ISSN (Print): 2476-8316
ISSN (Online): 2635-3490
Dutse Journal of Pure and Applied Sciences (DUJOPAS), *Vol. 4 No. 2 December 2018*

Environmental Impact Auditing of Aggregates Mining in Jajirawa Village, Kiru LGA, Kano State, Nigeria

***Ahmed Maigari Ibrahim[1] & Nura A. Yaro[2]**
Department of Environmental Management,
[1]Bayero University, Kano
[2]Department of Geography,
Yusuf Maitama Sule University, Kano
Email: wadeconsult2@gmail.com

Abstract
The paper assessed the environmental impact of aggregates mining in Jajirawa village of Kiru LGA, Kano State based on regulatory compliance audit. The methods used include: questionnaire administration; in-depth interviews; field measurement and observation; and laboratory analysis of soil and water samples collected from and around the facility site. The study demonstrated the efficacy of environmental audit as an efficient tool of managing and controlling of environmental quality. Specifically, the study reveals that the mining operation exacts both positive and negative impacts on the environment and socioeconomic wellbeing of the people in the study area. The positive environmental and socioeconomic impacts include: enriching soil fertility status of the surrounding area; efficient storm water management; employment opportunity; community development activities; and rise in the standard of living. While the negative impacts are: increase in noise level; occupational health risk; and problems associated with non-compliance of regulations such as closure and other sanctions. The study suggested that the mitigation measures to be adopted in order to come to term with the identified negative impacts to include: noise level reduction and strict compliance with regulations and operational ethics, among others. It was also recommended that, the facility proponents should develop an effective environmental management plan in order to ensure best environmental management practice in the facility in particular and the surrounding area in general.

Keywords: Environment, Audit, Mining, and Aggregates

1. Introduction
Quarrying is a form of land use method concerned with the extraction of non-fuel and non-metal minerals from rock. Sand, gravels and limestone are used for building houses and other civil constructions are obtained from quarrying of rocks of the earth's crust. Keeperman (2000) defined quarrying as an act of exploring and exploiting stone from rocks. Metal ores are extracted by mining which involves removal of rock from the ground. According to Cassidy (1997), there is now a great demand for stone especially as limestone in form of crushed rock and it is also an essential constituent of many building and construction materials. A wide

**Author for Correspondence*

variety of product from mining and crushing of rocks form primary raw materials in many industrial applications (Ellen, 2000). Crushed rocks are used as aggregate in highways or concrete construction; in bituminous mixture and railroad ballast (Wills 1995).

Quarrying is done using diverse methods such as hard rock mining, rock drills, explosion of dynamite and other sophisticated methods. The process could also be open pit or surface method, underground and solution mining. The mining method used depends on the particular mineral, the nature of the deposit and the location of the deposit. Each mining method has its own impact on the environment. However, several wastes are generated when rocks are extracted from the earth. Environmental disturbances as a result of mining and processing activities constitute a major threat to public health and environmental quality (Adepoju, 2002). Severity of the environmental problem depends on the characteristics of the mineral being extracted, the methods of mining, waste materials generated and the site characteristics. The effect is manifest in air, land, plants and water associated with mining process.

Quite fortunate, the current process of national development connotes finding solutions to the problems of health, urban management, social and cultural advancement of the people for a better and more meaningful survival. Currently, among the standard practices is the consideration of the potential environmental effects of industrial activities including mining. Various procedures, including particularly Environmental Impact Assessment (E1A) and Environmental Audit (EA) are applied to assist in ensuring that environmental consequences are identified at an early stage of any developmental facility or project.

Environmental Audit is a management tool that comprises systematic, documented, periodic, and objective evaluation of how well organization, management and equipment are performing on environmental terms; that is safeguarding the environment and human health. Thus Environmental Audit is designed to protect the environment and human health with aim of:
a) Assessing performance against a set of requirements or targets, related to specific issues;
b) Evaluating compliance with environmental legislation and corporate polices;
c) Measuring performance against the requirements of an environmental management system standard; and
d) Exploring the potential economic, social and environmental benefits that an improved performance can achieve.

In Nigeria, therefore, with the formulation of the Environmental Protection Decree No. 58 of 1988, and the formulation of National Policy on the environment, based on the principles of sustainable development, it has become necessary for the proponents of all existing industries, commercial, agricultural, and any other development which is deemed to have a degree of impact on the environment to produce an environmental audit report (EAR) after every three years. This has been adequately provided in section 21 of the S.1.9 regulations of 1991 on National Environmental Protection (Pollution Abatement in Industries and Facilities Generating Wastes); EIA Decree No. 86 of 1992 and 7(a) and 7(k) of the National Environmental Standards and Regulations Enforcement Agency (NESREA) Act of 2007.The efficiency of this environmental management tool (Audit) has not been widely ascertained academically, especially in terms of quarrying activities in the study area. The aim of this study therefore, is to assess the environmental and socioeconomic implication of aggregates mining in the study area

based on regulatory compliance audit (RCA) with a view of ascertaining its efficacy or otherwise in managing environmental impacts arising from quarrying activities.

2. Materials and Methods

The study area is a rural settlement within the Kano Close Settled Zone; a densely populated rural agrarian settlement with good accessibility to markets and urban Kano, stable agricultural ecology, and relatively free from hazards associated with urban pollution due to waste; noise; water and air contamination. Jajirawa village is in Kiru Local Government Area of Kano State. The study facility is located in a piece of land (about 512 meters away from the settlement area) with a total area of about 26,250m^2; comprises mainly with granitic rock outcrop. On a global scale it lies between latitudes 11°43'408" to 11°43'590"N and Longitudes 008°05'806" to 008°05'971"E and at about 568.3 metres above sea level; to the Eastern part of the road leading to Karaye from Kiru town.

