Operational Risk Assessment and Management in Dangote Cement Company Ibese Plant, Ogun State

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Abstract

The study carried out an operational risk assessment and management in order to identify and analyze the event sequences leading to hazards in Dangote Cement Industry, Ibese plant using qualitative and quantitative methods. The hazards associated with each work area were identified after which a matrix is created for work areas versus hazards. The likelihoods and consequence of each hazard were determined by a walk-through survey. The ranking of various risk activities was classified into extreme, high, moderate and low. The use of flammable gases, noise from machineries, dust that can affect human health and equipment were rated high and extreme while radiations from sunshine, slip/trip hazards and falling of objects/structures were rated moderate. Also, exposure to chemical/heat; injury from electrical appliances and mine excavation were rated low. The study therefore concluded that despite the comparatively low identification of risks and hazards in different groups of the work areas, there still some risks/hazards which extremely high that need urgent mitigation attention.

Keywords: Risks, Hazards, Management, Likelihoods

1 Introduction

Cement industry makes a major contribution to the economy and to the wellbeing of society as a whole (Mojekwu *et al.*, 2012; Ohimain, 2014). For the continuing viability of the industry it is important that full advantage are taken in advance mining methods and procedures, design of mining machinery and equipment, and approaches to management of all mining activities (Udai, 2016). Operation in cement production involves a lot of modern mining operations, which include prospecting, development, exploitation and processing. Each of these operations is associated with hazards and risks that need to be assessed and managed effectively (Kumar and Mishra, 2019). There are many standards which are relevant to mine operations and equipment, but these standards cannot keep fully abreast with continuing development of techniques and technology, or how they interact. As a result of the inherent hazards of mining as an activity, and the complexity of mining machinery and equipment and the associated systems, procedures and methods, it is not possible to be inherently free from hazards (Akosman and Karahan, 2018).

Regardless of how well machinery or methods are designed, there will always be the potential for serious accident. It is therefore not possible for any external agency to ensure the safety of an organization such as a mining company, nor of the machinery or methods it uses. The principal responsibility for the safety of any particular mine, and the manner in which it is operated, rests with the management of that mine (Raheem *et al.*, 2013). It is now widely accepted within industry in general that the various techniques of risk management contribute greatly toward improvements in the safety of complex operations and equipment (McCaffrey, 2018). In many industries there is a legislative requirement for risk management and assessment to be undertaken of all hazardous equipment, machinery and operations, taking into account of the procedures used for operation, maintenance, work area, supervision and management (Mike, 2013; Armando, 2014). Hazards and risks in cement production has led to a number of accidents that caused loss and injury to

human lives, damage to property, interruption of production and so on (Radosavljević and Radosavljević, 2009; Tripathy, 2008),).

As a result of this, many studies have been carried out on operational risk assessment and management in mining industry. Qureshi (1987) conducted hazard and operability study (HAZOP) on a design in order to identify the nature and scale of the dangerous substances; give an account of the arrangements for safe operation of the installation, control of serious deviations that could lead to a major accident and emergency procedures at the mine site. Khan and Abbasi (1995) put forward optimal risk analysis (ORA) which include hazard identification and screening, probabilistic hazard assessment and consequence analysis. Orsulak *et al.* (2010) presented an application of a risk assessment approach in characterising the risks associated with safety violations in underground bituminous mines in Pennsylvania using the Mine Safety and Health Administration (MSHA) citation database. Jeong *et al.* (2007) carried out a qualitative analysis by using hazard and operability method (HAZOP) to identify the potential hazards and operability problems of decommissioning operations. Nor *et al.* (2008) studied risk related to loaders and dozers and were assessed and ranked. The hazards "failure to follow adequate maintenance procedure" and "failure of mechanical / electrical/ hydraulic components" were the most severe and frequent hazards for the loaders and they fell into the category of high risk. Kecojevic and Radomsky (2004) studied the causes and control of loader- and truck-related fatalities in surface mining operations.

