

Sustainable Supply Chain Concerns in Diamond Industries

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Abstract

Green Supply Chain Management (GSCM) is one of the major areas of concern for industries. All the sectors are mostly aiming on the “GREENING” things. In this aspect, this study focuses on detecting various parameters associated with GSCM practices in Diamond mining industries globally. In this context, diamond mining can be viewed as an important activity for providing raw materials needed to produce essentials items for the growth and development of the society. The severity of past mining disasters and the casualties associated with them have raised the public's perception of mining as being a high-risk activity not only for the public's and workers' health but also for the environment. In this work, a several parameters have been identified from literature which relates to sustainable supply chain concerns in diamond industry.

Keywords

Green Supply Chain Management, Dimond Industries, Environment Concern, Sustainable Concerns

1. INTRODUCTION

Mined materials play a great role in the growth and development of modern civilized society (Muduli & Barve, 2015), technological advancements and progress to satisfy growing demand arising from increased levels of consumption creates large accumulations of waste on the environment and faster depletion of non-renewable resources. Governments of various countries have enacted laws and regulations to address the growing environmental issues. In response to these laws and regulations most of the companies have switched to the implementation of GSCM (Barve & Muduli, 2013). Diamond mining is a labor-intensive activity, requiring a large workforce of skilled workers often deployed in remote environments, so the concern is clear that workers' safety and maintaining the environment health is big task. For environment's heath we should focus on biodiversity conservation, reduction of greenhouse gasses and reduction of pollution, land use and waste, with this we should take into account workers concerns which includes salaries and benefits, workplace safety, gender wage gap, proper overtime pay, reduction in insufficient income, forced labor and child labor.

Diamond mining is a complex, requiring energy and resources, generating potential impacts to the natural environment. But Diamond Producers Association (DPA) members create environmental benefits through investments in conservation and rehabilitation works in the regions surrounding the mines which enhance and protect natural ecosystems. The environmental sustainability of the diamond sector is dependent on the degree to which environmental risks are managed, whilst maximizing benefits to natural landscapes (Lord, et al., 2016).

Diamond has been the most valuable among gems for more than 2,000 years. Diamond occurs in two types of deposits primarily in igneous rocks of basic or ultrabasic composition and in alluvial deposits derived from the

primary sources. Its composition is pure carbon and has cubic crystal system and common form octahedron. In addition, diamond exhibits highest thermal conductivity amongst minerals and has high electrical resistivity making it suitable for application in semiconductors. The prices of gem diamonds depend upon their rarity, weight, quality, shape and flawlessness. But at the same time, cumulative effect of the diamond mining activities like, drilling, blasting, crushing and material transportation, produces huge noise and vibrations in the mining area leading to hearing loss and many other health related problems and loss of performance. In the process of removing desired mineral material, the original vegetation is inevitably destroyed, and soil is lost or buried by waste (Singh, 2009).

To address these issues, this work is conducted to explore current challenges faced in implementation of green practices in Indian diamond mining supply chains. It is essential to maintain an equilibrium between diamond extraction on the one hand and the restoration of the environment on the other.

2. LITERATURE REVIEW

This section categorizes literature on GSCM and its components:

2.1. Green Supply Chain Management

The term ‘green’ has been used in literature in conjunction with various activities such as green design, green purchasing, green packaging and green supply chain management, those encompass concern for energy efficiency, environment, water conservation, use of recyclable products and renewable energy (Mudgal, et al., 2010). GSCM concept has many variations over the years. A research work by Zhu and Sarkis (2004) on China’s manufacturing sector, identified internal environmental management, green purchasing, customer cooperation with environmental concerns, investment recovery, and eco-design as various dimensions of GSCM practices. Hence, GSCM that has been designed not only to improve environmental performance of the individual organization but also that of the entire supply chain is gaining importance. Material resources are not infinite; hence, mining operations that result in the depletion of these material resources are unsustainable. According to F.Mikesell (1994), sustainable development in the mining sector can be practiced by annually saving and investing the revenue that mining generates in activities that will be available to multiple future generations. So, companies have started working on this.

