law governing quarrying activities are adhered to by concern parties.

1.6 Research Hypothesis

The hypotheses for the study areas follow:

H_0 There is no significant relationship between quarrying activity and the physical environment.

H_1 There is significant relationship between quarrying activity and the physical environment.

H_0 There is no significant relationship between quarrying activity and the health of the workers in the quarries.

H_1 There is significant relationship between quarrying activity and the health of the workers in the quarries.

H_0 There is no significant relationship between quarrying activity and the area resident.

H_1 There is significant relationship between quarrying activity and the area resident.

1.7 Justification of the study

This study is an attempt to assess the environmental problems of quarrying in areas around Embakasi in Nairobi. This is because most of these quarries are located next to the residential areas and the people living there are affected by the activities that go on. The topic of study helped to establish the effects of quarrying activity to the environment, this include the physical environment and human environment: the quarry workers and residents around the area of study.

There several studies that have been carried out (Musyoka 1997, Okafor 2006, Azad and Ashish 2006) in other area and have identified that quarrying activities have negative effects to the health of the quarry workers and the people living near them. The study endeavored to establish if the same problems are also experienced in this area of study. The study need to be done in order to find a solution to problem that affects the people living in that given area.

Quarrying in Kenya suffers from a number of constraints including lack of basic knowledge, safety precautions, poor working conditions, low socio-economic status, lack of clear quarrying legislation and environmental degradation that call for special attention. These are more pronounced in small scale quarry operations all over the country.

There has been growing public dissatisfaction in the manner in which quarrying activities are being undertaken in the country. The country has witnessed various quarry disasters and complaints associated with quarrying activities especially with the abandoned quarries. A lot of research has been done the rehabilitation of quarries after use and all projects usually conduct EIAs before the beginning of the projects but during the actual process of quarrying nothing much is done.

Most quarry sites are unsafe for operation and most quarry operators also fail to observe environmental and safety measures when carrying out mining activities. Most quarries use of explosives for blasting operations, this has made the site weaker. Most the workers do not wear protective gear and as a result they are exposed to great danger. Lack of clear regulatory framework for the management of quarries in the

country and inadequate and uncoordinated enforcement of existing legislation has led to haphazard and unsafe quarry operations.

The task force that was set by the Ministry of Environment and Mineral Resources (MEMR) established that most of the quarries are located near the residential area and because of this, the study tried to examine the how their location has affected the people from the neighboring community and the workers in general. There are constant problems between the quarry owners and the community as a result there is need to identify some of these problems that arise.

The quarries were directed to relocate to an area that is less populated some have complied with this orders and they have relocated to Athi River area but the seven quarries in Embakasi are still very active , with some of them still carrying out blasting regardless of the effects to the environment and the people in the area.

EMCA (2009) Mines and quarries where explosives and machinery used are located in designated areas and not less than two kilometers away from human settlements. Any person carrying out construction, demolition, mining or quarrying work shall ensure that the vibration levels do not exceed 0.5centimetres per second beyond any source property boundary or 30metres from any moving source.

In the Embakasi District the legislation has not followed by the quarries and so the study will try to examine how this has contributed to the pollution of the environment.

The finding will help environmental institutions such as NEMA whose function is to examine land use patterns so as to determine their impact on the quality and quantity of natural resources advice the government on legislative and other measures for the management on the environment. The government through the Ministry of Environment and Mineral Resources (MEMR) will then make decision on whether to renew the licenses or not.

1.8 Scope and limitation of the study

The study covered Embakasi Division within Nairobi where there is an active quarry site. It dwelt with only seven active quarries where active blasting and crashing was on going this was due to accessibility. Proximity to the quarries, economic activities

and social status are some of the factors that were considered in drawing up the sample.

The study embraced a holistic approach which enabled in the generation of useful information of various aspects of environmental effect of quarries in the area, the effect on the quarry workers and residents around the quarries. The study has suggested several far reaching implications to the planners, policy makers, and change agents in tackling the various environmental issues.

There are many quarries but time and money being the main constraint, the study confined to only the active quarries in the area due to availability of funds. These are some of the limitation that the study faced. However, proper care and considerate thought was exercised in making the study as empirical and systematic as possible.

CHAPTER TWO
LITERATURE REVIEW

2.1 Introduction

This chapter presents a review of the related literature on the subject under study presented by various researchers, scholars and authors. It gives an overview of what has been written or researched on different aspects of the subject. It also summarizes selected studies that would be relevant to organization and interpretation of data. Finally it presents the conceptual framework utilized in this study.

2.2 Quarrying process

Quarrying like many other man-made activities causes a significant impact on the environment. In particular, it is often necessary to blast rocks with explosives in order to extract material for processing but this method of extraction gives rise to noise pollution, air pollution, damage to biodiversity and habitat destruction.

Quarrying is a process that undergoes different step. The first step of quarrying is prospecting an area to locate an ore. This involves physically going out into the field and searching for different types of minerals and fossils to give you an indication of where you might find an ore body. The company that intents to carry out the exploitation of the mineral then gets licenses from the ministry concerned

Next is the exploration of the area, which involves finding and determining the extent and value of the mineral-rich ore, through several different methods including hands-on fieldwork, remote sensing, and drilling.

This is then followed by the actual excavation of minerals from the ground. This is achieved in many different ways, depending on what type of mine it is and what you want to take out of the ground. After quarrying activity is finished there is need for ecological rebuilding, this involves the reclamation of the quarry site to make the land suitable for usage in the future. This means returning the land as much as you can to its former self, after all the quarrying is done. The land becomes degraded after it is quarried, so it is important to restore it as much as possible.

The extend of the impact can range from scarcely perceptible to highly obtrusive and the nature of the impact can similarly vary widely depending upon the mineral worked, the method of mining and the characteristics of the quarry site and its surrounding. One of the most frequent complaints the public makes to the crushed stone industry situated near population centers is about blasting noise. Blasting may occur daily or as infrequently as once or twice a year. In our case it is due to the method used in the mining and the closeness of the quarries to the effects can be experienced in different parts of the country.

2.3 Effects of quarrying in different parts of the world

Rock quarrying and stone crushing is a global phenomenon, and has been the cause of concern everywhere in the world, including the developed nations. Quarrying activity is an important activity because it provides much of the materials used in traditional hard flooring, such as granite, limestone, marble, sandstone, slate and even just clay to make ceramic tiles. However, like many other man-made activities, quarrying activities cause significant impact on the environment (Okafor, 2006). In particular, it is often necessary to blast rocks with explosives in order to extract material for processing but this method of extraction gives rise to noise pollution, air pollution, damage to biodiversity and habitat destruction.

Unfortunately, quarrying involves several activities that generate significant amounts of noise. The excavation of the mineral itself involves considerable noise, particularly if blasting methods are used. Following this, the use of powered machinery to transport the materials as well as possibly processing plants to crush and grade the minerals, all contribute even more noise to the environment. Such extraction of raw materials from their natural habitats by mining, drilling and harvesting affect the natural environment considerably.

Dust from quarry sites is a major source of air pollution, although the severity will depend on factors like the local microclimate conditions, the concentration of dust particles in the ambient air, the size of the dust particles and their chemistry, for example limestone quarries produce highly alkaline dusts, whereas coal mines produce acidic dust. The air pollution is not only a nuisance in terms of deposition on surfaces and possible effects on health, in particular for those with respiratory

problems but dust can also have physical effects on the surrounding plants, such as blocking and damaging their internal structures and abrasion of leaves and cuticles, (Guach, 2001).

One of the biggest negative impacts of quarrying on the environment is the damage to biodiversity (Anand, 2006). Biodiversity essentially refers to the range of living species, including fish, insects, invertebrates, reptiles, birds, mammals, plants, fungi and even micro-organisms. Biodiversity conservation is important as all species are interlinked, even if this is not immediately visible or even known, and our survival depends on this fine balance that exists within nature (Anand, 2006).

Quarrying activity has the potential of destroying habitats and the species they support (Mabogunje, 2008). Even if the habitats are not directly removed by excavation, they can be indirectly affected and damaged by environmental impacts such as changes to ground water or surface water that causes some habitats to dry out or others to become flooded. Even noise pollution can have a significant impact on some species and affect their successful reproduction. Nevertheless, with careful planning and management, it is possible to minimize the effect on biodiversity and in fact, quarries can also provide a good opportunity to create new habitats or to restore existing ones (Tanko, 2007).

Many other man-made activities including quarrying involve the production of significant amounts of waste. Some types of quarries do not produce large amounts of permanent waste, such as sand and gravel quarries, whereas others will produce significant amounts of waste material such as clay and silt (Wang, 2007). However, there is still potential for damage to the environment particularly with water contamination. Plants are major components of the ecosystem – a complex interaction between the biotic and a biotic entities of the environment.
The activity discharges dust that settles not only on land, plants and trees but also on surface waters used for drinking and other domestic chores.

For thousands of years man has used stone for building, whether it was for monuments, religious buildings or houses. Early on, when Britain was only sparsely populated, man’s use of stone and his primitive quarrying would have had little

lasting impact on the environment. Gradually, as time went on, more stone was used in building. It was a good material with which to build castles, walls, churches and important buildings since it was strong and weather resistant. As the demand for stone grew, so did the demand for quarrying. During the Industrial Revolution demand soared. The Victorians used stone for all their major buildings and with better transport and new technology they were able to meet these increasing demands, probably with little thought as to their impact on the environment.

The only countries which have made efforts to control the undesired impacts of mining are those with relatively high per capita income, and low population density. Many poorer countries (Kenya being one of them), in which the primary mining industries are proportionately of greater economic importance than in other countries are understandably reluctant to place non-essential restrictions upon their main earners of wealth and foreign exchange.

(Warhurst 1999) He stated that most international firms locate their production activities where they can easily externalize the environmental damage cost of their production that is developing countries where environmental regulation are either limited or poorly enforced. The most controversial problems of mineral development in developing countries have to do with their relation to the developed countries as providers of capital and technology.

In India quarrying has affected many of the people working in the mining industry. According to (Azad S.A and Ashish 2006) stone quarrying and crushing has been known as a highly hazardous work, whereby workers are affected by many debilitating occupational health hazards and diseases. Mostly the migrant workers are engaged in this highly unorganized industry. The most common exposure is from silica dust, which causes Silicosis among the exposed workers.

