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Developing a sustainable development framework in the context of mining industries: AHP approach

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ABSTRACT

Although mining companies contribute positively to the social and economical components of sustainable development (SD) by generating employment and wealth, they still negatively contribute to the ecological component of SD. Therefore, mining companies are increasingly showing their inclination toward the adoption of green supply chain management (GSCM) in order to improve their ecological performance. With an extensive literature survey, various criteria and sub-criteria for improving the effectiveness of GSCM implementation are identified from the literature. Analytic hierarchy process (AHP) is used to evaluate the competitive priorities of these criteria, and interested organizations can use it as a procedural guidance for GSCM implementation. It has been found that mining companies have not given the "soft" factors of GSCM adequate attention. This study explores how the "appropriate implementation approach" and "continuous improvement" are the weaker areas of GSCM practice in the case of the Indian mining sector. Hence, mining industries need to focus on these weaker areas and bring necessary improvements to these areas in order to enhance their GSCM performance.

Introduction

Mining can be viewed as an important activity for the growth and development of society by providing raw materials needed to produce everyday items. Computers, televisions, large building structures, electricity, and automobiles would only be dreams without the extraction of minerals. Without a doubt, all technological and medical advancements today are virtually dependent on mining activities. If managed properly, the wealth derived from mining and oil extraction could provide substantial financial nourishment, thus raising the living standards of poverty-stricken populations and "kick-starting" a number of manufacturing and service sector industries in countries that are struggling to develop (Hilson, 2012). Recently, there has been a gradual convergence toward the view that mineral resource wealth can, and should, serve as an engine of growth and of poverty reduction (Aubynn, 2009). In responding to this, developing countries such as India are increasingly focusing on mining activities for the generation of wealth and employment.

India is ranked globally among the top 10 mineral-producing nations for having mineral deposits of 257.4 billion tons of coal, 25.2 billion tons of iron ore, and 3.3 billion tons of bauxite ore, which constitute 10%, 3%, and 4%, respectively, of the world's resources (Singh, 2009; Muduli et al., 2013). Besides these, 84 other minerals—including three fuel minerals, three atomic minerals, and 23 minor minerals—are produced in the country. As per Central statistical organization's estimation, the present value of mineral production in India is US$ 41790 million, which accounts for 2.5% of national gross domestic product (GDP), in contrast with US$ 13.5 million in 1947. Further, a strategy report from the Ministry of Mines, a branch of the Government of India (2011) estimates that unlocking the potential of the mining sector in India could add about US$ 210 billion to US$ 250 billion, or 6 to 7%, to the GDP and create 13 to 15 million jobs through direct and indirect contribution by 2025. Despite the tremendous support provided for the country's economic development, Indian mining industries are blamed for their adverse environmental and social consequences. One of the major issues is the generation of huge amounts of mine waste, which was 1,841 million tons during 2005–06 and is increasing continuously (Bhushan, 2008). In fact, this issue will be further intensified in coming years due to depletion of superior grades of ore (high metal content), leaving behind the inferior grades of ore to be extracted. The extraction of these inferior grades of ore involves a higher amount of energy consumption and the emission of more greenhouse gas (Norgate and Haque, 2010). Historically, the mining industry has had significant environmental impacts through poor waste management, the lack of or poor rehabilitation, an emphasis on production over environmental impacts, and so on (Mudd, 2007). Dust, noise, light, water, visual pollution, contaminated water, gas emissions including green house

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Table 1
Various sustainable development issues in the mining industries.

Economic issues	Environmental issues	Social issues
• Contribution to GDP and wealth creation • Reduction of costs • Increased sales and profits • Creation of new business opportunities • Distribution of revenues and wealth • Investments (capital, employees communities, pollution prevention and impacts, mine closure) • Shareholder value • Value added • Wide spread smuggling activity leading to losses to miners and government.	• Biodiversity loss • Emissions to air • Energy use • Global warming and other environmental Impacts • Land use, management and rehabilitation • Product toxicity • Resource use and availability • Solid waste • Water use, effluents and leachates (including acid mine drainage) • Noise pollution • Underground mine fires • Sedimentation of rivers and flooding in nearby villages • Reduction in rainfall rates. • Lock-up of large areas of fertile land under waste dump. • Mercury pollution. • Water scarcity	• Bribery and corruption • Creation of employment • Employee education and skills development • Equal opportunities and non-discrimination Health and safety • Human rights and business ethics • Labour/management relationship • Relationship with local communities • Stakeholder involvement • Wealth distribution • Displacement and loss of land • Destruction of traditional forms of livelihoods • Degradation of social customs • Occupational illness • Heavy vehicular traffic causing traffic jams and accidents.

