Role of Green Issues of Mining Supply Chain on Sustainable Development

K. Muduli and A. Barve

***Abstract*—All the activities involved in extraction, production and distribution contribute to environmental concerns. Traditional supply chains which were only acting as links that connect organization's inputs to its outputs have extended their operations to meet various challenges of lowering costs, ensuring timely deliveries, reducing adverse environmental impacts and waste disposal to satisfy regulators, customers and environmental advocacy societies. The economy is often given priority in policies and society and environment are neglected by the extractive industries. However these three factors are interconnected and balance between these three is essential to attain sustainable development. This study discusses the role of Green Supply Chain Management (GSCM) to achieve Sustainable Development, and identified various challenges faced during greening the mining supply chains.**

***Index Terms*—Challenges to environmental management program, Green supply chain management, Mining sector, Sustainable development.**

I. Introduction

Minerals are the basic raw materials which contribute to the growth of both industrialized and industrializing countries. Mining industry is an important source of employment and wealth creation. On the other hand, extractive operations invariably lead to a variety of environmental impacts, including depletion of non-renewable resources, disturbance of the landscape and above-average threats for health and safety of workers and citizens [1]. Mining operations are strategic and essential industrial activities which rely on the extraction, transportation and use of non renewable natural resources, causing several relevant interactions with the environment. Years of unregulated mining and mineral processing activities have not come without high environmental costs. Mining and allied industries are confronted with the challenge of having to control a wide range of potentially serious environmental problems such as acid mine drainage (AMD), chronic soil erosion, tailings contamination, and heavy metals overloading. Many mines face additional complications in the form of toxic chemical additives such as Mercury, Cyanide, and surfactants, which are often, used in mineral concentration processes [2]. Mining disasters with several casualties occurred in the past have raised the perception in the public opinion of mining being an high risk activity for environment, workers and public health. Pressure groups, including some nongovernmental organizations, are drawing international attention to environmental incidents and in several sites local communities protest against and impede or even shut down mines [3].

These issues coupled with issues like energy crisis, rising prices of oil have forced managers to think about sustainable development as their stakeholders, (customers, regulatory bodies, non-governmental organizations, and even their own employees) are increasingly demanding that organisations to address and manage the environmental and social issues which are impacted by their operations [4]. With the increasing environmental costs and growing consumer pressure for greener-products organisations are forced to search alternatives for sustainable development of their supply chains. Sustainable development has become a wide-ranging term which has its applications in almost every sector. This burning issue is setting guide lines for healthy living, doing business, generating products, extracting raw materials, recycling and reusing materials and reducing waste and energy thereby reducing use of virgin materials and saving them for our future generation.

To secure its continued 'social licence' to operate, the mining industry must respond to various sustainability challenges it faces by engaging its many different stakeholders and addressing their sustainability concerns [1]. Whereas economic and social development is in the interest of the mining industry, the third pillar of sustainable development, namely environmental protection appears to be of least importance. To address negative environmental impacts of their supply chain and gain competitive advantage almost every sector has been chosen green supply chain management (GSCM) practices as an important new innovation that helps organizations develop 'win- win' strategies that achieve profit and market share objectives by lowering their environmental risks and impacts while raising their ecological efficiency [5], and the mining industry is no exception. Unlike the traditional environmental management, the concept of green supply chain assumes full responsibility of a firm towards its products from the extraction or acquisition of raw materials up to final use and disposal of products[6].Green supply chain management refers to managing all phases of a product's life cycle, from the extraction of raw materials through the design, production, and distribution phases, to the use of the product by consumers and its disposal at the end of the product's life cycle, for greening the entire supply chain[7],[8].

This paper outlines various green issues in mining supply chains and their impact on attaining sustainable development.

II. Sustainable Development

Traditionally sustainable development concept focuses on

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economic issue, but only economic dimension is not sufficient condition for the overall sustainability of a corporation. A single-minded focus on economic sustainability can succeed in the short run. But in the long run sustainability also requires environment and social view [9].Sustainability can be achieved by balancing its three components. Each of these components is discussed below.

A. *Economic Perspective*

This component mainly focuses on the financial needs. Generally economic perspective is seen as the most important one and it is the basic motivation behind any organization. It can be argued that, without economic success, no supply chain will exist in long run.