In this study, operational risk assessment and management were investigated. This is because only few studies have critically looked into the operational risk and their management in cement industry in Nigeria, despite Nigeria is one of the highest producers of cement in Africa.

2 Materials, Methods Used

2.1 Study Area

Dangote cement have operational facilities in ten African countries which includes Nigeria, Cameroon, Congo, Ethiopia, Ghana, Senegal, Sierra Leone, South Africa, Tanzania and Zambia (Makoju, 2010; White, 2015). It is Africa's leading cement producer with production capacity of up to 45.6 million tonnes per annum (Mta) across Africa at the end of 2017 and revenues in excess of US$2.2 billion and 24,000 employees (Akinyinka and Chibuike, 2017). Dangote Cement's home market is based in Nigeria and where it started production in 2007. It has established three fully integrated cement plants of 29.3Mta located in Obajana, Ibese and Gboko (Goddy, 2013)

Dangote cement's Ibese plant in Ogun State commenced cement production in December 2011. At a stroke Ibese plant transformed Nigeria into a nation self-sufficient in cement production (Thomson, 2013). The $850m Ibese plant has two 3-million tones lines built by Sinoma, using a state-of-the-art chinese European technology. The plant has a capacity of 12 million tons per year (Mojekwu *et al.,* 2012). Ibese plant has 1,150 million tonnes of limestone, enough for about 78 years, and is supported by 1,488 cement delivery trucks (Ohimain, 2014). The plant is gas-fired for both kilns and powered with LPFO and coal backups for its kilns and diesel for its power plant.

The Ibese limestone and mine under plan of exploitation is located about 50km SW of Abeokuta town and 90km NW of Lagos (Dangcem, 2019). The Ibese limestone deposit area exhibits more or less flat topography with some undulations cropping out. The elevation in the concession area varies from minimum 41 m above sea level to maximum 58m (Mobbs, 2004). The geology of the area is the Ewekoro Sedimentary formation with major rocks as limestone, sandstone and intercalations of these rocks overlain by overburden consisting of grit sand and laterite (Ola, 1977). Ibese, Ilaro, and indeed southern part of Ogun state which falls within the Ewekoro formation and country's Hydrological basin VI.

2.2 Data Collection and Analysis

Qualitative and quantitative risk assessment methods were used to collect hazard and risk data from the selected workers who involved in the activities of each work area. Qualitative risk assessment method was used to identify the consequences and likelihoods in order to compare risk events with used risk matrix and separate the risks into classes (ratings) while quantitative risk assessment method was used to identify consequences in terms of relative scale (orders of magnitude). The hazards associated with each work

area were identified which includes: hazardous substances, electrical energies, explosives, gravitational energies, radiation energies, mechanical energies, pressure (fluids/gases). A matrix was created for work area versus hazards. The likelihoods and consequence of each hazard were determined by a walk-through survey. The ranking of various risk activities was classified into extreme (L5), high (L4), moderate (L3), low (L2) and Insignificant (L1) depending upon their consequences and likelihood.

3 Results and Discussion

3.1 Risk Assessment and Analysis of Dust Substances

The risk assessment and analysis of dust substance were rated moderate and high as presented in Table 1. The dust activities that rated moderate and high are the dust that affects operations in the mine and processing plant. It was observed that the concession area is covered with laterite and the dust becomes airborne as earth moving equipment carry out their operations which make workers uncomfortable at work and this serves as a serious threat to their health and hamper their daily operations. To avoid the hazards due to airborne dust, remedial measures such as spraying with water must be taken to totally suppress the dust so that the environment can remain stable for workers and different operations.

3.2 Risk Assessment and Analysis of Flammable Gases Substances

The use of flammable gases such as acetylene, LPG was rated high while the use of chemical fumes (welding, grinding, glues); gases (H_2S, CO, CO_2); chemicals (petrol, diesel, oils, degreasers, solvent) and chemicals that may affect health (cleaners, oil/lubes, solvents) were rated low as presented in Table 2. As for the use of flammable gases such as acetylene, LPG, gas detectors and monitors should be put in place to control its release and accumulation to flammable levels, the cylinders should be stored to appropriate standard requirement and the appropriate firefighting equipment should be should be made available on the site.