Adopted from Azapagic, 2004; Ghose, 2003a, b; Ghose, 2009; Sharma et al., 2009; Chikkatur et al., 2009.

gases such as CH_4, CO_2, NO_x, and SO_x, a significant amount of waste generation, acid mine drainage, and altered geologic and fauna habitat conditions are some of the adverse environmental impacts of mining (Worrall et al., 2009). In addition, several mines face complications in the form of toxic chemical additives, such as cyanide, mercury, and surfactants, which are generally used during the concentration process of minerals (Hilson and Nayee, 2002). Similarly, occupational diseases such as pneumoconiosis, silicosis, asbestosis, and lung cancer; other health-related problems of local residents and employees due to environmental degradation; increased traffic volume; employee safety; and education are some of the social issues associated with mining (Azapagic, 2004). Besides these, accidents at mining sites are also an important issue. Eight mining disasters since 1973 have occurred in India, causing several causalities. In addition, major rivers in the country run the risk of disappearing, as most of the minerals in the country are found in the watershed and catchment areas of some major rivers (Bhushan, 2008). There have been several instances in the country when the local community had to face hardship because the mining operation changed the hydrological regime due to the breaching of groundwater (Bhushan, 2008). More mining-related issues are presented in Table 1. Recently, Indian mining industries witnessed strong public opposition to large projects such as Vedanta Aluminum, POSCO, and Kalinganagar steel projects in Odisha, India, as well as the stoppage of mining activities in Ballary iron ore mining in Karnataka, India, in 2011 (Mohanty and Goyal, 2012). This has raised concern for sustainable development in the Indian mining industry.

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 (Botta et al., 2009; Muduli et al., 2013). With growing awareness of the adverse impacts of mining, pressure on mining companies is increasing from society as well as from the government to reduce their environmental and social impacts. Mining companies in many cases have responded positively to such pressures in an effort to avoid slow-ups and shutdowns that occur frequently these days due to the underestimation of civil society's demands with regard to mining projects (Prno and Slocombe, 2012). Besides, mining companies have also begun to realize that their long-term success depends on their ability to align their economic interests with the values of society (Esteves, 2008). Consequently, the past decade, in particular, has seen an increasingly focused debate on the need to shift modern mining to a more sustainable framework, with many mining companies now reporting annually on their sustainability performance alongside their financial results (Mudd, 2010). Therefore, this research on sustainable development issues in the mining context is significant.

This research's objectives are as follows:

- To provide a framework for SD practices in mining industries
- To evaluate the relative importance of various criteria of GSCM
- To identify the extent of the impact of “soft” and “hard” components of GSCM criteria on its effectiveness in the Indian mining context.

Literature review

This section's objective is to summarize the literature on sustainable development in the mining context, the concept of GSCM, and GSCM's approach to achieving sustainable development in the mining industry. This section also summarizes literature on the criteria of cleaner production (CP), environmental management system (EMS), and total quality management (TQM) implementation.

Sustainable development

Many conceptualizations of SD exist in literature and sustainability has become an important part of any business (Govindan, 2013). In the context of mining, some of them are as follows:

SD is an integrated approach that recognizes the interdependence of three dimensions: the economic, the environmental, and the social performances of an organization (Chaabane et al., 2010).

SD is the integration of four spheres—economic development, social concerns, environmental pressures, and governance—that maximizes the contribution to the well-being of the current generation with an equitable distribution of costs and benefits without compromising the potential for satisfying the needs of multiple future generations (Fleury and Davies, 2012).