The methods used include: questionnaire administration; interviews; field measurement and observations; and laboratory analysis of soil and water samples. The questionnaire administration covers randomly selected respondents from Jajirawa village and the surrounding communities; and some employees of the study facility. The interviews involved face to face interactive questions and answer sessions with technical and administrative staff of the quarrying company. The interviews centred on occupational health; conventional operational practices; and environmental regulation and compliance. The field measurement and observations were on noise level; ambient air quality; housekeeping; technical operation; and waste management protocols. The laboratory analysis involved analyses of soil and water samples collected within and around the facility site, in order to determine their quality or otherwise. Some of the parameters analyzed include: soil physical properties such as texture; structure; and colour, nutrient status such as nitrogen and phosphorus contents as well as toxicity; total coliform; cadmium; mercury; nickel; and lead. In addition, water quality determinants such as pH; turbidity; hardness; lead; chlorine; and biological oxygen demand were analyzed.

3. Results and Discussion

3.1 General Housekeeping Practice

Housekeeping is concerned with the maintenance of the facility and the range of tasks involved. Maintaining a tidy working environment is a major step towards reducing or eliminating accidents in the workplace. Incidents such as slips, trips and falls can be eliminated with a good housekeeping procedure. Thus, as per the Quarry Company, Jajirawa, Kiru, LGA, the identified housekeeping components are:

i. Cleaning and clearance of its premises;
ii. Parking of scraps and non-functioning equipments and tools;
iii. Handling of diesel, engine oil, and lubricants;
iv. Landscaping and pruning of trees, shrubs and grasses;
v. Utility usage and maintenance;
vi. Packing of products, vehicles, tools and equipments; and
vii. Fencing and security outfit.

In order to ensure that, all chances of accidents and health risk factors directly related with housekeeping are reduced or eliminated in the facility, the above seven identified housekeeping inventories were assessed based on a score of Zero to Five (0 – 5); 0 – 1: poor; 2:

weak; 3: moderate; 4: very good; and 5: excellent. The overall score is expected to be over 35 (5x7 = 35); which can be further multiplied by 100% to get the relative maintenance performance index. A score of 100%: ($^{35}/_{35}$ x 100) or 70% and above is designated as excellent; 59 to 69%: good; 49 to 58%: satisfactory; and 0 to 48%: poor. The result is presented in Table 1.

Table 1: Housekeeping Assessment

Variables	Score (5)	Grade	RF	Remarks
Cleanliness	3	*Moderate*	*Low*	*Adequate*
Fencing and Security	3	*Moderate*	*Low*	*Adequate*
Fossil Oil Handling	2	*Weak*	*VH*	*Needs Improvement*
Landscaping and Pruning	2	*Weak*	*VH*	*Needs Improvement*
Parking of Products & Vehicles	4	*Very Good*	*NG*	*Adequate*
Parking of Scraps	1	*Poor*	*PMT*	*Needs Serious Attention*
Utility Usage and Maintenance	3	*Moderate*	*Low*	*Adequate*
Total	18	-	-	-
Performance Index: $^{18}/_{35}$x100	**51.43%**	***Satisfactory***	*Low*	*Adequate*

Source: Fieldwork, 2017
Key: RF – Risk Factor; VH – Very High; NG – Negative; PMT – Prominent

Based on the above analysis, it is clear that housekeeping, on general terms in the Quarrying Company, is adequate. However, on specific terms, Fossil oil handling, landscaping and pruning require improvement, while packing of scraps is grossly poor; it is the most glaring health risk factor in the company, thus requires serious attention.

3.2 Waste Management Protocols

According to Basel Convention (2016), wastes are substances or objects that are disposed or are intended to be disposed by the provisions of national laws (UNEP, 2016). Waste includes all items that people no longer have any use for, which they either intend to get rid of, or have already discarded. Moreover, wastes are such items which people are required to discard, for example, by law because of their hazardous properties. Numerous items can be considered as wastes such as household rubbish, sewage sludge, waste from manufacturing activities, packing items, discarded cars, old televisions, garden waste, empty paint containers etc.

Waste management practice, therefore, involves proper, supervised and regulated generation, collection, treatment, transportation, and final disposal in line with the provision of law. The general principle of waste hierarchy is prevention, minimization, reuse, recycling, energy recovery, and disposal. Prevention is most favoured and disposal is the least favoured option. Therefore, according to the revised National Policy on Environment (1998) and NESREA Act No.25 of 2007, the recommended strategy should focus on waste prevention and minimization through the '5 Rs' – Reduce, Repair, Reuse, Recover, and Recycle, and disposal in an environmentally sound manner. Going by the NESREA Act, 2009, B1153 Schedule 4: 13-(1) Polluter Pay Principle (PPP); the collection, treatment, transportation and final disposal of waste within the above specified standards and guidelines shall be the responsibility of the facility generating the waste.

In the Quarry Company Jajirawa, the level of awareness on polluter pay principle, and the practice of the above recommended waste management strategy were assessed. The result shows that there is a general awareness among most of the company staff (83.3%) on the responsibility of the company to take care of all the waste generated during its operational

activities, the detail is presented in Table 2. Similarly, the rate of waste prevention and minmisation in the company is encouraging as it is evident in the repairs of broken tools and equipments; reuse of used engine oil in lubricating machines and equipments; and sales of scraps to smelting companies. The detail finding is presented in Table 2.