Silicosis is a disabling, nonreversible and sometimes fatal lung disease caused by overexposure to respirable crystalline silica. Silica is the second most common mineral in the earth's crust and is a major component of sand, rock, and mineral ores. Overexposure to dust that contains microscopic particles of crystalline silica can cause scar tissue to form in the lungs, which reduces the lungs' ability to extract

oxygen from the air. In addition to silicosis, inhalation of crystalline silica particles has been associated with other diseases, such as bronchitis and tuberculosis. Some studies also indicate an association with lung cancer. There is no cure for the disease, but it is 100 percent preventable if employers, workers, and health professionals work together to reduce exposures by using proper protective gear.

The other health hazards could be due to noise pollution, heavy manual labour, minor or major injuries and accidents at workplace, and long working hours. Lack of basic sanitation facilities, drinking water, and shelter add to aggravation of the bad working conditions.

Both the operations of quarrying and crushing being a hazard to environment as well as to human beings, they require continuous monitoring of the work place as well as the workers. Mining operations cause deforestation, loss of vegetation, soil erosion, ground water level changes and pollution, which can lead to an ecological imbalance.

In some cases development has taken the front seat and the implications of the development process are not considered. Development require the utilization of available resources but it does not check the effects of resource utilization to the environment,(Oyaigheviven, 1998) The reason why there have been many environmental problems associated with resource extraction as in the case of quarrying, is that most quarrying activities lack environmental considerations in the planning and building of the major project.

According to (Ayodele& Lameed 2010) projects are usually sited for and embarked upon to satisfy the social and economic needs of the company without the need and aspiration of the people that are directly concerned at the nearest neighboring communities as well as the impact on the primary environment. In open cast mining and quarrying environment, vast area of land are usually existing, leaving behind stagnant ponds or open pits.

In Kenya with the construction of Thika Super Highway, the company in charge of constructing the road has started several quarries along the Eastern bypass which are

causing a lot of air pollution. The company is only concerned about their project and does not take into consideration the welfare of the people living close to the quarries.

The people living close to the quarries are also affected by the activities that go on in that area. (Azad and Ashish 2006) In Village Pali in India, the safety of human beings is not put into consideration. There is no personal protective equipment being provided to the workers, helmets, safety belts, masks, safety shoes are foreign things. It is alleged that approximately 200 have been buried alive in this area during the mine blasting operation in the past decade only. The worker and their families who are residing close to these units are more vulnerable to the silica exposure. The children, the women and elderly all are breathing this toxin day and night.

According to environmental experts, (Irin Africa 2003) the uncontrolled expansion of quarrying in Senegal has led to coastal erosion, a reduction in the area of available farmland and skin and lung problems for the quarry workers and people who live nearby. The effects have forced the government of the day to stop issuing more permits to the people who want to engage in the quarrying activities in the affected areas within the country.

(Aigbedion, 2005) according to him, large amount of dust from the cement factories and mining operations in the Nigerian limestone quarries are discharged daily into the air. Similarly a lot of air-borne particulate matters are generated by the numerous stone crushing industries in the country. When the air is laden with such dust, it causes health hazards for some people. For example, pollution studies around Sagamu and Ewekoro cement works in Ogun State have shown that several people are suffering from eye pain, and asthmatic attack due to the dust-laden air that prevails within a few kilometers radius of the factories.

Varying degrees of pollution of air, water and land occur in the course of mineral development depending on the stage and scale of activities attained. While only minor pollution occurs during mineral exploration, more intense air and water pollution emanates from the exploitation stages, particularly if carried out on a large scale. In Nigeria, the greatest pollution effect comes from a large scale exploitation of petroleum, limestone and rocks used in the construction works (Unesco-Mab, 1995).

A common negative effect of quarrying minerals from the earth's surface is the destruction of its natural landscape, creating open space in the ground and generating heaps of rock wastes that cannot be easily disposed off. These phenomena are amply demonstrated in several parts of Nigeria, where commercial mining or quarrying had occurred in the past or is currently taking place.

2.4 Related studies done in Kenya

(Kibichi1998) carried out a study about quarrying in Kayole and its contribution to defects in adjacent residential building. His study aimed at highlighting the problem that houses near the Kayole quarry which had developed cracks and the cracks were more pronounced in houses near the quarry. His intention was to investigate and relate the blasting of rocks in the quarry to development of defects to these building but did not deal with the effects to the environment as this study intend to do.

(Malashi 2007) carried out a research on environmental impact of sand mining in Barut location in Nakuru Municipality. He examined the effects of sand mining to the environment and the working conditions of the sand miners. He established that sand mining affect the environment especially the drainage systems that the rivers by leading to more erosion taking place in that area.

(Musyoka, 1997) Impact of mining to the environment and land use a case study of stone quarrying in Kangudo division; observed that stone quarrying had both negative and positive effect to the environment and land use. He observed that increasing demand for stone had led to more area being opened for exploitation of resources and this has affected the environment negatively. This study compared if the effects observed in Kangudo area are the same as this study area.

(Mweu 2003) investigated extend of Kenya quarry worker welfare. The main concern of his study was to establish if the quarry owner were taking care of the welfare of their workers. He recommended that there was need for further study to be done on the environmental impacts being caused by increased quarrying activities in certain areas in Kenya. Not much research has been done in relation to the effects of quarrying activities to the health and the environment in Embakasi area. The study

examined the effect of quarrying activity to the environment, to the health of quarrying workers and the people living near the quarries as recommended.

However, quarrying in Kenya suffers from a number of constraints including lack of basic knowledge, safety precautions, poor working conditions, low socio-economic status, lack of clear quarrying legislation and environmental degradation that call for special attention. These are more pronounced in small scale quarry operations. Notably, there has been growing public dissatisfaction in the manner in which quarrying activities are being undertaken in the country. The country has witnessed various quarry disasters.

As a result mining is virtually threatening the life of people working in the quarries and the people living next to the quarries. Quarrying causes air pollution. (Down 1978) According to him mining can cause air pollution-air borne dust and gaseous emissions which can cause damage, the extent depend upon their composition and concentration. Allegation of dust damage are most common when the dust has toxic constituents, such as metallic ions, however even non-toxic constituents dust can contaminate if present in sufficient concentration and this can be an issue of importance if the mines are close to the population centers. This can be compared to the case of Village Pali in India.

The critical role of mineral in development makes mining operations invertible. How could an urban area exist without the quarries stones, sand and gravels needed for construction or the mineral needed for industrial and energy use? However, the destruction of the land resources, with soils blighted and water fouled, needs to be accounted against the expediency of economic short term gain (Simon 1992).

The dust particulates that result from the disintegration of solid can cause air pollution when it remains in the atmosphere for long. The particulates may cause interference with the respiratory functions, it is susceptible to persons with respiratory disease, young and elderly and to vegetation it may led to reduction in plant growth by physical blockage of light when deposited on the leaf surface.

The vegetation in the area around the quarry is also affected because the dust blocks the leaves and as result their growth is interfered with. Recent environmental impact studies of limestone mining and cement industry in Sagamu, Nigeria, have revealed a declining kola nut output from the plantations within a few kilometers radius of the cement factory (Aigbedion, 2005; Adekoya, 2003). This phenomenon is associated with dust pollution as plenty of dust is discharged into the air mainly from the cement factory. The particulate matter eventually gets deposited on the kola nut leaves and flowers as well as the soil supporting the plants. The overall effect of this is that the photosynthetic and fruiting ability of the kola nut tree is impaired with a consequent decrease in kola nut production.

Most of the effects of dust particles on plants include the potential to block and damage the stomata such that photosynthesis and respiration are affected. Other effects are shading which may lead to a reduction in photosynthetic capacity, wearing down on the leaf surfaces and cuticle (Igbal and Shafig, 2001). Pollutants such as dust, gaseous emissions and air- borne particulates will be produced and get deposited on the plants. This will no doubt affect the physiological activities of the plants most especially those around the quarry site such as in photosynthesis and respiration. The implication of these is that some of the plants may have retarded growth while others may be eliminated.

Resources are diminishing very fast and others being rendered useless, as indicated by wide-spread environmental degradation. There is need to live in harmony with the natural environment. This would ensure continuation of life on earth, benefits for all and sustenance for future needs (Muthoka 2005).

Several efforts have been made in order to reduce the effect of quarrying or mining to the environment. For example in the World Summit on Sustainable development (WSSD) in 2002, in Johannes burg, South Africa- the governments adapted an implementation plan for sustainable development whish committed state to address the environmental, economic, health and social impacts and benefits of mining. This was to promote transparency and accountability for sustainable mining and mineral development.

In 1991 Mining and environment research Network (MERN) (Warhurst 1999) was established. It is an international collaborative research program involving centers of excellence in the major mineral producing countries of the world. The main aim was to help mining companies to achieve environmental compliance and improve competitiveness in the context of growing environmental regulation and technological innovation.