B. *Social Perspective*

This component of sustainable development, focuses on the social needs of employees which include equity, healthcare, employee benefits, education, to name a few. Every organization has to pay attention to these needs of employees in order to achieve success. When employees' needs are not satisfied or not taken care of, the productivity of their work decreases. This has been explained by Maslow's hierarchy of needs [10], which is employed by most organizations [11]. As per Maslow's theory the higher levels remain latent until the lower level needs are satisfied [11], [12].

C. *Environmental Perspective*

Environmental perspective component focuses on one of the most important aspect in today's world, Environmental Hazards. It deals with protecting environment from the hazards caused by industrialization and other technological advancements. Humans are so busy focusing on their own needs and demands that they forget they are depleting resources and causing damage to the nature. This eventually will lead to catastrophic effects; a few of them are already evident like global warming, depletion of Green lands, degradation of ozone layer and so on [11].

Many authors have attempted to show the interrelationship between these components and its effect in achieving sustainability. Triple Bottom line [9], Nested Model [13] and Triple Bottom Line with 4 facets [14] are some of the examples.

The model Triple Bottom Line with 4 facets given by Carter and Rogers [14] demonstrates that fulfilling either one or two of the components of triple bottom line will not help achieve sustainability. For Instance integration of environmental performance with social performance will make the process a good one, similarly Environmental performance integrated with Economic performance will make it better and Economic performance integrated with Social performance will give similar results, but integration of all the three components will make the process the best or Sustainable.

Nested Model given by [13] suggests that economy is a subset of Society and society is a subset of environment. As human society depends on environment although in contrast the environment would continue without society [15]. The economy depends on society and the environment although society for many people did and still does (although under siege) exist without the economy.

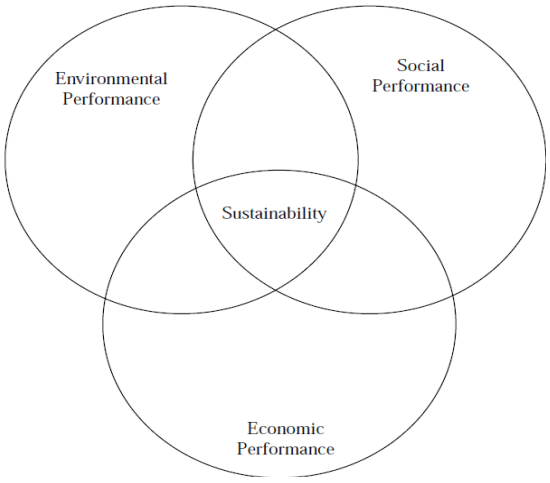

Fig. 1. Triple Bottom Line(TBL).

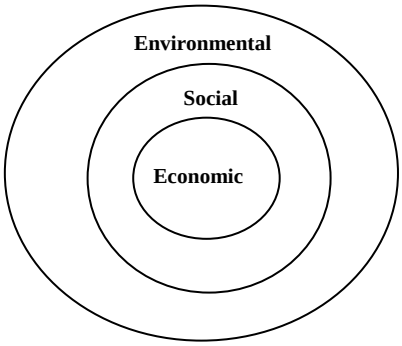

Fig. 2. Nested model.

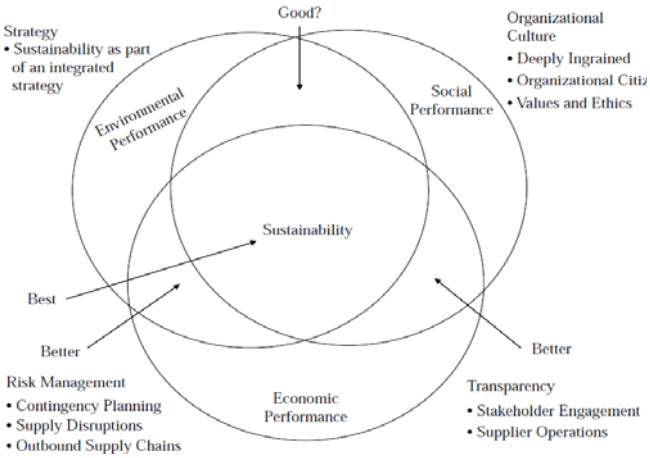

Fig. 3. TBL+ 4 Facets.