Table 2: Level of Awareness on Polluter Pay Principles

Category of Staff	Number	Response (Yes)	Percentage
Administration	3	3	100
Drivers	3	2	66.7
Labourers	4	3	75
Technical	2	2	100
Total	**12**	**10**	**83.3**

Source: Field Work, 2017

Table 3: Waste Prevention and Minimisation - Practice of Five (5) 'Rs'

Hierarchy	Aspect	Duration/Period	Result
Reduction	*Not physically seen*	-	-
Repair	*Tools and Equipments*	*As the need arises*	*Cost Saving*
Reuse	*Used Engine Oil*	*Lubrication of Equipments*	*Cost Saving*
Recycle	*None*	*None*	*None*
Recovery	*Sales of scraps*	*As the need arises*	*Cost Recovery*

Source: Field Work, 2017

3.2.1 Volume of Waste Generated

Quarrying industry is among the modern industries that produce low waste in their production processes, thus the Quarry Company is not an exception. A rapid assessment based on the amount of waste stored in waste receptacles in administrative building, mechanical workshop and power generation unit, the company produces about 1.35Kg of Office waste (rubbish), 3.82Kg of scraps and 120litres of used engine oil monthly. Annually, the company is producing an average volume of 16.2 Kg of rubbish; 45.84 Kg of Scraps; and 1,440 litres of used engine oil. Based on audit finding these figures (volume of waste generation) were not adequately documented and thus, no database on volume of waste generation in the company.

3.2.2 Waste Characterisation

Based on field observation and interview with the staff of the Quarry Company Jajirawa, the company generates three major categories of waste. These are: i. Rubbish which is generated on daily basis from cleaning, clearance, and office maintenance. It is mainly composed with of papers, empty cartons, litters, rags, cellophane, and cans. ii. Scraps which include different kinds of metallic substances, occasionally generated, from worn and tear spare parts and broken tools and equipments. iii. Liquid waste that composed mainly of gasoline, oil and grease; occasionally generated from servicing and lubrication of machines and equipments. Among these three categories of waste produced by the Quarry Company, none is toxic in nature and as such have no direct health effect. However, gasoline, oil and grease if improperly handled may have disastrous effect on soil, plants and ground water.

3.2.3 Waste Disposal Practice

Conventional literature has demonstrated that, waste if improperly handled can result into serious environmental disaster and health hazard. In order to ensure that improper handling and disposal of wastes do not lead to the spread of disease and the pollution of land, air and water, priority was given to the methods of waste collection and disposal employed by the

Quarry Jajirawa in disposing waste generated in the company. Based on field evidence solid and liquid waste (use engine oil) are stored in waste receptacles and kept in a decent manner; not liable to cause harm or detraction to the normal running of the affairs of the company. Compound swept and trash are being disposed through open burning at a designated site, about ten (10) metres away from the administrative building and the burnt residues are used in fertilizing orchard garden within the company premises.

This observed waste disposal practice, on environmental terms has less effect to soil and biota of the surrounding area but may have effect on human health, especially if synthetic compounds are involved, thus the control burning culture should be done with precautionary measures against such eventualities (NESREA: Waste Control and Sanitation Regulations S.1.28).

3.3 Health and Safety

Health and safety are important concerns of most businesses, particularly those in the manufacturing, infrastructural and service industries. Thus, health and safety audit is conducted in order to ensure that working environment is as safe as possible for all employees. It is a methodological approach to evaluate potential hazards enabling suggestion for improvement. Moreover, it is an important tool for identifying deterioration of standards, area of risks or vulnerability, hazards and potential incidents in the machines or production lines for determining necessary action to minimize hazards thus ensuring effective and meaningful safety efforts.

Therefore, as per the Quarrying Company, Jajirawa, Kiru, LGA, the identified occupational health and safety issues are:

i. Medical surveillance;
ii. First Aid including first aid provisions and training;
iii. Accident and illness investigation, record keeping and reporting;
iv. Workplace requirements including general workplace requirements, ventilation, temperature, lighting, sanitary provisions, visual screen equipment, manual handling of loads and back injury prevention;
v. Important notice and warning signs and signals;
vi. Personal Protective Equipments (PPE); and
vii. Emergency Preparedness and Response.

3.3.1 Medical Surveillance

An open ended questionnaire was administered to the employees of the company which covers last period when felt sick; nature of sickness; nature of treatments offered; when recovered; medical allowance or consideration received or offered; health insurance cover; and place of medical retainer-ship. The result indicated that the sickness factor is not directly related with routine operation of the facility. It further shows that, the company to some extend comes to the aid of its employees in terms of medical allowances but has no health insurance cover and medical retainer-ship with any health care facility for its employed staff; contrary to the provision of Occupational Health and Safety Act of 1990 and Legislation 2006 which among others, stipulated that 'all corporate bodies or companies operating in Nigeria should have Health Insurance cover to its employees and/or medical retainer-ship with reputable health care facility for medical care'. The detail is presented in Table 4.

Table 4: Medical Surveillance

Parameters	Frequencies					Total
	2 Weeks	2 Months	3 & Above	A Year	Over 1 Year	
Felt Sick	1	1	2	8	3	15
Sickness	*Malaria*	*Malaria*	*Not Specify*	*Not Specify*	*Not Specify*	-
Treatment	*Antimalaria*	*Antimalaria*	*Not Specify*	*Not Specify*	*Not Specify*	-
Convalesce	*3 days*	*4 days*	-	*1 - 7 days*	*1 – 3 days*	-
Allowance	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	-
Insurance	*No*	*No*	*No*	*No*	*No*	-
Retainership	*No*	*No*	*No*	*No*	*No*	-

Source: Field Work, 2017

3.3.2 First Aid, Provision and Training

First Aid is an emergency medical care offered to a victim of sudden illness or injury before a more skillful medical treatment is available. It very often saves life or improves certain vital signs including pulse, temperature, a patent (unobstructed) airway, and breathing. In minor emergencies, first aid prevents a victim's condition from worsening and provides relief from pain; it must, therefore be administered as quickly as possible. First-aid measures depend upon a victim's needs and the provider's level of knowledge and skill. Knowing what not to do in an emergency is as important as knowing what to do. Improperly moving a person with a neck injury, for example, can lead to permanent spinal injury and paralysis.