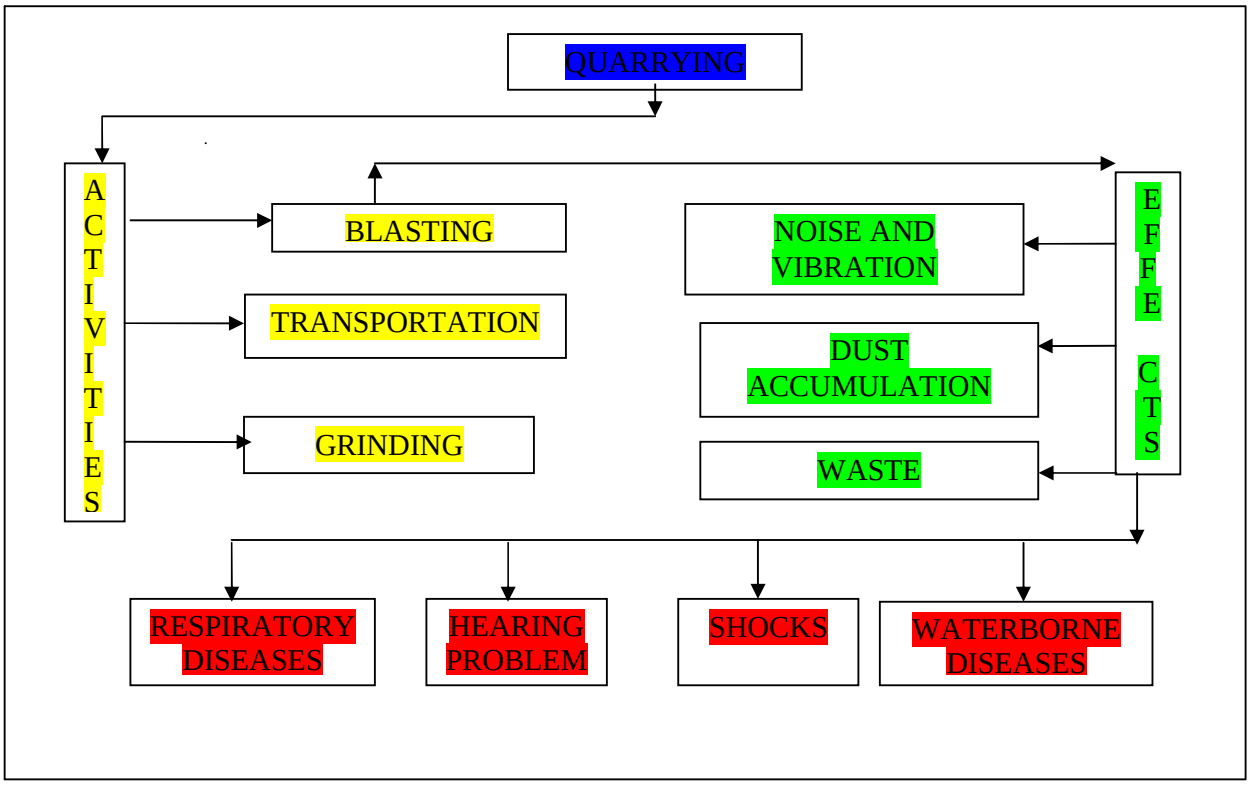
In Kenya, the Ministry of Environment and Mineral Resources (MEMR) set up a task force to investigate on the management of quarrying activities in different parts of the country due to the increasing number of accidents associated with quarrying. (Task force Report 2010), several quarry sites have been set up in close proximity to homestead, schools roads rivers railway lines, shopping centers exposing them to danger. There have been several complaints of nuisance and danger posed by uncontrolled and illegal blasting, dust emission and water ponds in the quarry pits. It was also noted that many quarry sites have notable negative effects such as illicit brews, drug abuse and HIV/AIDs prevalence.

There is lack of clear and specific regulations to administer quarrying activities and as a result there is poor site management, use of illegal explosives, inadequate inspection and enforcement regulation to administer quarry activities. Most of the quarry owners do not consider the welfare of their workers and the impact that their quarries have to the health of the people living next to the quarries.

This study will try to find out if what has been investigated in other area such as the effect of quarrying to the people and the environment is happening in the area of study. The study will then suggest measure that can be taken to reduce these effects and establish if measures that have been taken in other areas can be applied to this case.

2.5 Conceptual framework of effects of quarrying

The conceptual frame work tries to illustrate the relationship between the two set of variables how the independent variables affect the dependent variables. for example if the production of dust increases then, the number of people with respiratory infections also goes up.



Source: researcher (2011)

Figure 1 Conceptual framework

The figure above represents the researcher's conceptual frame work of the effects of quarrying to the environment; it shows the relationship between the effects of quarrying and their outcome. It shows what is produced that is dust, noise waste and vibration and how these affect the people by causing waterborne diseases, respiratory infection, dumping of waste and shock.

Dust, waste and noise which are produced during the quarrying activities are the independent variable and they determine the occurrence of respiratory diseases, waterborne diseases and dumping which are dependent variables.

Quarrying like most human activities has both negative and positive effects to the environment and the people living closer to the quarry. Source of income to the traders nearby, employment to the quarry workers and production of materials that is use in the construction industry these are some of the positive effects of quarrying on the other hand it leads to production of dust, waste and noise pollution which affect the health of the people (quarry workers and people living near the quarry) by causing respiratory diseases, waterborne diseases and eventually death.

The occurrence of respiratory infections, waterborne diseases and dumping may be determined by the dust production, vibration and noise pollution which are mainly caused by the activities that go on in the quarry but can be controlled by watering or using the proper quarrying procedures that minimizes the effects. For the quarry workers they are involved in different activities within the quarry and the absence of protective gear determines if they are affected provision of protective gear to the quarry workers will improve the welfare of the workers. If the amount of dust and noise produced is reduced then the occurrence of these infections is also reduced but if they continue going up then the infections also goes up.

2.6 Definition of operational terms

Pollution: The process of introducing or adding materials to the environment. These materials, deliberately or accidentally introduced to the environment, are harmful and injurious to living systems.

Environmental impacts: These are the resultant effects that come with the activity of quarry mining or any other mining activity. They may be positive or negative impact to the environment.

Dust: a fine powder that consist of very small pieces of a particular substance.

Noise means any undesirable sound that is intrinsically objectionable or that may cause adverse effects on human health or the environment.

Noise pollution means the emission of uncontrolled noise that is likely to cause danger to human health or damage to the environment.

Quarry: A quarry is a type of open-pit mine from which rock material and sand are extracted.

Quarry pit: This is a surface excavation allocated to an operator within a quarry site for extracting building stone, construction aggregate, sand and gravel.

Quarry site: A cluster of quarry pits within a locality.

Quarry Worker: a person employed by a quarry operator to carry out quarrying activities.

CHAPTER THREE

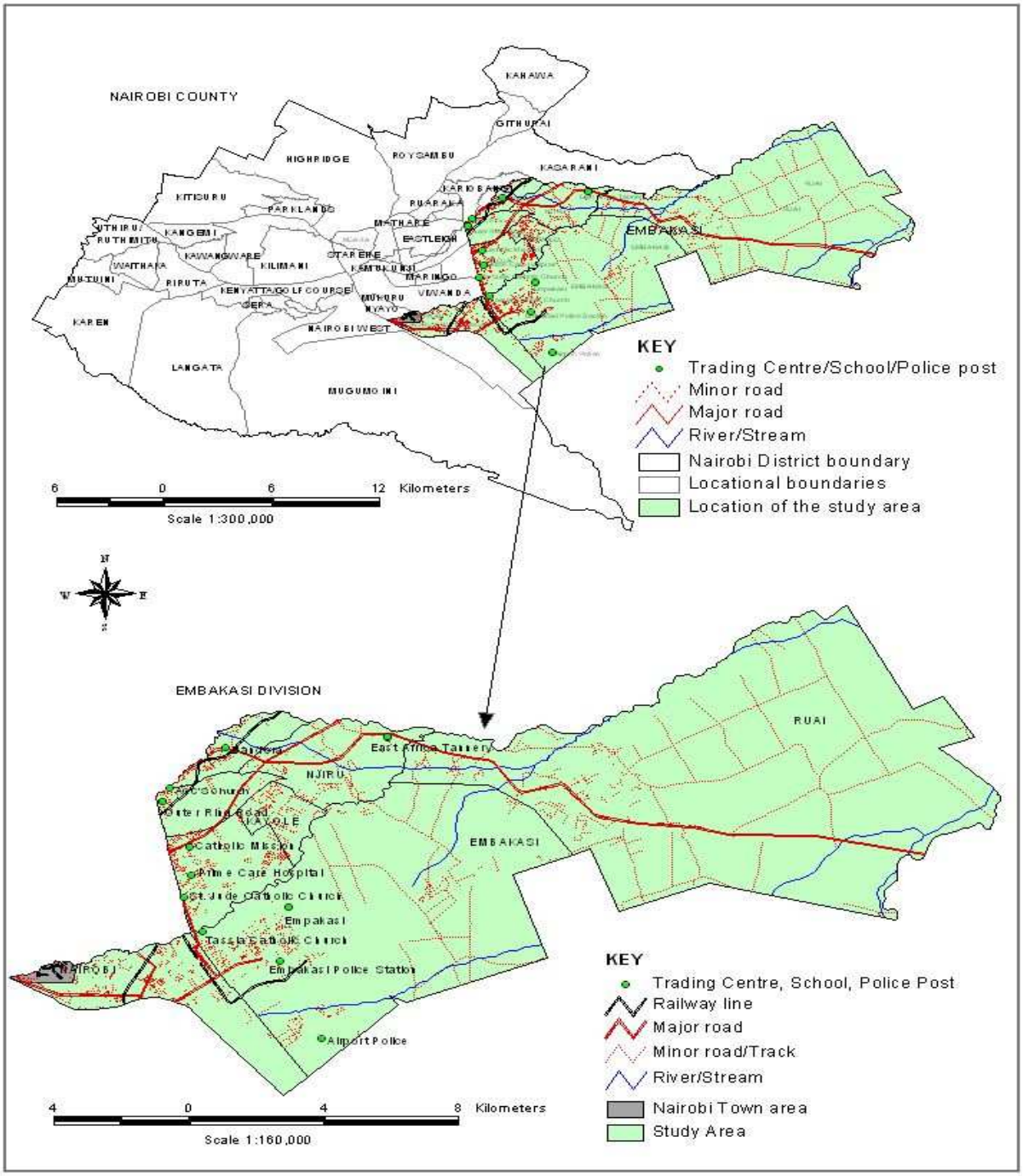
STUDY AREA

This chapter gives a description of the area where the research was conducted.

3.1 Nairobi County

Nairobi County is among the forty seven counties in Kenya. It hosts the capital city of the country. The City on Nairobi lies at an altitude of 1,670 meters above sea level and occupies an area of 696 km^2. The city is located at 1°17′S 36°49′E1.283°S 36.817°E . It is divided into nine administrative namely; Embakasi, Makadara, Pumwani, Kamukuji, Kasarani, Westlands, Langata, Njiru and Dagoreti.