3.3 Risk Assessment and Analysis of Electrical and Mechanical Energies

Meanwhile, the analysis from any form of electrical work and energies were rated low as presented in Table 3. This is because there are adequate precautionary measures and standard operating procedures are in place for handling electrical facilities. Also, all the activities of mechanical work and energies were rated low because very good technology and standard operating procedures are in place as shown in Table 3.

3.4 Risk Assessment and Analysis of Gravitational Energies

In case of gravitational energies only objects/structures falling on workers were rated moderate while others were rated low as presented in Table 4. Objects/structures falling on workers was moderately rated due to the lack of boulders handling equipment in the mines. In order to prevent the hazard secure barriers to prevent falling objects has to be constructed. Meanwhile the floor/pit wall/ stockpiles heaves; mine excavation and mine road design and construction activities that rated low were as a result of adequate designed and maintenance carried out by trained engineers and surveyors with standard operating procedures that are in place for all mines excavation and operations. Falling of workers and machinery working at heights was rated low because of the reinforcement of bench walls in the mine, constant maintenance of ramps to support moving mine machinery and safety berms in place for mine operators working at height.

3.5 Risk Assessment and Analysis of Explosives and Radiation

Explosive and drilling risk was rated low as shown in Table 5. This is as a result of absence of drilling and blasting operations because of a new technology in place (Continuous Miner). Meanwhile, standard storage facility (magazine) is in place and only authorized trained personnel handle drilling and blasting operation when needed. Similarly, under radiation/thermal/fires, radiations from sunshine was rated moderate because mines is an open area and there is a lot of exposure to sun as presented in Table 5. To prevent the hazard

personal protective equipment (PPE) must be provided and work shift must be strictly observed.

3.6 Risk Assessment and Analysis of Work Environment

Under general working environment, slip/trip hazards was rated moderate while noise was rated extreme as presented in Table 6. This is because slip/trip hazards occur due to uneven surface steps/stairs and sometime with wet or greasy surface. This can be avoided by proper cleaning and efficient lighting of the working environment. Meanwhile the noise is rated extreme because most of the heavy earth moving machines and other equipment are very noisy and therefore immediate mitigation measures such engineering and administrative control should apply.

4 Conclusions and Recommendations

The study discovered that hazard from dust, equipment, use of flammable gases and noise from machinery were rated high and extreme which are un-acceptable. The hazard of machinery and transport vehicles which cause a lot of noise, dust and accident in the work areas must be properly managed by placing traffic signals and boards in certain distance. Also, the use of personal protective equipment must be strictly obeyed by disallowing people without personal protective equipment from entering the work areas. The study therefore concluded that most of risks in different groups of the work areas are comparatively safe and efforts to reduce all the risks to as low as reasonably practicable should be intensified in few work areas that are not yet safe.

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Table 1: Risk Assessment and Analysis of Dust Substances

HAZARD TYPE	Are any of these present/ possible or considered	Tick if applies	Likelihood Level	Reasons for selecting the Likelihood	Maximum Consequence	Risk Rating
Dust that can affect health such as slilca	Work areas filled with dust and workers expose to dust that sufficient to affect their health.	✓	L 3	There is no dust monitoring or suppressing machine in the work area	C3	Moderate
Build up dust of combustible particles.	Dust level that affect operator visibility and equipment ignition sources are present.	✓	L4	Operations in the work area generally produce a lot of dust.	C4	High