In the quarrying company under study, it was observed that there is a provision of a first aid box and provision of all needed necessary emergency supplies such as iodine, disinfectants, bandages, cotton, aspirin, etc. The staff responsible for administering first aid in the company has been found to have undergone two health and emergency trainings under Medi-care Consult (certificate of attendance seen).

3.3.3 Accident and Illness Investigation

Individual interviews with three technical staff of the company and a backup medical records check at Kiru General Hospital (Outpatient Register) reveals that, for the past five years (2012 to 2017) none of the staff of the company has been involved in accident or fatal illness during routine operation of the company. However, it was observed that such vital information has not been documented either in the annual medical statement of the company nor does it appear in any official record. This practice goes contrary with the occupational health and safety management and National Guidelines for Environmental Audit in Nigeria.

3.3.4 Workplace Requirement

The general requirements for conducive workplace includes: adequate ventilation; regulated temperature; adequate lighting; good sanitary provision; provision of cloak room; drinking water; rest area; and absence of sexual harassment and violence. All these were assessed in the facility site and the audit findings on general terms revealed that the workplace requirement of the Quarry Company is good. On specific terms, however, cloak room and rest area requires serious attention. The detail is presented in Table 5.

Table 5: Workplace Requirements

Variables	Score (5)	Grade	RF	Remarks
Cloak Room	2	*Weak*	*VH*	*Needs Improvement*
Drinking Water	4	*Very Good*	*NG*	*Adequate*
Harassment	5	*Excellent*	*NG*	*Adequate*
Lighting	4	*Very Good*	*NG*	*Adequate*
Rest Area	2	*Weak*	*VH*	*Needs Improvement*
Sanitary Facility	3	*Moderate*	*Low*	*Adequate*
Temperature	3	*Moderate*	*Low*	*Adequate*
Ventilation	5	*Excellent*	*NG*	*Adequate*
Violence	5	*Excellent*	*NG*	*Adequate*
Total	31	-	-	-
Performance Index: $^{31}/_{45}$x100	**68.9%**	***Good***	*Low*	*Adequate*

Source: Field Work; 2017

4.3.5 Important Notice, Signal and Warning Signs

Based on the Health & Safety (Safety Signs and Signals) Regulations of 1996, it is essential to warn both workers, visitors and the public about potential risks in a given workplace or facility. One of the best ways to do this is by using hazard signs, which are widely understood and will help an organisation to comply with the Health & Safety (Safety Signs and Signals) Regulations of 1996. Hazard signs are markers that are used to draw attention to potentially dangerous situations within a public access premises or workplace. Hazard signs are instantly recognisable and usually incorporate designs that have become synonymous with danger in most cultures, such as biohazard signs, therefore instantly alerting those seeing them to a potential danger or hazard. The adequate signposting of potential hazards is a legal requirement in most premises that are accessed by employees and members of the public, a so placing hazard sign is an important part of ensuring that organization or facility comply with relevant health and safety legislation.

A field observation survey indicated that the company is fully complying with hazard signs and signal regulation. A total of nine sign post were seen adequately placed in strategic locations indicating and carrying different notice, sign and signals. Table 6 portrayed the observed findings.

Table 6: Inventoried Notice, Hazard and Warning Signs

Sings	Location	Quantity	Status	Remark
Danger	*Blasting Site*	4	*Functional*	*Adequate*
Crusher	*Crushing Site*	1	*Functional*	*Adequate*
EPS	*Entrance*	1	*Functional*	*Adequate*
Use of PPE	*Clog & Rest Area*	1	*Functional*	*Adequate*
Quarry	*Quarrying Site*	1	*Functional*	*Adequate*
Muster Point	*Loading Site*	1	*Functional*	*Adequate*
Total	-	9	-	-

Source: Fieldwork; 2017

3.3.6 Personal Protective Equipments (PPE)

Hazards exist in every workplace in many different forms: sharp edges, falling objects, flying sparks, chemicals, noise and a myriad of other potentially dangerous situations. The Occupational Safety and Health Administration (OSHA) require that employers protect their employees from workplace hazards that can cause injury. Controlling a hazard at its source is the best way to protect employees. Depending on the hazard or workplace conditions, OSHA recommends the use of engineering or work practice controls to manage or eliminate hazards to

the greatest extent possible. For example, building a barrier between the hazard and the employees is an engineering control; changing the way in which employees perform their work is a work practice control. When engineering, work practice and administrative controls are not feasible or do not provide sufficient protection, employers must provide personal protective equipment (PPE) to their employees and ensure its use. Personal protective equipment, commonly referred to as "PPE", is equipment worn to minimize exposure to a variety of hazards. Examples of PPE include such items as gloves, foot and eye protection, protective hearing devices (earplugs, muffs) hard hats, respirators and full body suits. The OSHA requirements for PPE as set forth in the Code of Federal Regulations (CFR) at 29 CFR 1910.132 (General requirements); 29 CFR 1910.133 (Eye and face protection); 29 CFR 1910.134 (Respiratory protection); 29 CFR 1910.135 (Head protection); 29 CFR 1910.136 (Foot protection); 29 CFR 1910.137 (Electrical protective equipment); 29 CFR 1910.138 (Hand protection); and regulations that cover the construction industry, at 29 CFR 1926.95 (Criteria 5 for personal protective equipment); 29 CFR 1926.96 (Occupational foot protection); 29 CFR 1926.100 (Head protection); 29 CFR 1926.101 (Hearing protection); and 29 CFR 1926.102 (Eye and face protection); and for the maritime industry at 29 CFR 1915.152 (General requirements); 29 CFR 1915.153 (Eye and face protection); 29 CFR 1915.155 (Head protection); 29 CFR 1915.156 (Foot protection); and 29 CFR 1915.157 (Hand and body protection).