Companies that adopt a pro-environment policy will see numerous positive results, both tangible and intangible. Early adoption of environmental strategies and green supply chain initiatives will Mitigate business risks, by differentiating themselves from competitors, transforming their companies into industry leaders, building credibility with stakeholders and attracting investors. (Bhattacharjee, 2015) Motivate better performing suppliers, become preferred vendors in green supply chain and attract consumers in the rapidly-growing green marketplace. Preserve business continuity, by attracting (the interest of) top job candidates, enhancing employee satisfaction and enhancing market access and degrees of business strategy freedom. Create significant competitive advantage by creating brand distinction and recognition (Bhattacharjee, 2015). Green supply chain includes various section as defined earlier i.e. environment’s health, workers’ concern and economic growth, which are discussed below.

2.2. Environment’s Concerns

Environment’s health includes biodiversity conservation, reduction of greenhouse gasses and reduction of pollution, land use and waste. Following table (Table 1) tells us about the Environmental Indicators which help us in maintaining environment’s health.

TABLE 1 (*Environmental Indicators*)

<i>Biodiversity Conservation</i>	Area of natural landscape protected from development or conversion to alternative uses.
<i>Air, Land and Water Pollution</i>	Direct and indirect (via fuel combustion) emissions of hazardous chemicals and heavy metals to air, land and water.
<i>Climate Change</i>	Direct and indirect emissions of greenhouse gasses contributing to climate change.
<i>Waste</i>	Quantity of industrial wastes disposed via landfill, recycling or

Land Use

incineration, and waste rock produced.
Use of natural land by mine sites and support facilities.

Now we will discuss the above-mentioned parameters in details that how they will help in getting a green environment for better implementation of GSCM.

- **Biodiversity Conservation**

Biodiversity conservation programs operated by DPA members protected a total of 263,626 hectares of natural land in Australia, Botswana, Canada, Russia, South Africa and Tanzania. This includes the ALROSA Yakutia Diamonds Live National Park and The Diamond Route, owned and managed by De Beers Group, a network of eight conservation sites spanning over 200,000 hectares of habitat in South Africa and Botswana (De Beers Group, 2018). Total land conserved by DPA members is equivalent to approximately three times the land used for mining. Land reclamation projects are approved in advance by local government and adhere to relevant environmental standards. (Lord, et al., 2016)

- **Reduction of Greenhouse Gasses**

For the DPA members, reducing greenhouse gas emissions is the major priority. Total greenhouse gas emissions per polished carat was estimated as 160 kg CO₂ per polished carat (equivalent to the emissions from driving 391 miles) or 56 kg CO₂ per rough carat (equivalent to the emissions from driving 137 miles) across the DPA members (EPA, 2019). This impact is driven by the use of fossil fuels in vehicles, equipment and machinery (42%) and in the generation and use of electricity (58%) (Lord, et al., 2016). The remote location of the DPA member mines present challenges in reducing fossil fuel use and greenhouse gas emissions, however DPA members have adopted renewable energy to offset some of their fossil fuel energy needs and have programs to reduce energy usage.

- **Reduction of Pollution, Land Use and Waste**

The majority of waste produced in diamond mining is waste rock (4,350 Kg per polished carat). This waste material is disposed of on site and is eventually reclaimed as part of the landscape during the mine closure and rehabilitation process. The DPA members produced approximately 1.86 Kg per polished carat of industrial waste and 26% by weight, or 0.49 Kg per polished carat, was recycled in 2016 (Lord, et al., 2016).

2.3. Social Concerns

Workers concerns includes salaries and benefits, workplace safety, gender wage gap, proper overtime pay, reduction in insufficient income, forced labor and child labor. Which are discussed in detail below:

- **Salaries, Benefits and Proper Overtime Pay**

The direct and indirect benefits of salaries and wages paid to employees should be significant. This includes the payment of salaries and in-kind benefits such as housing, meals and transport, and the economic multiplier effects of the spending of wages in the economy. Payment of wages to workers living in the local community helps to stimulate spending and demand with local businesses and contributes to the growth of the local economy – this is known as an economic multiplier effect.