The city's population has expanded from an estimated 350,000 people at independence in 1963 to the current 2.7 million people (Census Report 2010). After independence, Nairobi grew rapidly and this growth put pressure on the city's infrastructure. The great influx of people into the city without matched urban planning has continued to result in a wide variety of environmental problems. Due to economical and political pressures the city has continued to grow without integrating environmental considerations. The resulting poorly managed environment is now a major impediment to economic growth and is already impacting adversely on the health and livelihoods of residents and the long term sustainability of the city's natural resources.



Source: KARI 2011

The figure 2. Shows the study area that is Embakasi which is within Nairobi County.

Figure 2 The Map of the study area.

Quarrying activities in Nairobi has been going on since the 1950s when the place was sparsely inhabited. According to NEMA there were twenty eight quarries located in Nairobi County. Out of this nineteen quarries are located in Embakasi area alone. Eight quarries are still in operation while the rest have closed and relocated to other areas, some of the closed quarries have started rehabilitation but some have not.

3.2. Location

The area under study is Donholm, Mukuru Kwa Njenga extending to Kayole and Mihango area, which is located in the Eastern part of Nairobi in Embakasi district. The area neighbours Mihango estate to the east, Embakasi and Fedha estates to the south, Kayole and Donholm estates to the West.

3.3 Relief and drainage

Nairobi is at 1,795 metres above sea level. The study area which is Embakasi is relatively flat in some area while in some areas is it sloppy. The study area has several streams and rivers for example Ngong River. Most of the quarries are located along the rivers that flow through the area.

3.4 Geology

The exposed rock formation of the study area can be divided into three major geological formations: the Precambrian basement rocks: mostly metamorphic, Quaternary Volcanic and, to a small extent, Quaternary Sedimentary deposits. The rock being quarried at Embakasi quarries is phonolite which is tough dark grey lava commonly referred to as ‘block trap’ and is vesicular with a fissile and platy flow texture (Wamwangi 2013). The soils can be described as poorly drained, dark grey to black half ripe clay in most of the area.

3.5 Climate

Nairobi enjoys a moderate climate. In the June and July the temperature can drop to 10 °C, this are the coldest months in the year. The sunniest and warmest part of the year is from December to March, when temperatures are 22°C on average during the day. There are two rainy seasons, the first rainy season is between the months of March and May which is referred to as the long rains, while the second season is between October and December which are the short rains. The average annual rainfall

in Nairobi is about 900m, but the actual amount in any one year may vary from less than 500 mm to more than 1500 mm.

The only period of the year when the weather can be rather trying is during the hot, dry period shortly before the rains break in March. At this time mid-day temperatures rise to nearly 32°C, the relative humidity may fall to 10%, and a moderately strong easterly wind tends to raise the dust.

3.6 Vegetation

The area of study does not have gazetted forests, there is also no notable agro-forestry practiced in the area. Due to the quarrying activity, the area has lost most of its vegetative cover. However, there exist isolated eucalyptus trees and short grass within the quarry site.

3.7 Population

The population of Nairobi and specifically the Embakasi area has increased tremendously over the years. When the quarries were being established the population was very low with the total population of 7,749 people and that allowed the location at that particular time. Over the years as the population has continued to increase to close to one million during the last census there is increased competition for land use. The settlement has increased and this causes conflict in land use. The population is increasing compared to the population at independence which was 350,000 people the whole of Nairobi City but the size of land remains the same.

Table 1 Population in Embakasi area

YEAR	MALE	FEMALE	TOTAL
1969	5,078	2,671	7,749
1979	9,297	4,205	13,502
1989	88,864	72,098	160,962
1999	227,098	207,786	434,884
2010	468,097	457,678	925,775

Source: Census Report 2010

The City's population has expanded from an estimated 350,000 people at independence in 1963 to the current 3.1 million people (census report 2009). The great influx of people into the city without matched urban planning has continued to

result in a wide variety of environmental problems. Due to economical and political pressures the city has continued to grow without integrating environmental considerations. The resulting poorly managed environment is now a major impediment to economic growth and is already impacting adversely on the health and livelihoods of residents and the long term sustainability of the city's natural resources. The area consist of middle class houses in Embakasi, Donholm, Umoja while in Kayole and Mukuru Kwa Njenga area there are low cost housing

3.8 Other human activities

The area consists of individuals who are engaged in small and medium businesses. Other are engaged in income generating activities within the area and derive their livelihood from various activities such as offloading solid waste, gathering sand and small scale quarrying activities at the abandoned quarries. Several pastoralists can be found in this area especially during the dry season due to the presence of grass in the area. There are several schools that are located in the given area with some of them being very close to these quarries.

Several industries are located in this are for example the processing industries near the industrial area. Kenya power has a power station within this area. In transportation we have a railway line passing through the area.

CHAPTER FOUR
RESEARCH METHODOLOGY

4.1 Introduction

This chapter gives a description of the study's research methodology. It describes how the data was collected, the sample design and sample size.

4.2 Sample design

The population in the study area is large and this requires a lot of resources in terms of money and time. As a result sampling was done, where a given number of people were chosen to represent the entire population of the give area.

The study adopted stratified random sampling method in selecting the respondents. In this type of sampling there are clear cut groups within the given population.
Three groups of strata were identified:

- Quarry Company
- Quarry workers
- Area residents

According to Mugenda (2008) stratified random sampling helps to achieve the desired representation of various sub groups in the population. This method was used to ensure that sub-groups that constitute the majority in the population are also represented proportionately.
From each stratum the sample was then chosen randomly where a few respondents were picked in the case of the quarry workers to give a sample size of 6 from every quarry. For the area residents in each housing complex five housing units were used to get the respondents, the number from each group depended on the estimated population per group.

The study concentrated on seven active quarries in Embakasi area of Nairobi County. The sample consisted of:

- Six (6) workers from each quarry
- One administrator or the company owners
- Twenty (20) people living near each quarry

In total there were 42 quarry workers, 7 quarry owners and 140 residents' giving a total population of 189 samples.

Table 2: Categories of respondents

Categories	**No. received**
Quarry company	7
Quarry workers	42
Resident	140
Total	**189**

***Source*: researcher 2011**

Three clinics were visited where the interview method was used to gather the needed information.

4.3 Methods of data Collection

During field work, a comprehensive data gathering process was adopted. The study involved the use of both qualitative and quantitative data collection tools. Five research assistants were identified and trained on the administering of questionnaire and sampling techniques to be used during the study. After obtaining consent from the respondent the research assistants used both questionnaire and interviews in order to elicit uniform response due to the varied level of education and understanding respondent.

Data was collected by visiting seven quarries which included: Patel Concrete, Kenya Builders (which had two quarries at different location), Nyoro Construction, Karsam Murji & Co Ltd, Bimji Ramji and Shamji Vishram where quarry workers and company owners were interviewed. The other respondents were visited in their homes or place of work asking them questions and entering the answers in the questionnaire.

Three sets of questionnaire were formulated:

- A questionnaire for the quarry owners- this dealt with the quarry administration in order to find out the effort being taken by the company in dealing with the effects of the quarrying activity to the environment.

- The second questionnaire was administered to the quarry workers to identify the problems they experience as they carry out the quarrying activity on a daily basis.

- The third questionnaire was for the area residents to identify the effect that they face due to the presence of quarries in the area.

The questionnaire contained both open-ended and close ended questions. The opened questions provided the responded the opportunity to describe their experiences in detail.

There were different type of primary sources of data that was used in the collection of data during the study and these included observation, interview, questionnaire and photographs.

The observation method was used to gather information regarding some of the activities that were going on within the quarries and the surrounding area and this included the river that was flowing near the quarries. The vegetation around the quarries was also observed in order to determine the effect of the quarrying activity to the vegetation around the area.

At selected project sites, interviews were conducted with all the relevant stakeholders, although with varying intensity between sites. This technique was used so that the problem affecting the people in the given area could be completely understood by the researcher. The people working and living next to the quarry were interviewed further so that more information could be obtained in order to facilitate this research. Several nearby clinics in the area were visited to determine if the kind of infections that the area resident and quarry workers suffered from are have a relationship with their stay near the quarry and them working respectively. The clinic workers were asked few

questions related to their patients who visit the clinic in order to find out if there is relationship between the information collected from the area resident and quarry workers and the patient who visit the clinics.

Secondary sources of data were also used and these included books, journals, and internet sources.

4.4 Data analysis

The study used Statistical Package (SPSS) to analyze the data collected form the questionnaire.

Descriptive statistics such as cross tabulation and percentages were used to help the research to identify the existing relationships between the dependent variables and the independent variables of the study.

The Chi-square statistic was used to compute using the formula:

$$X^2 = \sum \frac{(O-E)^2}{E}$$

Where: O is the observed

E is the expected

The test is used to find out whether or not there is any association between variables that are under study: the quarrying activities and the effects to the people. It assists in drawing conclusion whether or not here is an association between the variables. The test works by testing a distribution actually observed in the field against the expected outcome.

Percentages, tables, pie charts and bar graphs were used for the presentation of results.

CHAPTER FIVE

RESULTS AND DISCUSSION

5.1 Introduction

This chapter gives a descriptive result, interpretation and findings of the study. The data collected was analyzed using (SPSS) Statistical Package for Social Sciences to generate frequency tables, charts and descriptive statistics and Chi Square Test was used to analyze the different variables. There are human settlements around the quarry site which included several estates around the quarries.

Data was collected through the use of questionnaire and oral interview from the quarry owners, quarry workers and area resident. A total of two hundred and twenty (228) questionnaires were distributed; 8 among the quarry companies, 78 among the quarry workers and 142 among the people within the quarry site in all 220 questionnaires were returned, 7 from the quarry company, 71 from the quarry workers and 142 from the people living near the quarry.

5.2 Response Rate

The response rate was 87.5% from the quarry company, 91.0% from the quarry workers and 100% from the area residents. The total response rate was 96.5%. The two hundred and twenty (220) questionnaires that were returned were subjected to statistical analyses.

Table 3: Response Rate

Questionnaire Categories	**No. distributed**	**No. received**	**Response rate**
Quarry company	8	7	87.5
Quarry workers	70	42	60.0
Resident	160	142	88.75
Total	**238**	**220**	**92.4**

***Source*: researcher 2011**

5.3 Background Information

5.3.1 Gender and age distribution of the respondents

Table 4 shows that there was 44.4% male respondent and 55.6% female respondent; hence it gives an overview that most of the people living here are female. The majority of the respondents were between the ages of 31-35 years which was 31%; age 26-30 years was 25.4%, while age 36-40 years was 23.2%. The respondents above age of 46 years were less than 5%.