To ensure the greatest possible protection for employees in the workplace, the cooperative efforts of both employers and employees will help in establishing and maintaining a safe and healthful work environment. In general, employers are responsible for:

i. Performing a "hazard assessment" of the workplace to identify and control physical and health hazards;
ii. Identifying and providing appropriate PPE for employees;
iii. Training employees in the use and care of the PPE;
iv. Maintaining PPE, including replacing worn or damaged PPE;
v. Periodically reviewing, updating and evaluating the effectiveness of the PPE program;
vi. Employees properly wear PPE, attend training sessions on PPE, care for, clean and maintain PPE, and inform a supervisor of the need to repair or replace PPE.

The above provision and requirements were examined and the result indicated a satisfactory provision and use of PPE in the facility under investigation. A total of six key PPEs were inventoried and some were physically seen in store and worn by working staff. These are: Helmet, Nose and Mouth Mask, Hand Gloves, Safety Boot, Goggle, and Overall Cloth Kit. The detail findings are presented in Table 7.

Table 7: Provision and Use of Personal Protective Equipments

Items	**Provision**		**Evaluation**			**Remark**
	In Store	In Use	Replacement	Training	Supervision	
Boots	*Available*	*Always*	*Occasional*	*Informal*	*Always*	*Satisfactory*
Cloth Kit	*None*	*Always*	*Occasional*	*Informal*	*At times*	*Weak*
H. Gloves	*Available*	*Always*	*Always*	*Informal*	*Always*	*Adequate*
Helmet	*Available*	*Always*	*Exceptional*	*Informal*	*Always*	*Satisfactory*
Goggle	*None*	*Always*	*Always*	*Informal*	*Always*	*Satisfactory*
P. Mask	*Available*	*Always*	*Always*	*Informal*	*Always*	*Adequate*

Source: Fieldwork; 2017

3.3.7 Emergency Preparedness and Response

Emergencies can create a variety of hazards for workers in the impacted area. Preparing before an emergency incident plays a vital role in ensuring that employers and workers have the necessary equipment, know where to go, and know how to keep them-selves safe when an emergency occurs. Good planning normally leads to good response. Therefore, good emergency preparedness programs enable emergency personnel to rapidly identify, evaluate, and react to a wide spectrum of emergencies, including those arising from internal or external events. Seldom, integration of safety, security, and emergency preparedness forms the basis of protecting public health and safety. To achieve that, protective actions are taken in order to avoid or reduce hazard; often referred to as protective measures. Increased confidence in public protection is obtained through the combined inspection of the requirements of emergency preparedness and the evaluation of their implementation.

The first step in developing an emergency response plan is to conduct a risk assessment in order to identify potential emergency scenarios. An understanding of what can happen will enable the manager to determine resource requirements and to develop plans and procedures to prepare his organisation. Next to that is to analyze event and evaluate possible recovery strategies, while other experts evaluate the effectiveness of protective actions that have been recommended. A prompt warning to employees to evacuate, shelter or lockdown can save lives. A plan should therefore be established and resources should be on hand, or quickly, available to prepare a facility. The plan should also include a process for damage assessment, salvage, protection of undamaged property and cleanup following an incident. These actions to minimize further damage and business disruption are examples of property conservation.

The usual protective actions for life safety under emergency preparedness and response programme include: i. Evacuation; ii. Sheltering; iii. Shelter-In-Place; and iv. Lockdown. Prompt evacuation of employees requires a warning system that can be heard throughout the building. Fire alarm system is often being tested in order to determine if it can be heard by all employees. If there is no fire alarm system, public address system is next option, air horns or other means to warn everyone to evacuate. Evacuation signal are sound up during planned drills so that employees are familiar with the sound. Sufficient exits are made available at all times. It is the duty of response team to check to see that there are at least two exits from hazardous areas on every floor of every building. Building or fire codes may require more exits for larger buildings. It is also the duty of response team to walk around the building and verify that exits are marked with exit signs and there is sufficient lighting so people can safely travel to an exit. If there is anything that blocks an exit, it should be removed. Evacuation team leader should be appointed to assign employees to direct evacuation of the building. At least one person is assigned to each floor to act as a "floor warden" to direct employees to the nearest safe exit.

In line with the facility under investigation, warning alert; emergency exist; evacuation facility; floor warden; and provision of functional fire fighting equipments were examined. The result indicated an overall satisfactory condition. The detail observation is presented in Table 8.

Table 8: Inventory of Emergency and Response Measures

Measures	Provision	Quantity	Status	Eff. Testing	Remark
Emerg. Exist	*Available*	2	*Functional*	*Always*	*Adequate*
Evacu. Facility	*Available*	1	*Functional*	*At Times*	*Satisfactory*
Fire Extinguisher	*Available*	4	*Functional*	*3 Months*	*Adequate*
Warden	*Available*	1	*Tech. Staff*	*Training*	*Satisfactory*
Warning Alert	*Available*	4	*Functional*	*Always*	*Adequate*

Source: Fieldwork, 2017

3.4 Environmental Quality

The general objective of environmental assessment is to protect, promote, maintain, and sustain environmental quality, thus in this audit study four major physical attributes of the facility area were examined. These are: i. Ambient Air; ii. Noise level; iii. Soil; and iv. Underground and surface water.

3.4.1 Air Quality and Noise Level

The results of field measurement, as presented in Table 9, shows the ambient air quality of facility area is within the acceptable limit. Toxic and poisonous gases such as sulphur oxide, Carbon monoxide, and hydrogen sulphide, are below the threshold level contained in the National Environmental Regulations, 2013: Air Quality Control (Schedule III, Regulation 6, 23(c), 24(a), 28, 29, 31(1)). Equally, the noise level of the facility area both during operational hours and non operational hours, as presented in Table 10, are within the safe level; as contained in the National Environmental Regulation of 2009: Noise Standards and Control (S.I.No.35).

