THE CHALLENGES IN THE APPLICATION AND PROCESSING OF SANDSTONE: A CASE OF QWAQWA, FREE STATE, SOUTH AFRICA

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ABSTRACT

The South African large scale mining industry is held with a very high regard compared to other Southern African nations, however artisanal and small scale mining is mostly informal with lesser contribution to economic development of the nation. The artisanal miners in QwaQwa, Free State Province of South Africa still use traditional tools such as chisel and hammer to mine sandstone as a form of dimension stone. This method is tedious; requires muscle power and yet very limited in production. This method of production does not meet the local demand and therefore South Africa is forced to import sandstone from the neighboring country, Lesotho. This paper examines the major challenges experienced by the artisanal miners especially in QwaQwa located only about fifty kilometers from Lesotho.

Key words: Artisanal mining; Sandstone; Dimension stone; QwaQwa; South Africa

INTRODUCTION

Mining and its associated industries play a significant role in the economic development of any nation. The top five mineral producers (i.e. China, United States, Russia, Australia and India) accounted for more than 55% of the global mineral production in 2015 (Reichl et al., 2017). Among Southern African nations, South Africa is held with a very high esteem when it comes to mining. In 2015, South Africa stood in the 11th position with a share of 1.82% in the global mineral production, which accounted for 113 billion USD (Reichl et al., 2017). Out of 1.82%, mining for mineral fuels contributed highest to the total mineral production in South Africa, followed by iron production and industrial minerals (Figure 1). According to South African Chamber of Mines (2017), mining sector in 2016 represented 7.3% of the overall South African Gross Domestic Product (GDP), and provided direct employment to about 457,698 individuals which represented about 6% of all employed in South Africa.

South Africa is very prosperous in the mining fraternity and well respected when it comes to the large scale mining industry (Fessehaie et al., 2016). On the contrary, its artisanal and small scale mining (ASM) industry is almost stagnant. ASM is mostly considered as a means of critical livelihood, and is the often activity available for the economic growth in rural areas with limited financial opportunities. As compared to large scale mining, ASM is often characterized by informal and illegal activities without

much contribution to the socio-economic development of the country (Hilson et al., 2017). Although several research has been conducted in artisanal mining, most of these has been concentrated on precious metals such as gold, diamonds and emeralds.

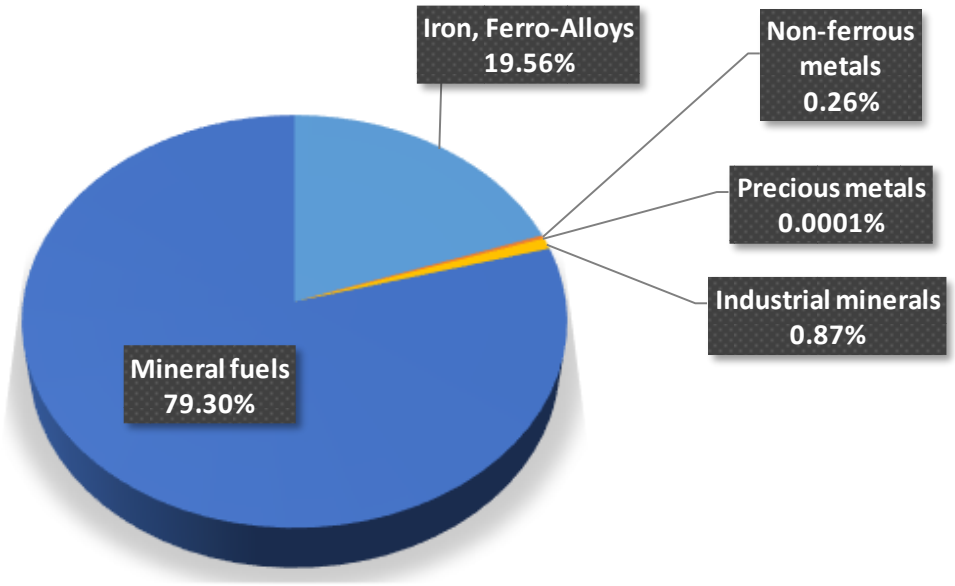

Figure 1: South African mineral production for 2015, Source: Reichl et al., 2017

Most of the dimension stone mining are performed at artisanal scale using traditional tools through small owner-operated businesses (Ashmole and Motloung, 2008a). Dimension stones are natural stones which can be cut into specific size and shapes for various construction and decorative purposes. Sandstone, a dimension stone, is popular for building housewares, domestic construction such as paving, landscaping, tiling, and other artistic works. In artisanal sandstone mining (ASAM), sandstones are typically quarried in large rectangular blocks using basic tools such as chisel and hammer, then transported to processing plants where stone blocks are cut and finished to required specification (Borlinin et al., 2012).