Table 2: Risk Assessment and Analysis of Flammable Gases Substances

HAZARD TYPE	Are any of these present/ possible or considered	Tick if applies	Likelihood Level	Reasons for selecting the Likelihood	Maximum Consequence	Risk Rating
Use of flammable gases such as acetylene, LPG	Escape and/or accumulation of flammable level; Exposure to heat sources that can affect health.	✓	L4	Constant usage of flammable gases in welding and power generation activities	C4	High
Gases such as H2S, CO, CO2 (including general ventilation)	Escape and/or accumulation of amounts sufficient to affect persons (e.g. vehicle emissions, blasting).	✓	L2	The mines work area is well open and ventilated.	C2	Low
Chemicals such as petrol, diesel, oils, degreasers, solvents	Exposure of chemical to heat source; ingestion or inhalation situations	✓	L2	Use of such chemicals is controlled and good storage is in place. Also, (PPEs) are in place	C2	Low

Table 3: Risk Assessment and Analysis of Electrical and Mechanical Energies

HAZARD TYPE	Are any of these present/ possible or considered	Tick if applies	Likelihood Level	Reasons for selecting the Likelihood	Maximum Consequence	Risk Rating
Electricity	Injury to persons from sources of electrical energy; Electrical equipment failure	✓	L2	Adequate precautionary measures are in place for handling electrical	C2	Low
Fixed and mobile mechanical equipment (conveyor, crusher, trucks, loaders, dozers etc).	Condition under which the equipment is used Conform to design parameters	✓	L2	Very good technology and Standard operating procedures in place	C2	Low

Table 4: Risk Assessment and Analysis of Gravitational Energies

HAZARD TYPE	Are any of these present/ possible or considered	Tick if applies	Likelihood Level	Reasons for selecting the Likelihood	Maximum Consequence	Risk Rating
Floor/pit wall/ stockpiles heaves; Mine road design and construction	Floor/wall pit collapse; falling of stockpile materials; Poor road design and maintenance	✓	L2	The designed are done and adequately maintained by trained engineers and surveyors.	C2	High
Mine excavation (quarry faces, pit wall faces, trenches etc.)	Inrush of water and other materials; Instability of the excavation/adjoining structures; Unauthorized entry to the extraction area	✓	L2	Standard operating procedures are in place for all mines excavation and operations	C2	Low
Objects/ structures falling on people	Raising and lowering of plant materials and debris	✓	L3	Boulders handling operation is not common in the mines	C3	Moderate
Working at heights	Falling of workers and machinery working at heights	✓	L2	Bench walls in mines are well reinforced.	C2	Low

Table 5: Risk Assessment and Analysis of Explosives and Radiation

HAZARD TYPE	Are any of these present/ possible or considered	Tick if applies	Likelihood Level	Reasons for selecting the Likelihood	Maximum Consequence	Risk Rating
Explosives Handling	Explosive storage Loading; drilling and blasting operations.	✓	L2	Explosive handling is rare due to absence of drilling and blasting operations	C2	Low
Radiations such as sunshine	Exposure of skin (sun burns) that could lead to cancers Reflected ultraviolet light to exposed eyes	✓	L3	Mines is an open area and there is a lot exposure to sun	C3	Moderate

Table 6: Risk Assessment and Analysis of Work Environment

HAZARD TYPE	Are any of these present/ possible or considered	Tick if applies	Likelihood Level	Reasons for selecting the Likelihood	Maximum Consequence	Risk Rating
Building maintenance and ventilation	Easy access to building; adequate maintenance of buildings and proper ventilation	✓	L2	Signage available to guide personnel and visitors; buildings are constantly maintained and have good ventilation systems	L2	Low
Fire equipment	Sufficient fire equipment	✓	L2	Fire extinguishers are strategically located around the environment	C2	Low
Storage Methods	Sufficient width of aisles and storage areas	✓	L2	Good storage facilities are in place and properly maintained	C2	Low
Slip/trip hazards	Uneven surfaces Steps/stairs; Wet/greasy surface	✓	L3	Signage is not adequately paced to caution workers	C3	Moderate
Noise	Noisy equipment Poor use of hearing protection Noise that exceed an 8-hour noise level equivalent to 85dB	✓	L5	Most of the heavy earth moving machines are very noisy	C5	Extreme