Table 10: Air Quality Measurement

Parameters	Actual	Standard Limit	Quality Score	Remark
Carbon monoxide (CO)	5.14 ug/m^3	11.4 ug/m^3	High	Within Limit
Hydrogen sulphide (H_2S)	2.06 ug/m^3	100 ug/m^3	Very High	Within Limit
NH_3	0.00 ug/m^3	600 ug/m^3	Very High	Within Limit
NO,	0.80 ug/m^3	500 ug/m^3	Very High	Within Limit
Sulphur oxide (SO_2)	0.064 ug/m^3	830 ug/m^3	Very High	Within Limit
Suspended particulate matter	71.6 ug/m^3	250 ug/m^3	Very High	Within Limit

Source: Field work, 2017

Table 10: Noise level Around the Facility Site

Sampling Points	Noise Level (dB) Out of Work		Remarks	
	Mean	Cumulative	Residential (55dB)DT	Industrial
A	47.6	47.6	Within the Limit	Within the Limit
B	44.3	50.9	Within the Limit	Within the Limit
C	48.1	47.1	Within the Limit	Within the Limit
D	45.0	50.2	Within the Limit	Within the Limit
E	46.7	48.5	Within the Limit	Within the Limit
Total	231.7	244.3	-	-
Mean Total	46.34	48.86	Within the Limit	Within the Limit
Sampling	Noise Level During Operation		Remark	
Points	Mean	Cumulative	Residential	Industrial*
A	92.6	92.6	Above Day Threshold	Within the Limit (6hr)
B	92.8	92.4	Above Day Threshold	Within the Limit (6hr)
C	90.0	95.2	Above Day Threshold	Within the Limit (4hr)
D	101.2	84.0	Above Day Threshold	Within the Limit (8hr)
E	92.1	92.9	Above Day Threshold	Within the Limit (6hr)
Total	468.7	457.1	-	-
Mean Total	93.74	91.42	Above Day Threshold	Within the Limit (6hr)

Source: Field Work, 2017

3.4.2 Soil Characteristic

Result of field and laboratory analysis of the soil sample collected from the facility area and its surrounding, as presented in Table 11, has indicated that the operational activities of the facility under investigation has not degenerates the soil physical and chemical characteristic of the area. The soil of the area support cultivation of arable crops such as millet, sorghum, cow-pea, pea-nuts, sesame, and orchard, among others.

Table 11: Soil Quality in the Study Site

Parameters	Result
Moisture content (%)	1.70
Bulk Density g/cm^3	0.24
Org.Mt Content %	1.00
pH	7.0
Base Saturation	45.10
Oil & Grease	Nil
Phos. Ppm	7.35
THC	Nil
Sand	72.00
Silt	19.00
Clay	9.00
Colour	6/6 2.5YR Olive Yellow
Temperature	30.0^{o}C
Texture Class	Loamy

3.4.3 Storm Water Management

Field observation indicated that storm water in the facility area is drained through drainage trench into a primary stream that passes near the facility site (about 560 metres northwest). Within the facility premises in particular, there is no any evidence of water logging, erosion incursion, or gullying. However, in an area (Farmland) about 16 metres away from the facility site, a serious gully erosion feature was observed. Further analysis of the flow pattern of the gully, shows it has originated from the far northwestern part of the nearby farm lands rather than the facility area. This indicated that gullying in the neighbourhood of the facility is not directly linked with the operation of the facility and in another direction the facility is managing storm water adequately.

3.5 Neighbourhood and Site Operation

The major aspect of consideration under neighborhood is community development agreement as contained in NMMA (2007) while for the site operation, the main aspects are: blasting holes; charge and load density; measures of controlling fly rock; and loading and dispatch.

3.5.1 Community Development Agreement

The 2007 Nigerian Minerals and Mining Act (NMMA) introduced a novel practice of mandatory community agreement between mining sector operators and a certain segment of the society referred to as "the host community". A Community Development Agreement (CDA) is defined as any negotiated agreement between an extractive industry proponent and a community stipulating how that community accesses development initiatives undertaken to be provided by the project proponent. In other words, one of the functions of a CDA is to regulate the manner in which a host community benefits from the resource exploration and production activity occurring on community land.

Nevertheless, the CDA process is also used in many jurisdictions to express a community's consent and support for a project and to agree how a project proponent engages or relates with the host community during the life cycle of the project. Section 116 (1) of the NMMA provides that: "*Subject to the provisions of this section, the Holder of a Mining Lease, Small Scale Mining Lease or Quarry Lease shall prior to the commencement of any development activity within the lease area, conclude with the host community where the operations are to be conducted an agreement referred to as a Community Development Agreement or other such agreement that will ensure the transfer of social and economic benefits to the community*". Furthermore, subsection (2) of section 116 stipulates that "*the Community Development Agreement shall contain undertakings with respect to the social and economic contributions that the project will make to the sustainability of such community*" (NMMA, 2007).

In line with the above given details, it was observed that the facility under study audit has been in existence several years (1970s) before the enactment of the 2007 Nigerian Minerals and Mining Act. Thus, there exist no formal community development agreement document signed or endorsed by the host community and the management of the Quarry Company Jajirawa. However, interviews with the community members and the management staff of the facility under investigation, revealed that the Quarry Company, from the year 2012 to 2017 (5 years period) has assisted its host communities with over ten (10) community development projects and other several assistance in cash and kind worth over Twenty five Million Naira (=N=25,000,000). Detail findings are presented in Table 12.