- **Reduction in Forced Labor and Child Labor**

Each company has established codes of conduct and auditing procedures in place to prevent these issues. The International Labor Organization (ILO) defines child labor as work undertaken by children that is mentally, physically, socially or morally dangerous and harmful to children, and interferes with their schooling (Organisation, 2018). The ILO defines forced labor as situations in which persons are coerced to work through the use of violence, intimidation, accumulated debt, retention of identity papers and other means (Organisation, 2018).

- **Gender Wage Gap**
In socioeconomic analysis the gender wage gap indicator represents the difference between the average remuneration of men and women across all roles. This gap can be explained in part by differences in education level, qualification, work experience, occupational category or hours worked, with the remainder attributed to conscious or unconscious bias. The presence of a gender pay gap does not necessarily imply a difference in pay between male and female workers in the same role, but rather a difference in the average wages paid to male and female workers across the workforce (Lord, et al., 2016).
- **Workplace Safety**
Workplace safety refers to the working environment at a company and encompasses all factors that impact the safety, health, and well-being of employees. This can include environmental hazards, unsafe working conditions or processes, drug and alcohol abuse, and workplace violence. Workplace safety is monitored by the Occupational Safety and Health Administration (OSHA) in Singapore. OSHA has three stated goals that serve as the cornerstones of its policies and regulations: 1) Improve the safety and health for all workers, as evidenced by fewer hazards, reduced exposures, and fewer injuries, illnesses, and fatalities; 2) Change workplace culture to increase employer and worker awareness of, commitment to, and involvement in safety and health; 3) Secure public confidence through excellence in the development and delivery of OSHA's programs and services (Evaluations, n.d.).

2.4. Economical concerns

As a high value natural resource, the production of diamonds represents an important contributor to the economies of many producing nations. Various parameters associated with it are as follows:

- **Local Purchasing**
Local purchasing of goods and services on mine sites, along with the multiplier effects on local economies, represent the most significant economic benefit. In this work it is surveyed that local purchasing as an important lever to support the economic development of the regions in which they operate and to develop an effective eco-system in which to operate their mines over several decades. Many have internal targets to maximize locally purchased share of goods and services to support the development of local businesses. Local purchasing not only supports businesses in the local region through demand for goods and services, but also has an economic multiplier effect on the broader local economy. As the incomes of direct suppliers increase, additional spending on goods and services is stimulated creating a multiplier effect that propagates throughout the economy. For example, increased spending in construction to build new infrastructure stimulates additional spending in those sectors that supply the construction project both directly and indirectly, such as raw material producers and engineering services (Lord, et al., 2016).
- **Awareness Programs**
This includes programs targeting the following areas, Healthcare and health promotion programs, such as the operation of hospitals and the provision of health screening services to employees. Training and education programs, including scholarships, apprenticeships and professional education initiatives. Local economic development initiatives to support the growth of small to medium enterprises, resulting in increased local employment. Charitable contributions to a range of third-party organizations and direct spending on social programs. Spending on conservation and biodiversity preservation initiatives.
- **Infrastructure Investment**
Continue to maintain and enhance efforts to procure local goods and services and to support the growth and development of local industry outside of the mining sector (Rick Lord et al. 2016). Many enterprises mistakenly begin implementation immediately following an initial environmental diagnosis without critically reviewing objectives and policies (Hale, 1995). Strategic planning is imperative, as it provides a framework for proactive decision-making to

evaluate performance continuously and also assess what could go wrong, determine significant risks and implement strategies to deal with those risks (Mudgal et al. 2010).

3. CONCLUSION

It can be observed that in future there will be big concern on sustainable issues of supply chains instead of the profitable supply chains. Therefore, to sustain in long run manufacturing enterprises need to re configure their strategies rapidly in anticipation to the changing opportunities and requirements towards sustainable growth. Growing attention towards environmental issues at both national and international levels is putting pressure on organizations to develop strategies that will integrate environmental concerns with their business strategies. Further, diamond mining industries can be placed at one of the extreme ends of the supply chain for being supplier of raw materials. For this, environmental improvement efforts of the mining industries will definitely reduce environmental degradation effect of diamond supply chain. In this regard this research assumes its importance by identifying potential sustainable concerns in diamond mining industries and their interdependencies.