ASM sector in South Africa was officially recognized after 1994 in order to develop socio-economic status of rural communities (Ledwaba, 2017). The ASM sector in South Africa is regulated by Mineral and Petroleum Resources and Development Act of 2002, the Health and Safety Act of 1996 and the National Environmental Management Act of 1998, which provide standard guidelines regarding mining practices, miners' safety and environmental management practices. In most part, however, ASM do not adhere to these regulations and guidelines and find them burdensome or not representative of their particular situation (Dreschler, 2001).

The mining sector, in general, is perceived to have adverse impacts on the environment, the society and the health and safety of the miners and the local community in some cases (Kitula, 2006). Since dimension stone mining are used in natural state which eliminates the concentration and extraction processes (Ashmole and Motloung, 2008a), the environmental impacts of this industry is relatively small compared to other minerals. However, the extraction of stones from quarries may lead to change in landscapes and negative visual impacts (Ashmole and Motloung, 2008b), dust pollution, and exposure to hazards and diseases (Miserendino et al., 2013). Furthermore, artisanal mining may also lack staff with appropriate awareness and training on environmental requirements.

Due to the fragmentation of stone industry and lack of capacity from within, sandstone mining is not spared and as a result the country is currently importing sandstones from the neighboring country, Lesotho. However, South Africa is blessed with spectacular sandstone landscapes and QwaQwa region in Free State Province is widely known for its massive sandstone formation. Several artisanal sandstone mine quarries can be found in QwaQwa, which are significantly contributing to the local economy.

This study aims at introducing the research findings on artisanal mining of dimension stone. The study will discuss the sandstone mining process being practiced in QwaQwa region, and the environmental and socio-economic impacts associated with the mining activities. The target audience of this paper are the miners, academic researchers, policy makers, Government officials and the local community in QwaQwa.

METHODOLOGY

The study used a multi-case study approach involving two sandstone mining sites in QwaQwa, Free State Province. Structured survey questionnaires were administered physically by the researchers to the miners and the surrounding community. The information obtained was triangulated by observation and brief interviews.

RESULTS AND DISCUSSIONS

Sandstone Production Process

The artisanal sandstone mining under study mainly involved three phases: (i) extraction, (ii) transportation, and (iii) processing (Figure 2). In addition to these three phases, there are other phases such as exploration and development phases which are conducted before the extraction of minerals. Extraction phase normally is the initial phase of mining where mineral deposits are identified, which is followed by development phase where necessary preparations are made before extraction. Since artisanal sandstone mining is done using chisel and hammer, no special equipment and facility is required in the site. Hence, sandstone miners especially overlooked the development phase. Delivery of final products to the customers is also not considered in this study.

(i) Sandstone extraction: The stones are extracted from various sites not far from the warehouse. The average distance of quarry is about 12 km from the warehouse. The miners use hammers to open cracks in the deposit, which are later enlarged by putting chisels between the cracks and hammering until blocks get separated from the deposit. Since only human power is used during the extraction phase, it can be assumed that no pollutants or toxic substances are emitted. However, little dust is generated during the process.

(ii) Sandstone transportation: The large blocks of sandstone are loaded in small trucks and then transported to the warehouse. These trucks are run by diesel and have a carrying capacity of 6 tonnes. Emissions from the combustion of non-renewable fossil fuel in these trucks contribute to the emissions.