Table 12: Inventory of Assisted Community Development Projects – 2012 to 2017

Project	Location	Period	Est. Cost =N=	Current Status
Pri. Sch. Classes	*Jajirawa*	2012	*Over 4 Million*	*Functional*
Renovation of Classes	*Jajirawa*	2015	*About 2 Million*	*Functional*
Culverts	*Rangas*	2013 & 2014	*About 1.5 Million*	*Need Improvements*
Road repair	*Kiru – Jajirawa*	2015	*About 5 Million*	*Need Improvements*
Hospital Beds	*Kiru*	2014	*About 0.5 Million*	*Functional*
Well Repairs	*Rangas*	2013	*=N=200,000.00*	*Need Improvements*
Free Supply of Aggregate	*Kiru, Jajirawa, Rangas*	2012 to date	*About 3 Million*	*On going*
Repairs of Grave Yard	*Jajirawa, Rangas*	2013 & 2015	*=N=250,000.00*	*Need Improvements*
Completion of Classes	*Bargone*	2014	*About 2 Million*	*Functional*
Mosque Repair	*Karaye, Kiru, Yako, Dantako Tasha*	2013 to 2015	*About 2.5 Million*	*Need Improvements*
Islamiya Classes	*Yako, Jajirawa*	2012 & 2016	*About 1 Million*	*Functional*

Source: Fieldwork, 2017

3.5.2 Blast Holes

The National Environmental Regulation of 2012 (Quarrying and Blasting Operations); part V – Operating mechanism/Guide line for blasting (Section 22) states that: i. Blasting shall be done between 10.00AM to 4.00PM; ii. Charge density shall not exceed 35Kg/hole and not exceed 3 metric tons per blast; iii. Depth and space for blasting shall not exceed 10 metres and 1.5 metres respectively; and iv. Use 17ms or 42ms relays to control vibration and limit transmission of energy.

Audit evidence generated from field survey indicated that the habitual blasting period in the facility is 2.00PM to 3.00PM (1hour), which is within the stipulated period of 10.00AM to 4.00PM. The depth of blasting holes is 15feet (5 metres) and interval space between holes is 3 feet (1 metre); also quite below the threshold limit. Other, protocols being followed before and after the blasting are: i. Informing and inviting police personnel to witness the operation; ii. Placing of personnel at strategic places and roadsides to control movement or traffic of people, vehicles and animal; and iii. Ringing of bell and alarm to alert people, among others. Thus, these observed operations demonstrated that the company is complying with blasting regulations as stated above.

3.5.3 Charge Load Density

As stated above, that charge density shall not exceed 35Kg/hole and not exceed 3 metric tons per blast (NER, 2012). It was observed that the company is using 5Kg/hole (ammonia) or 7Kg (CLD) and produces about 0.5 metric ton per blast; which is about seven times lower than the threshold limit. This connote that the company is not only complying with blasting regulation but is also operating on a very high safety level.

3.5.4 Measures to Control Fly Rock

It was observed that the company is employing three major measures to reduce and control fly rock. These are: i. Use of shallow holes; mostly 1 metre, which according to the head of blasting unit are meanly associated with fair or good blasting effect compared with deep holes; ii. Use of ammonia instead of cord dynamite, as it has less volatile effect compared to dynamite; and iii.

The use of a wide space interval between blasting holes (mostly 3 x 3 feet sidewise). A field check reveals that fly rock do not exceed 25 metres away from the blasting site; it was observed that most of the blast occurs within the range of zero to seventeen metres (0 to 17 metres) sidewise. This demonstrates that the fly rock controlling measures used by the company are very effective.

3.5.4 Loading and Dispatch

Loading of aggregates in the audited facility is done with the aid of loading vehicles (about 3) and the dispatching is carried out with heavy duty tipping trucks (about 5). The loading operation commences with safely positioning of truck, as directed by excavator operator; who discharge the load from operating bucket in to the receiving truck. On completion of the load and when the excavator operator is satisfied the truck is safely loaded the excavator horn inform the truck driver to move off. This observed practice goes in line with the conventional practices in modern quarry industries. Human labour is not used directly in loading and dispatching of aggregates. Thus, this reduces the chances of back pain and other related sicknesses among the employee of the company directly on that schedule.

4. Evaluation of the Findings

4.1 Evaluation Procedure

The evaluation procedure was based on National Environmental Standards and Regulations; Legislations such as the EIA Act (1992), NESREA Act (2007), Nigerian Minerals and Mining Act (2007), Occupational Health and Safety Act;and professional codes and ethic. These were corroborated with the operational findings in the audited facility in order to determine compliance or otherwise and environmental effects. On this basis, two scenarios were found; those in consonance with the stipulated rules and regulations and those with detraction or not in total harmony.

4.2 Compliance Aspects

The parameters observed were: i.) housekeeping; waste management; ii.) health and safety; iii.) environmental quality; iv.) neighborhood and site operation components. About 75% of the parameters under these four major audit aspects were found to be in compliance with environmental rules and regulations that, to some extent ensure safe working environment and best environmental management practice in the studied Quarrying Company.

4.2.1 House Keeping

Among the seven variables examined under housekeeping aspect, four were found to be in line with the Occupational Health and Safety Standard. These are: cleanliness, fencing and security, parking of products and vehicles, and utility usage and maintenance. Their respective relative performance index was found very satisfactory, thus the risk associated with these variables was observed to be very low; which is indeed in line with the main goal of Occupational Health and Safety Act.

4.2.2 Waste Management

Based on field evidence, the company stored its solid and liquid waste (used engine oil) in waste receptacles and kept them in a decent manner; not liable to cause harm or detraction to the normal running or affairs of the company. Moreover, the company a braces the 5Rs waste management concept, which is in agreement with the National Environmental (Sanitation and

Waste Control) Regulation S. 1.28. The observed waste disposal practice, on environmental terms has less effect to soil and biota of the surrounding area.