However the most well-adopted and most often quoted definition of sustainability is that of the Brundtland Commission (World Commission on Environment and Development, 1987, p. 8): "development that meets the needs of the present without compromising the ability of future generations to meet their needs" [14]. This implies future generations have rights over resources and current generation has a duty to include future generations' needs in its decision-making. However Brundtland Commission's definition is so far reaching, organizations often find it difficult to determine their individual roles within this broader, macro-economic perspective [14], [16]. Research on wider micro-economic applications of sustainability in the field of management, operations and engineering brought forward many conceptualizations of sustainability, focusing mostly on ecological perspective. However organizational

definitions of sustainability in the engineering literature have been more encompassing, and have explicitly incorporated the social, environmental, and economic dimensions of the macro-viewpoint by defining organizational sustainability as, "a wise balance among economic development, environmental stewardship, and social equity," [14],[17].

III. Mining in India

Minerals are the basic raw materials which contribute to the growth of both industrialized and industrializing countries; judicious utilization of mineral resources promotes the economic development of a nation and its people. India is rich with various mineral resources, which include fossil fuels, ferrous and non-ferrous ores and industrial minerals. Globally, India ranks among the top five players in terms of production of several important minerals. Since 1947, India's mining industry has shown rapid growth. In the preplan period prior to 1950, India produced 24 types of minerals with a total value of US$23 million [18]. Today, it produces 90 minerals, with a projected total value to touch over $30 billion (about Rs. 1, 27,662 crore) accounting for about 2.5% of the GDP in the next four years [19]. Public sector mines comprise 91 percent of the nation's total mineral value, even though 80 percent of mines are privately owned. By 1996-97, India had 3,488 mines. Of these, 563 were coal, 654 were metals and 2,271 were non-metals [18]. The growth in Indian mining industries due to suitable policy and investment climate supported by favourable market demand has intensified the adverse impacts on environment.

IV. Environmental Impact of Mining

Low investment capacity and poor working conditions, associated with mining industries enforces use of primitive extraction techniques and unskilled manpower, which ultimately leads to wasteful mining, poor mineral recovery, consumption of more energy, generation of mass mine waste, seasonal scarcity of ground water, drastic damage to landscapes, alterations to drainage patterns and a number of environmental threats including:

A. Air Pollution

Green house gases like Methane and Carbon Dioxide, released from mining activities, contribute towards global warming besides causing health hazards to the exposed population. Emission of harmful gases like Carbon Monoxide, Sulphur Dioxide and Oxides of Nitrogen cause severe air pollution and acid rain [19]. Smelter operations with inadequate safeguard have the potential to pollute the air with heavy metals, sulphur dioxide and other pollutants. Besides, dust produced from blasting operation in surface mines and from movements of heavy vehicle on haul roads also contribute to air pollution.

B. Water Quality

Drainage from surface and underground mines, wastewater from beneficiation and surface run-off are major sources of water pollution from mining sites. Other potential sources of water pollution include pollution from domestic and sewage effluents, sedimentation of river and other stored water bodies, leachates from wash-off from dumps, solid waste disposal sites, broken rocks, cyanide and other toxic chemicals waste release, salinity from mine fires, acid mine drainage etc.

C. Noise and Vibration

A cumulative effect of the 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.

D. Impact of Mining on Ecology

As a result of mining, significant areas of land are degraded and existing ecosystems are replaced by undesirable wastes. The mineral extraction process drastically alters the physical and biological nature of a mined area. Strip-mining, commonly practiced to recover coal reserves, destroys vegetation, causes extensive soil damage and destruction and alters microbial communities. In the process of removing desired mineral material, the original vegetation is inevitably destroyed and soil is lost or buried by waste [19].

V. Challenges to Green Management Practices in Mining Industries

Gracefully many possibilities to reduce the environmental burden of mining activities exist. For example; optimization of the environmental performance through good housekeeping and total quality management, appropriate end-of-pipe techniques, recycling of waste and non-renewable products, substitution of, or a ban on the use of environmentally unfriendly products, or by incremental and more radical technological innovations[20]. However implementation of these technologies faces lot of challenges. Following challenges from literature survey and expert opinion have been identified.

A. Resistance to Change and Adoption

Local people object to proposals for increased mechanization, contending that it would reduce employment opportunities at resident mines. Because operations are therefore highly rudimentary, unhealthy, unsafe and negligent towards environmental degradation prevailing throughout the area [21]. There is a fear among employees of getting obsolete by the adoption of new technologies, which drives them to offer resistance to changes. General resistance to change is often a barrier to new programs [16]. A chief barrier seen in implementation of GSCM is the resistance to change [22], [23] due to human nature

B. Insufficient Pressure from Societies

NGOs and environmental advocacy groups forces companies to seriously think about their environmental management programs [7]. Indian mining industries lack direct attacks from such societies. Unless there is a counterbalance on the conservation side there will be pressure to adopt measures that seek only short-term gains [24].