This research can be used for further analysis of these factors and their dependency and driving power by using MICMAC and other tools. Also, a systematic model of these factors can be developed using Interpretive structural modelling (ISM) technique, this model will give a perfect idea about the factors arranged in a proper way. Structural equation modeling (SEM) have the ability to validate an already developed model but unable to develop the initial model. ISM and SEM are complementary in nature, therefore, in future SEM can be used to test the validity of the developed model, through ISM.

About Authors:

Dr Akhilesh Barve is working as associate professor in the Maulana Azad National Institute of Technology Bhopal. He has worked as assistant professor in School of Mechanical Sciences, Indian Institute of Technology Bhubaneswar, India from 2010 to 2018. He obtained his M.Tech. And Ph.D. from Indian Institute of Technology Delhi, India. He has about seventeen years of academic and research experience. He has authored several research articles in a number of International Journals of repute including— Journal of Cleaner Production, Resource Policy, Resources, Conservation and Recycling, International Journal of Disaster Risk Reduction, Electronic Commerce, and Benchmarking: An International Journal. He has presented papers in many National and International Conferences. His area of research includes agile and lean issues of Supply chain, green supply chain management, and humanitarian logistics.

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References

- Barve, A., 2013. Modelling the challenges of green supply chain management practices in Indian mining industries. *Journal of Manufacturing Technology Management Vol. 24 No. 8, 2013.*
- Barve, A. & Muduli, K., 2013. Modelling the behavioural factors of green supply chain management implementation in mining industries in Indian scenario. *Asian J. Management Science and Applications.*
- Bhattacharjee, K., 2015. Green Supply Chain Management- Challenges and Opportunities. *Asian Journal of Technology & Management Research*, p. Vol. 05 – Issue: 01.
- Botta, S., C., C., Quaglino, A. & Torchia, A., 2009. Implementation of environmental management systems in the extraction of construction aggregates from gravel pit lakes. *American Journal of Environmental Sciences*, pp. Vol. 5, No. 4, pp.525–534..

- EPA, 2019. *Greenhouse Gas Equivalencies Calculator*, s.l.: s.n.
- Evaluations, W., n.d. *Ergonomics Singapore*, s.l.: s.n.
- FMikesell, R., 1994. Sustainable development and mineral resources. *Resources Policy*, pp. Pages 83-86,vol20 issue2.
- Hale, M., 1995. Training for environmental technologies and environmental management. *Journal of Cleaner Production*, pp. Vol. 3 Nos 1/2, pp. 19-23.
- Lord, R. et al., 2016. *The Socioeconomic and Environmental Impact of Large-Scale Diamond Mining*. ALROSA, De Beers Group, Dominion Diamond, Lucara Diamond, Murowa Diamonds, Petra Diamonds, and Rio Tinto: Trucost.
- Mudgal, R., Shankar, R., Talib, P. & Raj, T., 2010. Modeling the barriers of green supply chain practices: an Indian perspective. *Int. Journal of Logistics Systems and Management*, pp. Vol. 7 No. 1, pp. 81-107.
- Muduli, K. & Barve, A., 2015. Analysis of critical activities for GSCM implementation in mining supply chains in India using fuzzy analytical hierarchy process. *Int. J. Business Excellence*, Volume Vol. 8, No. 6, pp. 767-798.
- Organisation, I. L., 2018. *What is Child Labour?*, s.l.: s.n.
- Shen, L., Muduli, K. & Barve, A., 2015. Developing a sustainable development framework in the context of mining industries: AHP approach. *Resources Policy*, Volume 46, pp. 15-26.
- Singh, G., 2009. Environmental issues with best management practices of responsible mining. *paper presented at the 20th National Convention of Mining Engineers, Neyveli Local Centre, India.*
- Zhu, Q. & Sarkis, J., 2004. Relationships between operational practices and performance among early adopters of green supply chain management practices in Chinese manufacturing enterprises. *Journal of Operations Management*, pp. Vol. 22, pp. 265-289.