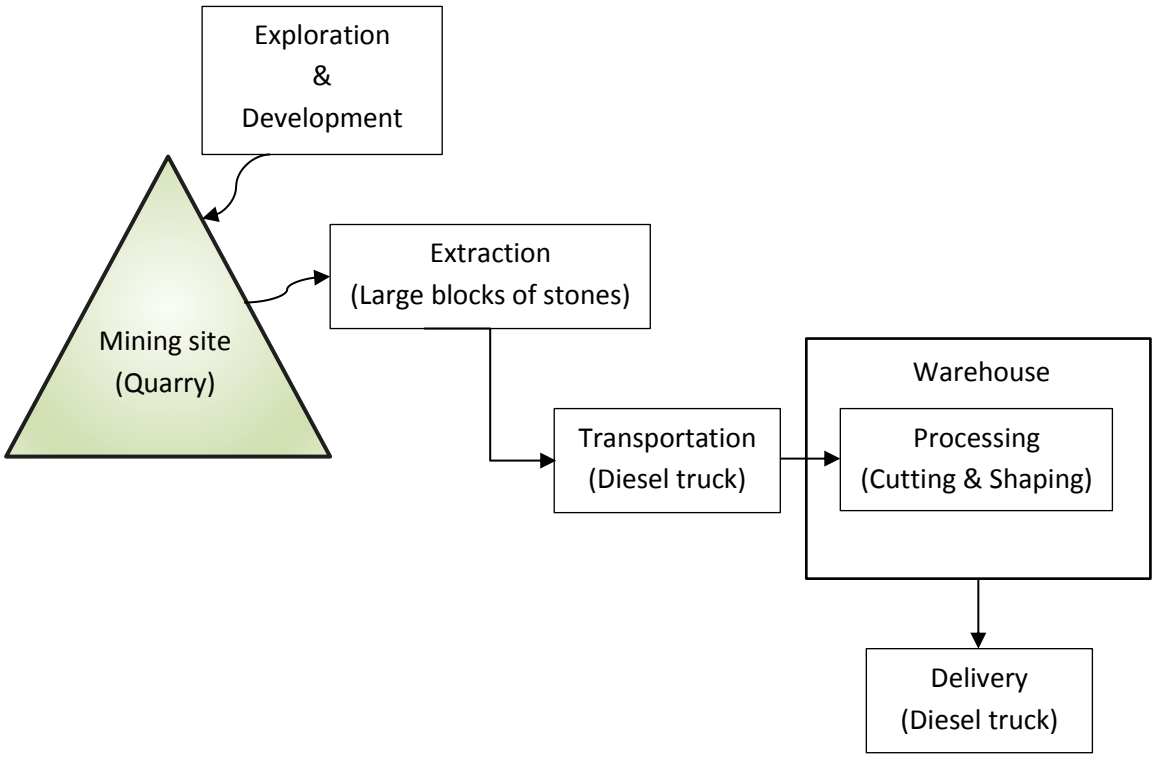

Figure 2: Artisanal sandstone mining process

(iii) Sandstone processing: In the warehouse, cutting machines are used to cut and shape large blocks of stones as per the required specifications. The cutting machines are powered by electricity and requires a constant flow of water over the cutting blade to dissipate the heat generated during cutting process. Small hammers and chisels are also used to shape the bricks for cladding. Since electricity used to run cutting machines is generated using coal which is a non-renewable energy source, the processing phase also contributes to the emissions. This phase produced about 30% of the waste or overburden for every 1 tonne of bricks produced, which is usually brought back to quarry to fill up the holes created by mining activities.

Challenges of Artisanal Sandstone Mining

Productivity

The extraction and processing of sandstone are labour-intensive activities. The extraction of sandstone blocks is done using manual or human, which limits the daily production rate. The miners did not have fixed target and timetable for everyday production. They mostly operate on an order basis, i.e. they operate when a customer places an order, hence their annual production varied from one year to another. In 2016, the annual production of sandstone was reported to be about 50 tonnes. Since the annual production at times could not meet the demand, South Africa imports sandstone from the neighboring countries such as Lesotho.

The work rate of these miners depend on size of the order the mining company receives. They would then work every day for 8 hours until the order quantity has been reached. In other normal days when there is no order, they might not even work. The inconsistent workload and timetable, and the lack of data keeping makes it difficult to evaluate the productivity of the artisanal sandstone mining and the

miners. In the warehouse, most of the sandstone blocks are processed using electrical cutting machine, however hammer and chisel are also used during processing to fine-tune sandstone products.

