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The mining sector of Guyana has emerged since the 1990's as the leading source for economic growth surpassing sugar. Guyana which is rich in non renewable resources including diamond, gold, bauxite, manganese, copper, uranium and other rare earth metals has used these resources to lead its foreign exchange and total exports. In 2015 Gold was recorded as the leading economic sector with a resounding 42.8 percent of overall exports in Guyana (Wenner, 2017). In order to effectively benefit from our resources, it is important to adopt more efficient and environmentally friendly technologies that are financially feasible and will shift us into the modern era.

When the Omai Gold Mines closed in 2005, the industry was dominated with Small and medium scale miners which sustained the industry. However, these miners were constrained with lack of finance. They also had challenges since they were forced to comply with stringent regulations against deforestation contained in the Memorandum of Understanding (MoU) between the Government of Guyana and the Kingdom of Norway and the Low Carbon Development Strategy. They were also faced with financing environmentally friendly technologies and practices due to the impending ban on the use of mercury (GGMC, 2012).

With the knowledge of the harmful impacts of mercury on the environment it is important for the miners in general to commit to new mercury free technologies that are both financially feasible and promotes a healthy environment. For example, Jigs, Cones, Spirals, Centrifugal concentrator and Knelson concentrator which are proven to offer more advantages.

Jigs hydraulic and mechanic are both simple, easy to setup with a low cost of investment. They are safe and economical which makes them easy to maintain. Although they may have some drawbacks, in order to keep them in prime it is important to periodically lubricate, check filters and seals regularly, hence this promotes longevity (Gillespie, 2018).

Shaking Table continuously discharges product, its relatively low in cost with high flexibility and operation requires minimal supervision. Using the shaking tables allows small- medium scale miners to benefit from high safety conditions and it is possible to be manufactured in developing countries for example Guyana (Gillespie, 2018).

Spiral concentrators is simple to operate with no moving parts, requires no power and is very affordable (Mine Engineer, 2015).

Studies conducted by a staff of GGMC revealed that Knelson Concentrator is a mercury free technology that can be used by large scale miners (Wenner, 2017). Knelson concentrator can easily recover extremely fine free gold more efficiently than other devices. Being the first

fluidized centrifuges they have a higher availability in the industry with a longer lifespan. Knelson concentrators are leading others with its durable and cheaper to operate machinery and a proven track record of over 40 years in the world market (GCA, 2016).

In development of cleaner technologies, it is important to first tackle the socio-environmental risks of mining and implement technologies and techniques that improve waste management and pollution. For example, some technological improvements include reduction of natural capital losses which fosters maximization of production in an area of disturbance, improved compliance of environmental standards, highly efficient environmentally friendly equipment and improved control systems. Together these technologies are destined to address environmental problems (Hilson, 2000).

Cleaner mining practices and technologies that tackle water pollution have seen great efficiency in relation to treating chemicals, heavy metals, sediments and pH discharges. Developing new techniques that involve water reusing by neutralization and bioremediation will reduce loss of marine life and thus lessening its impact on wildlife. It is important to ensure these technologies facilitate re-vegetation and contribute to the reduction of negative mining activities by large and small scale miners (Masson, Walter, Priester, 2013). In order to reduce environmental impacts of mining it is important to consider the operational optimization initiatives, end-of-pipe technology investments and integration of technology in optimized mining operations. These measures have a limited impact of the environment and often least expensive for mining companies. However, end pipe technologies appear to be costly and focuses on treating the by-products of mining operations. This as a whole contributes to reducing the environmental impact only to a limited extent. the operational effectiveness of the industry and the impact on the environment is solely depend on the availability of adequate technology. The environmental threats from mining has repercussions ranging from public and private related to influences of political, legal and regulatory frameworks and mine operation practices (Pasha, Wenner, Clarke, 2017). The structure in the mining sector is inseparable from the environmental impact of mining. The relative cost of introducing environmentally friendly technology is higher for small and medium scale miners than for large scale companies (Pasha, et.al., 2017).

In the low carbon development strategy mining issues were not addressed although the country's initiative is to preserve Guyana's forest which is the "lungs of the world." However, due to mining's extensive contribution to the employment and socio-economic development it is not required under the LCDS to be ceased. There is no guided sector-specific policy in the mining industry. However, there are several laws and regulations that have evolved over the years that are focused on: ownership and authority over mineral resources; regulation of labor, claims and capital, Amerindian rights and environmental impact; revenue and other economic considerations; and dispute resolution (Mars, 1998)

The industry has a major shortcoming with the absence of a defined policy and the robustness of the legal framework (Thomas, 2009). However, a mining policy will be a necessity if

international practices are to be observed since the legislation governing the sector cannot substitute for a policy (Thomas, 2009).

Advances in the mining technologies will aid in greater productivity, efficiency and profitability which is destined to modernize the entire mining industry for the present and future generations. Small and large scale miners will be able to:

1. Produce higher yields

New technologies aid in the discovery and accurate quantifying of deposits and systems capable of real time analysis to increase efficiency and profitability (Alaska Structures, 2019). Digitization gives operators and technicians access to important information at their fingertips enhancing decision making and performance efficiency on the mining site (Schneider Electric, 2018).

2. Reduce cost of exploration

The cost can be reduced for expensive trial and errors since the data collected from machinery and monitoring devices are used to analyzed and hence determine optimum operational scenario. The efficient operations are faster and maximizes yield and production. These new technologies in drilling, geological science and geochemical methods are destined to improve the effectiveness of mineral exploration for large and small scale miners (National Academic Press, 2002).

3. Prospect and analyze mining resources

With the use of mining technologies, engineers are able to schedule the operations to the finest details are planned out step by step to maximize the benefits of the underground ores (National Academic Press, 2002). Technologies such as Geographic Information Systems (GIS) and geo-referencing tracking devices are used to monitor miners where the environmental risks are higher (Pasha, et.al., 2017).

4. Data driven decisions

Information collected in the field is now revolutionized to help miners locate mineral veins, determine risks to workers and streamline operations. Using the Internet of Things, data such as water pressure, temperature and concentration of gases are easily managed to increase efficiency, improve safety and increase sustainability of the operation (TechNexus, 2017).

5. Connecting information through the cloud

Cloud technology would allow employees to access information whenever they need it through their phones. This certainly will produce improved growth, better cost-efficiencies and more control for both small and large scale miners (Mining Safety, 2019).

In order for the Caribbean as a whole to adapt more environmentally friendly and efficient technology it is important to consider granting concessions, cluster and equipment sharing or even mining cooperatives. This allows small and medium scale operators to share expensive technologies. However, if the dominance of small and medium scale miners continues this poses serious environmental, social and health challenges (Pasha, et.al., 2017).

It is important for the Government of Guyana to consider reviewing the mineral revenue as tool that can foster the growth of the low carbon economy to improve decision making in land use design and technical inter-agency integration. This also will address the impacts of small and medium scale operations. The government of Guyana should pursue implementing more stringent monitoring practices to meet the international mining industry standards. Finally implementing proper framework for land use approaches before releasing for mining purposes. It is important to invest in clean technologies that will alleviate the impact of tailings on the environment and foster land re-vegetation, reduce energy consumption and screen oversize gravel. Recovering used land to use for alternation income generation within Amerindian communities is also a practical measure that can be considered to improve the efficiency of mining.

Developing new technologies not only leads to reduced production cost and enhanced quality of existing mineral commodities but it also reduces the environmental impacts of mining. In the long run both producers and consumers are likely to benefit greatly from these technologies. Thus reducing the negative environmental impacts and improve worker safety (Pasha, et.al., 2017).

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