The Chi-square test was used to test the significance of the gender and the age of the respondent in the gathering of the required information for the study. The test was carried out and come to the conclusion that there is no significant association between gender and age of the respondent (p=0.136)

Table 4: Distribution of respondents by age and gender

Age	Male		Female		Total	
	n	%	n	%	n	%
20-25	3	33.3	6	66.7	9	6.3
26-30	22	61.1	14	38.9	36	25.4
31-35	15	34.1	29	65.9	44	31.0
36-40	12	36.4	21	63.6	33	23.2
41-45	7	53.8	6	46.2	13	9.2
46-50	4	66.7	2	33.3	6	4.2
51 and above	0	0.0	1	100.0	1	0.7
Total	**63**	**44.4**	**79**	**55.6**	**142**	**100.0**

***Source*: researcher 2011**

5.4 The effects of quarrying to the environment.

The quarrying activity has several effects on the environment; this is evident by the number of response that was gotten from the people living near the quarry. The quarries are located near residential area and there have been several complaints from the resident about vibration, dust and noise pollution. The people complain of dust from the quarry and also the roads from the area near the quarry which were in a bad state and were used by heavy machines. This is findings corresponds with (Aigbedion, 2005) whose study concluded that plenty of dust from the cement factories and mining operations in the Nigerian limestone quarries caused a lot of problems with people living near the quarries.

During blasting which is done once a week or depending on demand resulted into the production of loud noise and vibration which to some extend affected the houses in the area. Majority of the resident complained of shock, vibration and dust as indicated in Table 5 which represents 28% who complained of the dust which resulted into a lot of health problems that they experienced 25% of noise that resulted from the blasting and the heavy trucks that were used for transportation, 18% of shock and vibration. A few of the respondents experience shock due to sudden noise from the use of explosives and ground vibration that result from rock blasting. According to reports, the detonation of explosives in quarrying operation causes ground vibration, which produces effects such as stress, anxiety, loss of sleep and fatigue among residents living near quarry site.

Table 5: Effect of quarrying activities to the environment by resident

Effects	**Responses**	
	Multiple response	**Percent**
Dust	95	28.2%
Noise	85	25.2%
Shocks	63	18.7%
Vibration	61	18.1%
Dumping	12	3.6%
Insecurity	6	1.8%
Disrupting classes	4	1.2%
None	11	3.3%
Total	**337**	**100.0%**

***Source*: researcher 2011**

The quarrying has a lasting effect on the environment in that most of the quarries leave scare on the earth surface and some of the quarries have been unable to reclaim the land to make it productive again as it was before. This destroys the beauty of the land area permanently making it uneconomical.

Out of the seven quarries that visited three quarries are not fenced and this posed a danger to the people living close to the quarries as in some cases people are attacked and thrown into the quarry pit. Three school that are located next to the quarries e.g. Presbyterian school in Mukuru Kwa Njenga and Kayole 1 primary in Kayole

complained of disrupti bn non of classes due to the noise that is produced by blasting and the passing lorries.

Plate 1 shows a quarry at the point of crashing where the production of dust is high which affect the people who are living in the area. Most of the dust is produced during the crushing point and from the dusty roads which are used by the heavy machinery used for transportation.

Plate 1: Dust produced at the crashing point

***Source*: researcher 2011**

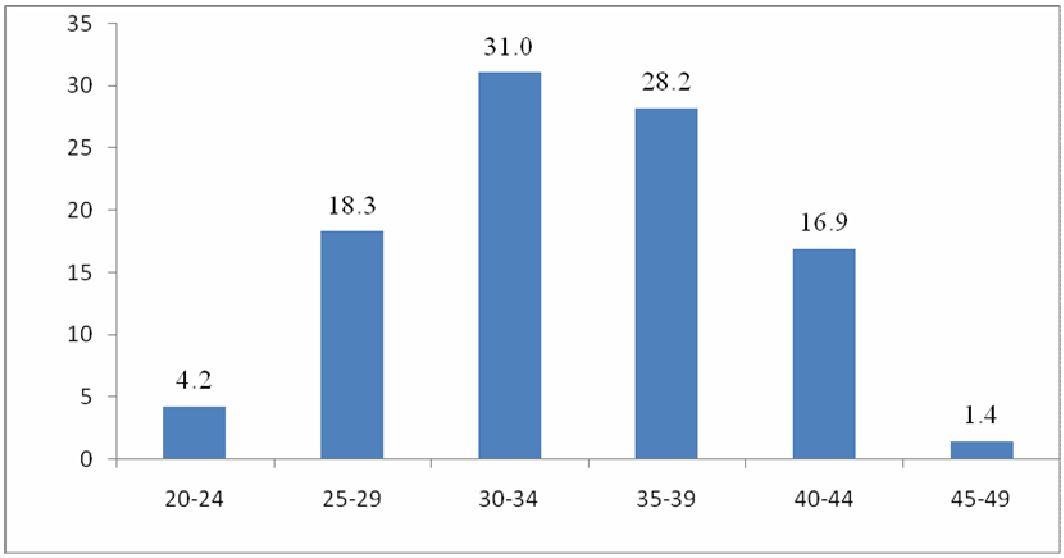
According to the company owners and administrators, the quarrying activities had few effects to the environment because they had tried to reduce the effects. But still there were experiencing a few problems such as dust accumulation and noise pollution were 38.9% while vibration was 22.2% as shown in the Table 5 above.

5.4.1: Age distribution of the quarry workers

When it comes to the respondent who worked in the quarry majority of them were men. There are only men engaged in the quarrying activity, there are very few women in these companies and they are not directly involved in the quarrying activity. The companies have two or one lady in the office. The percentage of male working in the quarries is 100%

The companies have employed people of different ages, 31% being between 30-34 years, and 28% being between 35-39 years. Very few are above 44 years and below 24 years as shown in the figure 3.

Figure 3 Age distribution of the quarry workers

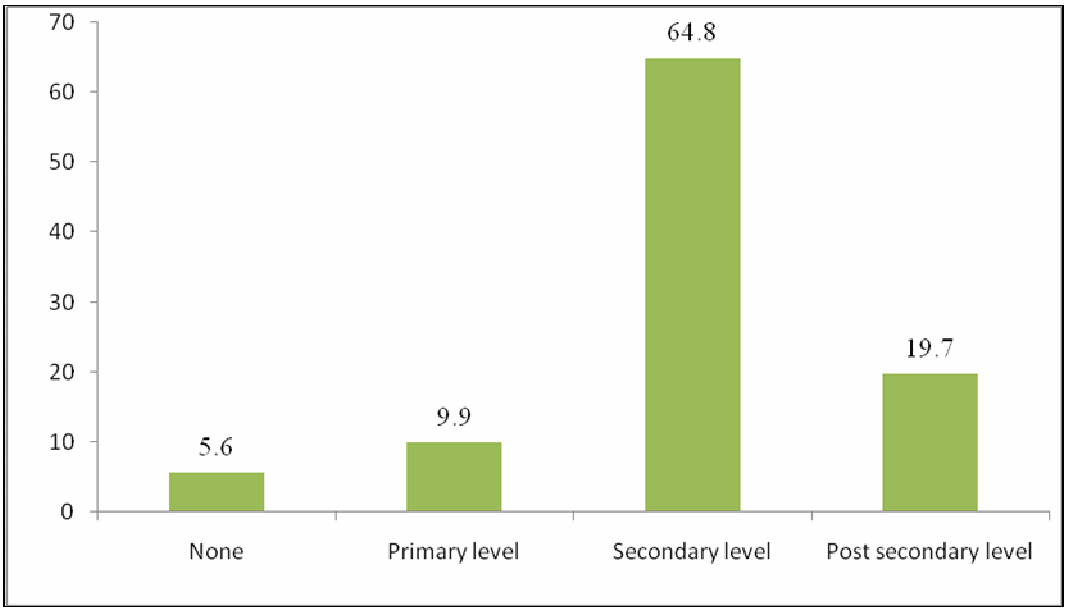


***Source*: researcher 2011**

5.4.2 Level of education for the workers

Educational background was found to be generally poor. Most of the workers in the quarry had gotten to the secondary level of education (64%) and quite a few had gone beyond the Post secondary education (19%). Due to poverty level they were not able to further their studies and as a result they are not aware of safety regulation that they are required in their nature of work. Most of them are not even aware of the safety requirement needed in the kind of job that they are in engaged in. 5.6% of the workers do not have any form of education, 9.9% have gotten the primary education. Due to low literacy levels the quarry workers are not aware of their rights or the requirements for the kind of job that they do.