4.2.3 Health and Safety

Among the seven variable examined under health and safety components, three were found to be absolutely in compliance with Occupational Health and Safety Act of 1990 and Legislation 2006. These are: First Aid provision and training; Important Notice and Warning Signs; and Emergency preparedness and response. While in the remaining four components, majority of the sub-components are in greater compliance with OHSA standard. Therefore, it connotes that occupational health and safety in the company is satisfactory.

4.2.4 Environmental Quality

Three major environmental variables were considered in the survey, namely: Ambient air quality and noise levels; soil; and underground water and storm water management. Results of ambient air and noise level measurements are all within the permissible limit contained in the National Environmental (Air Quality Control) Regulation of 2013 and National Environmental (Noise standards and Control) Regulation S.I. No.35 of 2009 respectively. Similarly, laboratory analysis of soil and underground water samples collected from the facility site revealed that their respective quality standards correspond with the provision of National Environmental (Access to Generic Resources and Benefits Sharing) Regulation of S. I. No. 30 and National Environmental (Surface and Ground Water Quality Control) Regulations of 2011, respectively. This to some extent indicates good environmental management practice within and around the facility.

4.2.5 Neighbourhood and Site Operation

By virtue of the huge number of community development projects executed by the company, over a period of five years (2012 to 2017: an average of 4 CDP per year), it is an indication that the company has embraces the concept and practice of Community Development Agreement (CDA). This entails that the company is complying with the provision of the 2007 Nigerian Minerals and Mining Act (NMMA).

The four key parameters considered under site operation; namely: Blast holes; charge load density; measures to control fly rock; and loading and dispatch were found below the threshold limits contained in the National Environmental (Mining and Processing of Coal, Ores and Industrial Minerals) Regulations of 2009. This indeed corresponds with the principles of sound management.

4.3 Noncompliance Aspects

The noncompliance aspects include all the subcomponents or variables that were found to be either in deviation, detraction, partial implementation, improper usage/application, substandard, or absence as against the stipulated rules, regulations, standards, and or professional codes and ethics. A total number of five subcomponents were found under this segment. These are: Parking of Scraps (House Keeping Aspect); Record and volume of waste generation (Waste Management); Medical retainership (Health and Safety); Cloak room and Rest area (Workplace); and Cloth Kit (PPE).

4.3.1 Parking of Scraps

Parking of scraps, broken tools and equipments in the facility are done indiscriminately and in shabby conditions. Thus the observed situation could be a very high potential health risk factor in case of emergency or routine activities of the company. This is not in line with the provision contained in the Occupational Health and Safety Act of 1990: Housekeeping aspect. Among other thing the Act stipulated that, '… all health risk factors should be eliminated or minimized in order to maintains a tidy working environment, reduce or eliminate accidents in the workplace'. It was therefore concluded that this aspect of housekeeping in the facility requires serious improvement.

4.3.2 Volume of Waste Generation

Good recordkeeping and statistical data are very essential in planning and decision making be it in private or public places. It was observed that such are not fully functional in the studied facility. The volume of waste generated in the company is not being measured and other related records such as the volume or amount of waste reused, sold out etc were not kept in record. These on their own spheres are deformation to waste management principles and practices; there are, indeed detraction to the protocols of waste management, as contained in National Policy on Environment (1998) and NESREA Act No.25 of 2007.

4.3.3 Medical Retainership

Medical retainership is a medical facility arrangement organized by companies or enterprises in order to cater for the medical care of their employees. Ideally such medical facility should be based within the premises of a given company, where such is not obtainable; the company is supposed to make service arrangement with either public or private health care facility under a written agreement known as Medical Retainership. Audit study findings revealed that the company does not have in-house medical facility or medical retainership agreement with any kind of health care facility elsewhere. This entails that the company is not fully complying with all of the provision of Occupational Health and Safety Act of 1990.

4.3.4 Cloak Room and Rest Area

Cloak room and resting area are very essential for the normal running of an organized system be it in the public place or private. A cloak room is a specially designed building structure where workers (usually technical staff) change their clothes; from normal wares to working wares. While resting area as the name implies is also a specially designated area for workers to rest during break hours or any special resting time. The study findings show the company has made these places available, but their conditions in terms of adequate provisional contains, sizes, and maintenance are grossly inadequate. Indeed, this observed situation goes contrary to Occupational Safety and Health Administration (OSHA) requirements.

4.3.5 Cloth Kit

The use of Personal protective clothing is one of the PPE requirements contained in the Health and Safety Regulations of 1996, in order to protect employees from likely exposure to occupational hazards such as toxic or corrosive chemicals, biological pathogens, molten metal splashes, thermal extremes, etc. The protective clothing may take the form of aprons, coveralls, coats, pants, hats, hoods, sleeves, gloves, and totally encapsulating chemical protective suits. Audit evidence shows that workers in the studied Company are not always using personal

protective clothing during operational hours which is not in line with the above stated Health and Safety Regulation.

5. Conclusion

In view of the above findings, it is evidently clear that environmental, socioeconomic and health impacts arising from the studied facility were identified and their magnitudes were ascertained with the aid of regulatory compliance audit (one of the environmental management tools). The study has successfully documented and evaluated how well the studied quarrying facility is performing on environmental term; that is safeguarding the environment and human health. The study tool has clearly identified and evaluated areas of best environmental practice in the studied facility as well as lapses, upon which mitigation measures could be applied. The multi dimensional approaches contain and associated with the tool (RCA) enable the study to generate sufficient biophysical and socioeconomic data, based on which policy and ethical inferences were drawn. Thus, it can be concluded that, the tool (Regulatory Compliance Audit) is efficient in identifying, highlighting, and mitigating environmental impact arising from quarrying industry, in particular, and other specific developmental companies in general. The study suggested some mitigations measures to be adopted in order to come to term with the negative impacts to include: Sound insulation/Padding to prevent the transmission of noise; ambient air and ground water monitoring; imbibe good recordkeeping culture; and total compliance with regulations and professional ethic.

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