Technology

The miners use opencast mines to extract sandstone using traditional tools. They use hammer and chisels to break blocks of sandstone from its deposit. Such a use of traditional tools for mining is the main reason behind higher time consumption, lesser production, and even causes some health problems to the miners. Some technological intervention or mechanization is required to lessen the intensity of labor input and increase the productivity, for instance use of solar energy triggered microwave energy to replace traditional tools (Philip, 2006). The mechanization of extraction process will also help lower the overburden or waste generated, which currently stands at 30% with traditional method of extraction.

Energy and Environment

Artisanal sandstone mining mainly uses two major sources of energy: (i) combustion of diesel fuel in trucks during transportation of sandstone blocks from mining site to the warehouse, and (ii) coal generated electricity during sandstone processing. The total energy input of about 8000 GJ was required to produce 50 tonnes of sandstone, in which diesel fuel accounted for the majority (96%) of the energy input (Table 1). This energy input resulted in the emissions of 658 kg of carbon dioxide (CO_2) (Table 2).

Table 1: Major energy inputs required for the production of 50 tonnes of sandstone

Input	Amount Used	Energy Conversion	Energy (GJ)
Electricity	74958 kWh	3.6 MJ/kWh	270
Diesel	216000 L	35.9 MJ/L	7733
Total			8003

Table 2: Air emissions resulting from the production of 50 tonnes of sandstone

Input	Emission Factor	Emissions (kg CO_2)
Electricity	1.01 kg CO_2/kWh ()	75
Diesel	2.67 kg CO_2/ (EPA, 2005)	583
Total		658

During extraction phase, no equipment or instruments requiring electricity or fossil fuels are used, hence there is no emissions associated with this phase. However, there are some visible environmental challenge such as the acoustic and aesthetic impact on landscapes because large blocks of stones are directly extracted from quarries. The miners usually try to fill up holes with overburden created during mining activities. Poor disposal practice may have negative impact on the environment even years after mine closure. This phase may also influence the vegetation, animal life, and quality of ground and surface water.

Social and Health

The mines have been operating since last 10 to 15 years, and employ 5 to 7 full time contract workers. If they require additional workforce to meet high demands from customers, they hire other independent miners. The industry is being carried forward mostly by old employees because young people are less attracted towards sandstone mining, mainly. The hardship, lack of use of modern technology, and low return are major reasons limiting the involvement of youth in artisanal sandstone mining.

Musculoskeletal problem is one of the major health issues associated with artisanal sandstone mining, 8 out of 10 miners reported to suffer from musculoskeletal problems. The intensive use of human labor to separate and extract heavy blocks of sandstone has inflicted back and muscle pain to most of the miners. Skin infection and respiratory problems due to extended exposure to dust are other major health issues, 5 out of 10 miners reported to experience skin infection and 7 out of 10 reported to have respiratory problems. Minor injuries occur occasionally due to lack of protective gears such as helmet and gloves. Furthermore, some miners also reported of noise issues.

Policy

According to the White Paper on South African Minerals and Mining Policy, the government intends to encourage and facilitate the sustainable development of small-scale mining to ensure the optimal exploitation of small mineral deposits and to enable the sector to make a positive contribution to the national, provincial and local economy (DoME, 1998). The ASM sector is regulated by Mineral and Petroleum Resources and Development Act of 2002, the Health and Safety Act of 1996 and the National Environmental Management Act of 1998, which provide standard guidelines regarding mining practices, miners' safety and environmental management practices. In most part, however, ASM do not adhere to these regulations and guidelines and find them burdensome or not representative of their particular situation (Dreschler, 2001). The Department of Minerals and Energy (DME) initiated the development of a National Small-Scale Mining Development Framework whose objectives are to assist small-scale miners regarding the necessary and compulsory regulatory and administrative procedures, reserve determination, business plans and mining methods (Heath et al., 2004).

CONCLUSION

Artisanal mining sector plays a vital role in the economic growth of local community. However, the sector is often informal or not well organized, hence production capacity from the artisanal mining is quite low. Due to the traditional method used in the mining of sandstone, it is labor intensive. Furthermore, very few youngsters are interested in learning the traditional skill of artisanal sandstone mining, leaving only the older miners to extract the sandstone. The major visible environmental impact is the visual aesthetic. Miners mostly reported musculoskeletal, respiratory and skin infection issues. Mechanization and technological intervention will enable artisanal mining to be less labor intensive and lower associated health risks.

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