Figure 4: Level of education of the quarry workers



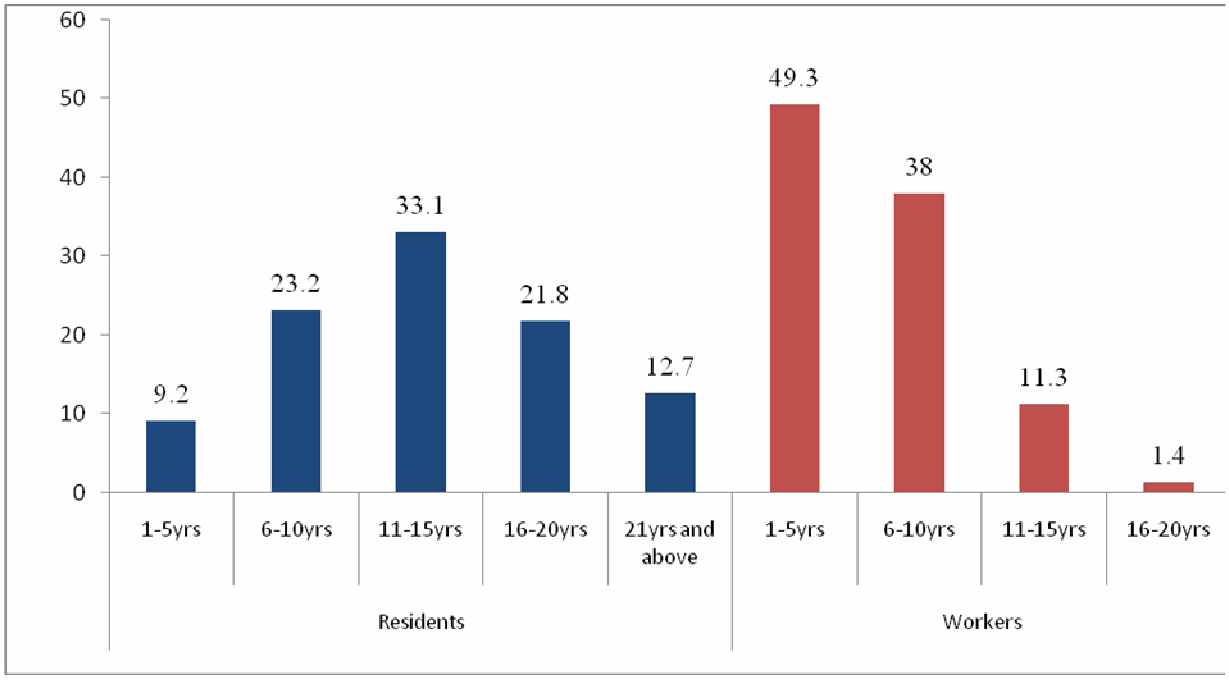
***Source*: researcher 2011**

5.4.3 Number of years lived and worked in the area

Most of the respondent had lived in their present resident for more than 15 years. This is because the area is mainly contained low cost housing and due to their low income they are forced to live there even if the conditions are not good. Some of them had been born there and so have lived in the area all their life. 9.2% of the resident had lived in the area for1-5years, 23.2% had lived for 6-10 years, 33.1% had lived for lived for between 11-15 years, while 21.85 had lived for 16-20 years and 12.7% had lived for more than 21 years.

The workers had worked in that quarry for several years. 49% had been their current working station for between 1-5 years, 38% had worked for between 6-10 years. The quarry workers were not staying in their working place for long because of the working conditions and the effects of the quarrying activity to their health. Due to lack of any other form of training and therefore for getting another job can be very difficult.

Figure 5 Comparisons of years lived and years worked



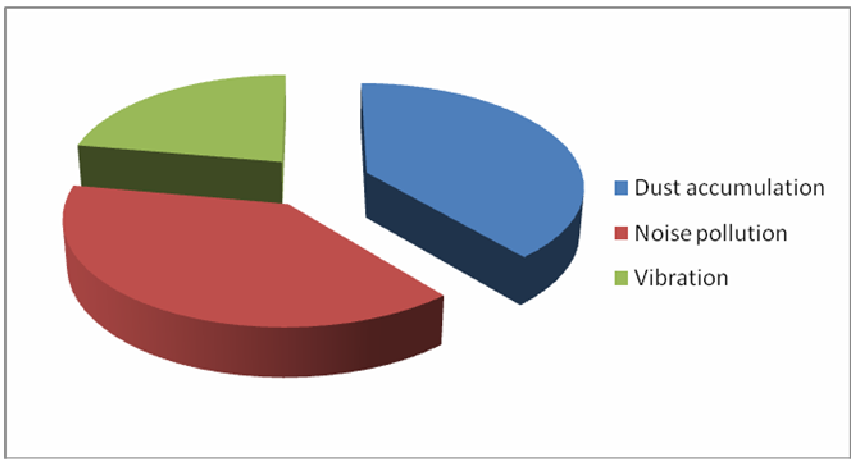
***Source*: researcher 2011**

Table 6: Effect of quarrying to the environment from quarry owners

	Responses	
Effects	**N**	**Percent**
Dust accumulation	7	38.9%
Noise pollution	7	38.9%
Vibration	4	22.2%
Total	**18**	**100.0%**

***Source*: researcher 2011**

Figure 5: Effect of quarrying to the environment by the company owner

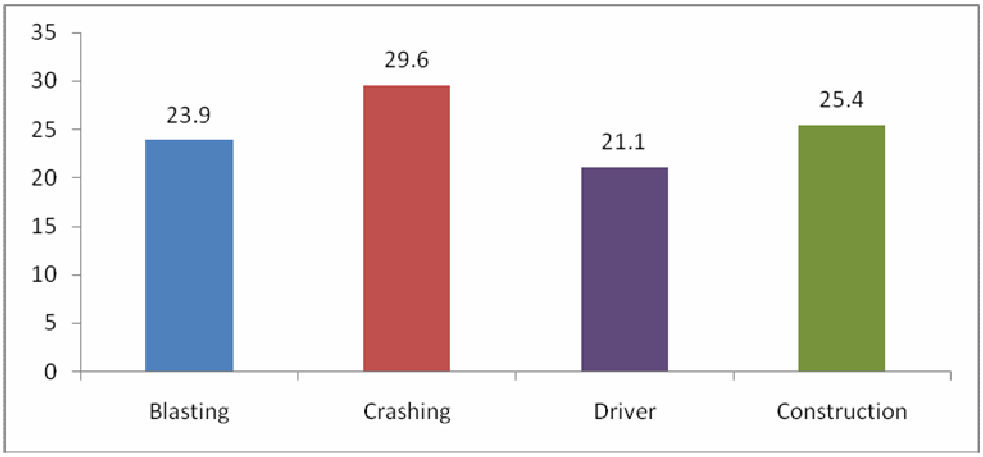


***Source*: researcher 2011**

5.5 Activity carried out within the quarry

There are several activities that go on within the quarry and as a result the workers are engaged in the different activity: Among those who were involved in the study 23.9% are involved in blasting, 29.6% are involved in crashing and packing of the finished product, 21.1% are drivers and 25.4% are engaged in the construction.

Figure 6 Activity the quarry workers are involved in

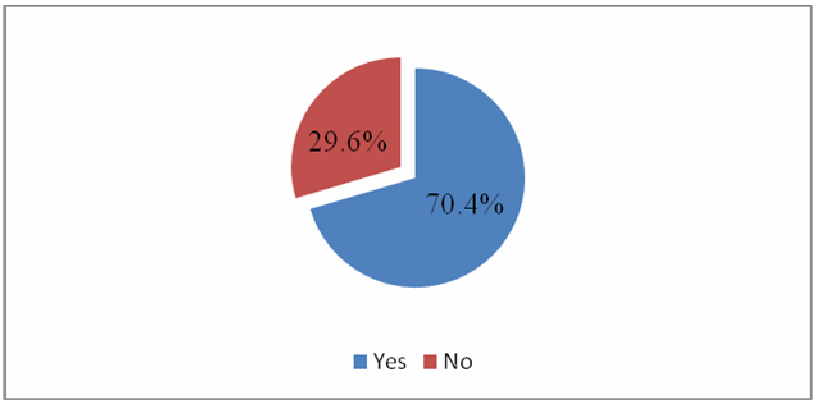


***Source*: researcher 2011**

5.5.1The effect of the quarrying activity involved in and the health of the workers

The quarry workers who experience health problem that are related to the work that they do were 70.4%, while 29.6% did not experience any health problem. The problem that they complained about were caused by dust, noise and the nature of work that they did for example construction that goes on within the quarries. This can be compared to studies that have been done in other areas such as Nigeria where according to (Aigbedion, 2005) a lot of air-borne particulate matters are generated by the quarrying activities had caused health hazards for some people.

Figure 7 Distribution of quarry worker with health issues



Source: researcher 2011

5.5.2 Effect on the health of the quarry workers

The high level of dust particulates generated at the drilling and crushing areas depicts them as hazard zones. Moreover, exposure of quarry workers to particulate pollution, coupled with the general non-use of protection gadgets predispose them to several respiratory ailments similar to health problems found prevalent among residents living near quarry sites. Considering the various health risks associated with inhalation of particulate matter, environmental impact assessment should be mandated for all quarries.

The workers who experienced health problems had the following issues: 22.9% respiratory infection, 20.8% hearing problem, 19.8% chest problems, 18.8% common cold, 10.4% coughing and 7.3% eye infection. This was due to the lack of proper

working gear that they had as shown in Table 7. This was further supported by the Chi-square test which was used to test the quarrying activities and the health of the workers. When the hypothesis was subjected to the Chi Square test the P value was 0.005 at 16 degrees of freedom and 0.05 level of significance. This leads to failure to reject the null hypothesis and which shows that there is association between the quarrying activities and the health of the quarry workers.

Table 7: Effects of quarrying activity to the health of the quarry workers

Effects to the workers	Responses	
	Multiple responses	Percent
Respiratory infection	22	22.9%
Hearing problem	20	20.8%
Chest problems	19	19.8%
Common cold	18	18.8%
Coughing	10	10.4%
Eye infection	7	7.3%
Total	**96**	**100.%**

***Source*: researcher 2011**

There is no much variation in the ailments suffered by quarry workers compared to the area resident. We can therefore conclude that the quarrying activities have significant effect on the well being of the quarry workers. The health problems suffered by the residents are those that associate with the presence of quarries near their area of residence. There is water accumulation in these quarries; this has made the area more prone to waterborne diseases such as malaria.

Plate 2: Quarry workers at work

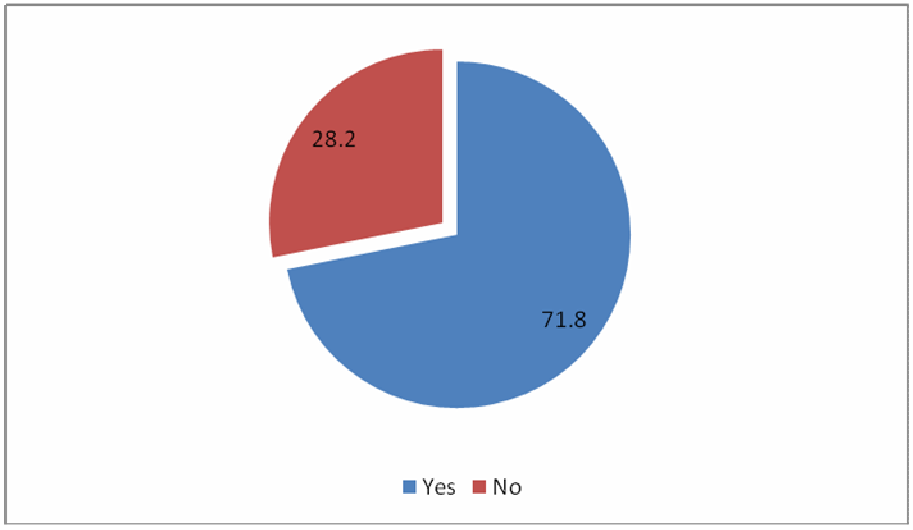
***Source*: researcher 2011**

5.6 Protective gear used during quarrying activity

According to Occupational Safety and Health ACT No 15(2007) every employer should provide and maintain for the use of employees adequate, effective and suitable protective clothing and appliances, including, where necessary, suitable gloves, footwear, goggles and head coverings, especially the employees who are involved in activities such as breaking or dressing of stone, concrete or slag at their work place.

The quarry workers require protective gear in order to protect themselves from the harsh working condition, but not all of them are provided by the protective gear that they need. During the study it was established that only 71.8%were provided with the protective gear while 28.2% did not have. Even those who had the protective gears they were not complete or in good condition and therefore not completely protected.

Figure 8 Distribution of protective gear to the quarry workers



***Source*: researcher 2011**

5.6.1 Protective gear for the quarry workers

The use of protective gear by workers at quarry site should be enforced by the Health and Safety unit or the Management of every quarry company. This is in view of the fact that most workers consider wearing protective gadget while at work an unnecessary burden. The quarry workers were given some protective gear but some of them are old and not complete. 28.9% had helmet, 18.5% had face mask, 18.9%

had gumboot, 10.7% had earplug and 11.3% had goggles. The condition of the protective gear was wanting as show by the Plate 3.

Plate 3 Quarry workers without protective gear

***Source*: researcher 2011**

Table 8: Protective gear used by the workers

Protective gear	Multiple response	percent
Helmet	46	28.9%
Mask	29	18.2%
Gumboot	30	18.9%
Ear plug	17	10.7%
Goggles	18	11.3%
None	19	11.9%
Total	**159**	**100%**

***Source*: researcher 2011**

5.7 Effects of the quarrying activity to the area residents

Quarrying activities have negative impacts on human health and well-being of the people living near the quarry. Mainly due to the dust that was produced from the quarrying activity and the poor roads used by the lorries used for transporting the products had affected the people health.

The most prevalent health problem of the nearby residents was identified as nasal infection, 28.6% of the people complained of malaria, 21.8% of the population had respiratory infection, and 13.4% eye infection in children, 12.6% common cold, 9.5%

allergy, 7.3% chest problem, 6.9% had no health problems. The Chi-square test was used to test the significance of quarrying activities and the effects on the people of the surrounding area. The hypotheses was subjected to the Chi Square test the P value was 0.005 which shows that there is association between the quarrying activities and the health of the area resident.

Three health clinics that were visited in the Kayole area showed that majority of the people were mainly suffering from the common diseases such as malaria and common cold which might not be directly as a result of the quarrying activities in the area.

Table 9: Effects of quarrying activity to the area resident

EFFECTS	**Responses**	
	Multiple response	**Percent**
Malaria	56	28.6%
Respiratory infection	46	21.8%
Eye infections in children	22	13.4%
Common cold	22	12.6%
Allergy	19	9.5%
Chest problems	8	7.3%
None	8	6.9%
Total	**181**	**100.0%**

***Source*: researcher 2011**

	Observed O	**Expected E**	**O-E**	**$(O-E)^2$**	**$(O-E)^2/E$**
MALARIA	56	23.3	32.7	1069.29	45.89
RESPIRATORY	46	23.3	22.7	515.29	22.12
COMMON COLD	22	23.3	-1.3	1.69	0.07
ALLERGY	19	23.3	-4.3	18.49	0.79
CHEST PROBLEMS	8	23.3	-15.3	234.09	10.05
OTHERS	8	23.3	-15.3	234.09	10.05
					88.97

Chi Square score 88.97 at 23
significance level
P - value < 0.0001
Result is significant at P <0. 05

5.8 Problems being faced by the companies

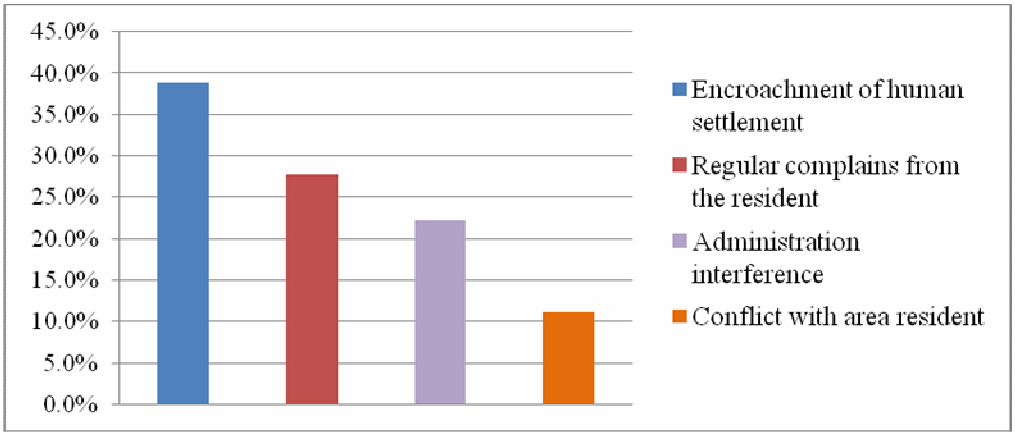
When the quarries were being established the area was mostly bare and was used by the pastoralists to graze their animals. Over the years the population has resulted in residential housing development taking place in these areas and this has resulted into the following problems. Due to their nearness to residential area the companies do experience problems or challenges due to their activities in their area of operation. At first when the quarry activities started the area was un occupied but due to population increase more residential building have come up in the area and as a result the companies experience the following: encroachment of human settlement 38.9%, regular complains from the area resident 27.8%, administration interference 22.2% and conflict with the area resident 11.1% as shown in Table 10.

Table 10: Problem faced by the quarrying companies

Problems	Multiple response	Percent
Encroachment of human settlement	7	38.90%
Regular complains from the resident	5	27.80%
Administration interference	4	22.20%
Conflict with area resident	2	11.10%
Total	**18**	**100%**

***Source*: researcher 2011**

Figure 9 Challenges facing the quarry companies



***Source*: researcher 2011**

5.9 Challenges facing workers

The quarry workers are faced by several problems in their working place. 38.1% complained of poor working condition such as lack of proper working gear, 23.8% complained of low income in relation to the hard job that they do, 23% had issues with the type of gear that they were being offered which were old and incomplete, 7.1% reported that the machine used were old and in some cases they had to stay without jobs for several days, 4.0% did not have permanent employment they were casual workers, 3.2% suffered from sickness related to the kind of jobs that they do.

Table 11 Problem facing the quarry workers

Problems facing workers	Multiple response	Percent
Poor working conditions	48	38.1%
Low wages	30	23.8%
Old and incomplete protective gear	29	23.0%
Machine are old and so break up most of the time	9	7.1%
No permanent employment	5	4.0%
Sickness caused by the job done	4	3.2%
None	1	0.80%
Total	**126**	**100.0%**

***Source*: researcher 2011**

5.10 Benefits of the quarry

The quarries have both negative and positive effects. Apart from form the negative effects the quarry has positive effects to the people that live nearby. For 14.8% they are involved in business due to the quarry workers purchasing power, 6.3% have been able to get employment from the quarry either directly or indirectly, 7.0% are able to get material that they use in the construction , but 71.8% did not see any benefit from the quarry.

Table 12: Benefits of the quarries to the area residents

Benefits	N	Percent
Business	21	14.8%
Employment	9	6.3%
Building materials	10	7.0%
None beneficial	102	71.8%
Total	**142**	**100%**

***Source*: researcher 2011**

5.11 Mitigations to reduce the effects of quarrying to the environment.

The area resident had different suggestion to reduce the effects from the quarry. 30.5% of total area resident who were interviewed felt that there was need to reduction of dust that is produced by the quarries, 29.5% recommended that the blasting to be reduced, 21.4% suggested the relocation of the quarries to another area, the roads to be repaired or constructed with the quarry companies, fencing of the quarry in order to reduce accidents such as people falling into the quarry pits this is also a requirement by the Occupational Safety and Health Act and compensation for the damage and accidents that are caused by the quarrying activity in the area.

(Occupational Safety Health Act no 105- 89, 4)In every workplace where any vibration, which is transmitted to the human body through solid structures, is harmful to health or otherwise dangerous, all practicable control, preventive and protective measures shall be taken by the employer to secure the safety and health of any such person who may be exposed to the vibration.

Table 13: Mitigation to reduce the effects of quarrying to the environment

Mitigations	Responses	
	Multiple response	Percent
Reduce the dust produced	64	30.5%
Control their blasting to reduce vibration	62	29.5%
Relocate to another area with less population	45	21.4%
Construct and repair the roads	17	8.1%
Fence the quarry	16	7.6%
Compensate for the damage caused	5	2.4%
None	1	0.5%
Total	**210**	**100.0%**

***Source*: researcher 2011**

5.12 Measures to control the effects taken by the companies

The area was mainly a grazing land and farm land before the location of the quarries, when they started the quarrying process a lot of vegetation was lost. A few companies have tried to plant trees but very few have survived. The quarry activity results in dust production, noise pollution, vibrations and vegetation loss. The quarry companies have tried to control these effects to some extent. At the crushing site and the loading point there a lot of dust produced which they try to minimize by watering. Noise which is produced at the quarry is controlled by using mild explosives and small machines which reduces the amount of noise produced. Vibration which results during the blasting period has been controlled by the use of mild explosives, electric detonators and the shock tubes that minimizes the vibration.

Table 14: Control measures

EFFECTS	MEASURES TO CONTROL
Dust	Watering at the grinding plant
Noise	Controlled blasting Using small machines Using mild explosives
Vibration	Using mild explosives Use of electric detonators Use shock tubes
Loss of vegetation	Planting trees

***Source*: researcher 2011**

Quarrying is very important activity in the building industry. It produces the materials that are needed for construction of buildings and roads. The quarrying industries provide employment to a large population and to other related industries such as block building and construction of drainage materials. The quarry companies do not rely on the quarrying activities only but most of them are involved in construction. The quarrying activity has both positive and negative effects but it seems like the negative outweighs the positive.

The quarries are located very close to the residential areas and even school and this interferes with the smooth running of the human settlement in the area. The quarries dump a lot of waste next to the residential area and this affects their health.

The quarries produce a lot of dust that result from the quarrying activity itself and other relation activities near the quarry such as transportation. The heavy lorries that carry up to 12 tonnes and are used for transportation damage the roads leaving a lot of dust.

Plate 4: Dust produced by the lorries used for transport

Source: researcher 2011

The machineries that are used in the quarrying activity are very old and they emit a lot of dusts which affect the workers themselves and the people near the area. As much as the company owner claim that they do watering to reduce the amount of dust that is emitted no evidence was seen during the research.

The quarry workers who are involved in the quarrying activities do not have proper protective gear that they need in order to protect themselves from the effect of danger as they carry out their daily activities within the quarry. The quarry workers need to have face mask which helps them protect themselves from the dust that results for the activities that they are involved in. but in our case we discovered that most of them do not have the proper gear that they need.

Some of the quarries sites lack proper fences around their premises and this is very dangerous to the people passing by who can fall into the quarry pit which are more than 30metres deep. This poses a danger to the people who live next to the quarries. The quarry companies have not used warning signs which are very important.

Plate 5: Quarry site without proper fencing

Source: researcher 2011

The vegetation in the area is also affected because there dust accumulation which hinder their growth. The dust accumulates on the leaves of the plants therefore blocking the stomata which are very important for the growth of the plant as is used in the process of gaseous exchange.

Plate 6: dust accumulation on vegetation

Source: researcher 2011

The quarrying activity has resulted into rock debris accumulating in the river that flows next to the quarries and these blocks the river from flowing properly and has lead to accumulation of garbage. The river flow through the industrial area and carries plenty of waste from the industries which is dumped in the area where the quarries are because of the rock debris.

Plate 7: Rock debris in the river channel

Source: researcher 2011

There several quarries that have been abandoned and they act as dumping site. The area is developing at a very fast rate, with a lot of construction taking place in the neighboring estates. Due to lack of proper damp site many people are dumping in the abandoned quarries at a small fee.

Plate 8: Dumped waste at abandoned quarry

Source: researcher 2011

Plate 9: Dumping at abandoned quarries

Source: researcher 2011

The abandoned quarries were to rehabilitate by the previous owners but up to now the quarries have turned into dumping site. Within the abandoned quarries people are engaged in quarrying manually as a source of income generation. Their production is small scale and some people prefer to buy from them because they are cheap compared to the quarrying companies. The abandoned quarries are dangerous spots were several children have drowned in them and people killed and thrown into them. The concern authority has not done much to ensure that the quarries are rehabilitated.

Plate 10: manual quarrying in the abandoned quarries

Source: researcher 2011

CHAPTER SIX
FINDINGS, CONCLUSION AND RECOMMENDATIONS

6.1 Summary of the findings

The aim of the study was to examine the effects of quarrying to the environment and the people living in the nearby area. The study found out that majority of the respondents from the quarries was 100% men. Respondents who were the area resident was mainly comprised of women who were 55.6% and men were 44.4%. Most of the respondents were between the age of 25 and 40 years.

The study established that quarrying activity in the area has affected the environment by leaving scares on the surface which are not easy to rehabilitate, this has rendered part of the area uneconomical. The people living in the surrounding area are affected by water borne diseases such as malaria, which result due to the presence of the quarries in the area. The study established that some companies do not provide their workers with the proper protective gear that they need to use so as to protect themselves as they carry out their duties. This has resulted into the worker health being affected as they suffer in silence.

The study also established that some companies have taken measures to reduce the effects of their activity on the environment although the area resident have not felt any of these measures being taken by the quarrying companies.

Although it is a requirement by the Occupational, Safety and Health act 2007 that the workers are provided with protective gear the study established that some of the quarry workers do not have the required complete gears for protection and as a result some of the suffer health issues. The quarry workers are affected in the following way; 22.9% respiratory infections, 19.8% had chest problems and 20.8% had hearing problems, this can be associated with the kind of work that they do.

The people living in these areas are mainly low income earners and as result they are not able to move to a different are because there is low cost housing that is available in that area. They are therefore forced to suffer in silence.

6.2 Recommendations

6.2.1 Recommendations to policy makers

- The Government of Kenya should ensure that the laws governing the quarrying and mining industries are observed through enhanced surveillance.

- The government should ensure that all stakeholders are part in the decision making when it comes to the location of quarrying industries.

- The government should revoke licenses of that the quarry owner who do not adhere to the set laws.

- Compliance monitoring visits to quarry sites should be done routinely so as to minimize the negative effects of quarrying operations on human health and the environment. Ensure that the EIAs are carried out regularly.

6.2.2 Future research

- Further research involving the search for more advanced methods on reducing the effects of the quarrying activity on the environment should be carried out.

- Research should be done to identify measures that can be undertaken in order to rehabilitate the abandoned quarries to make them more beneficial to the area residents.

- Research should be done to identify the effects of the waste being dumped in the abandoned quarries on the health of the people living in the surrounding area.

6.3 Conclusion

The working condition of the quarry workers has not been taken care of as recommended by the occupational Safety and Health Act. This can be attributed to lack of awareness on use of protective gear by the quarry workers. Poor planning within the Nairobi County has led to the rapid development of residential facilities near the protected areas such as quarry sites and railway line. Quarry companies should be mandated to adopt modern technology of dust strapping such that a

negligible quantity of dust escapes from the various operations at quarry site. This has affected the residents in those areas in a negative way.

Therefore we can conclude that the quarrying activity has affected the environment mostly in a negative way and this includes the people in the surrounding area, the quarry workers and the physical environment.

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APPENDIX I

QUESTIONNAIRE FOR THE QUARRY WORKERS

Questionnaire to examine the effect of quarrying to the environment in quarries within the Nairobi County

This questionnaire is strictly for learning purpose and the information obtained from the respondents shall be treated with confidentiality.

INSTRUCTIONS

1. TICK THE APPROPRIATE ANSWER
2. STATE WHERE APPLICABLE

1. Gender: Male ☐ Female ☐

2. Age :

☐ 20-25 ☐ 26-30

☐ 30-35 ☐ 36-40

☐ 40-45 ☐ 46-50

☐ 50 and above

3. Level of education

☐ Primary education

☐ Secondary education

☐ Post secondary

☐ None

4. For how long have you been engaged in the quarrying activities?

☐ 1-5years ☐ 6-10years

☐ 11-15years ☐ 16-20years

☐ 20years and above

5. Which activity are you involved in within the quarry.

Blasting

Crashing

Others (specify)……..

6.a. Do you have any protective gear that you use during your quarrying activity

Yes ☐ No ☐

b. If yes, which specific protective gear?

_____

_____

_____

7.a. Have you ever experienced any health problem(s) since you started working in the quarry?

☐ YES ☐ NO

b. If yes what are some of the problems:

_____

_____

_____

8.a. Do you have a medical cover

☐ YES ☐ NO

b. If yes, specify the type of medical cover

9. What are some of the challenges that you experience from then quarrying activities?

_____

_____

_____

_____

_____

10. What other benefits do you get from your employer apart from the salary?

_____

_____

_____

APPENDIX II

QUESTIONNAIRE FOR THE QUARRY COMPANY

Questionnaire to examine the effect of quarrying to the environment in quarries within the Nairobi County

This questionnaire is strictly for learning purpose and the information obtained from the respondents shall be treated with confidentiality.

INSTRUCTIONS

i. TICK THE APPROPRIATE ANSWER

ii. STATE WHERE APPLICABLE

1. Name of the company ……

2. Gender: Male female

3. Age :

☐ 20-25 ☐ 26-30

☐ 30-35 ☐ 36-40

☐ 40-45 ☐ 46-50

☐ 50 and above

4. What is your position in the company.

5. When this quarry established?

6. What is the size of land where the quarrying is taking place

7. What was the land used for before the quarrying started.

8. How many workers do you have

9. What do you use for the blasting

10. What are some of the challenges do you experience in your quarry.

11. What are some of the effects of quarrying activities on the environment?

12. What are the effects of your quarry on the surrounding communities?

_____

_____

_____

_____

13. What plans do you have after the completion of the quarrying activities in the area?

_____

_____

_____

_____

_____

14. How do you control

(i) Dust……..

(ii) Noise……..

(iii) Land subsidence……..

(iv) Loss of vegetation cover……

(v) Risks associated with the use of explosives in quarrying……..

15. Do you have any waste management programs in your quarry

a. If yes which one

b. If no how do you dispose off your waste

APPENDIX III

QUESTIONNAIRE FOR THE AREA RESIDENT

Questionnaire to examine the effect of quarrying to the environment in quarries within the Nairobi County

This questionnaire is strictly for learning purpose and the information obtained from the respondents shall be treated with confidentiality.

INSTRUCTIONS

1. TICK THE APPROPRIATE ANSWER
2. STATE WHERE APPLICABLE

1. Gender: Male female

2. Age :

☐ 20-25 ☐ 26-30

☐ 30-35 ☐ 36-40

☐ 40-45 ☐ 46-50

☐ 50 and above

3. For how long have you lived in this area.

☐ 1-5 yrs ☐ 6-10 yrs

☐ 11-15 yrs ☐ 16-20 yrs

☐ Over 21yrs

4. What are some of the benefits do you get from the quarry near you.

5. a. Do you have a family

   ☐ YES ☐ NO

6. What are some of the problems do you and your family experience as a result of the location of the quarry.

   _____

   _____

   _____

   _____

   _____

7. a. Do you experience any health related problem as a result of the activities of the quarry

   ☐ YES ☐ NO

   b. If Yes specify the health problems that you experience

8. What do you think the quarry owners should do to reduce some of the problems that you experience.

   _____

   _____

9. As resident of this area what are some of the activities are you involved in to reduce the problems caused by the quarry.

   _____

   _____