C. Ignorance Towards Sustainability Issues

Sustainability and corporate social responsibility are becoming ever more common as agenda items in boardrooms across the globe. Corporate social responsibility calls for sustainable development, which is a framework for companies and their management to transform their responsibility for environmental, economical and social behaviour into business practices [25]. Within industry, managers have often viewed social responsibility as just that – a responsibility – which did not necessarily yield financial rewards [4], [26]. In 2009, out of 1,289 sustainability reports submitted to Global Reporting Initiative(GRI) from separate companies only 57 (4.4%) coming from the mining community[27]. Indian small scale mines particularly the very small ones, normally do not bother about eco-friendly operations. They not only destroy inadvertently the vegetation and the trees, particularly at and near the area of mining operation, but also do not take any step to regenerate environmental status or create greeneries [28].

D. Poor Legislation

The Indian mining sector was closed to foreign investors till 1994, and there after steps were taken to liberalise in order to attract higher volumes of FDI in this sector. It is alleged that in the search for new sources of capital labour and raw materials, TNCs (transnational companies) relocate their firms where environmental regulations are lax [29]. A frequently changing regulatory climate of India, obstructs long-term environmental plans, and discourages a mine from implementing greener management practices. For smaller mines, which already have limited resources, from a business management and economics standpoint, rather than wasting time, energy, capital, and resources to re-establish proactive corporate environmental "position", it makes more sense to simply operate in line with the standard set by the environmental legislation, and to change operations only when necessary[30]. Corruption and a lack of political will also play its role in non-performance of these and related pollution control measures [31]. Enforcement is a key drawback with regulatory arrangements in the sector. It is better enforcement, rather than more regulations that can begin to remedy the ills plagauing the sector today [32].

E. Lack of Direct Incentives

In the minerals industry, regulatory costs cannot be passed on to consumers because international metal prices are determined in terminal auction markets and cannot be controlled by the producers. The policy of requiring firms to reduce pollution at source, which necessarily involves changing their production technology and organization, overlooks the possibility that firms might already be searching for new ways to improve metal recovery, reagent use, energy efficiency, water conservation, and so on as part of their corporate strategies to increase competitiveness[33]. ISO standards are increasingly proving to be an integral marketing tool in the manufacturing sector because of escalated demands for green consumerism , The management of a mining company, on the other hand, is largely unconcerned with ISO certification of sites because it does not provide anywhere near the competitive edge[2].

F. Financial Constraints

Study reveals that environmental management practices need high levels of funding. Specifically, some companies spend over 20% of their total revenue in adopting environmental measures, employee environmental training and appropriate equipment [34]. Changes to conventional technologies could make workers and managers obsolete, and would require investment by companies in training programs, an added difficulty for a firm with a limited budget [30]. High staff turnover needs frequent conduction of training programs increasing the amount of fund requirements.

G. Technical Barriers

Small-Scale mine owners of industrializing countries like India lack the technical or financial capabilities for proper exploitation, mining development, mineral extraction, or processing. They also often lack sufficient mechanical equipment and adequate maintenance facilities which reduces output per unit input and increases waste production [21]. Besides Many mines in India are either not aware of current version of technologies or fail to identify the areas where these advanced technologies could be utilized. And in the event that possibilities for the advanced technologies have been identified, at some of the mines, shortage of expertise is experienced. Unfortunately, international standards, which are designed generically and, hence, only provide general guidance, lend little in the way of methods to implement practical industry-specific environmental management practices [2]. Fixed location of the mineralized zone of interest imposes a constraint on all aspects of mining development including the method of mining, requirement for new infrastructure and services, and the suitability of waste management or, disposal methods [32].

H. Lack of Top Management Commitment

The extent of environmental management and investments mostly rely on the attitude of the top management towards the environmental issues [35].Top management in most of the mining companies is less concerned over environmental issues and reluctant to allocate adequate financial, technological and human resources to implement the green management practices. There is also an inevitable amount of hesitancy by top management towards implementation of green management practices as it involves huge amount of documentation work and a serious non-compliance uncovered during environmental auditing process might lead to social outcry or, even legal action[36].

I. Lack of Employee Commitment

Employee's commitment to change programs is crucial given that they actually execute implementation activities [37]. Mining companies do not have proper performance evaluation system, they also do not have proper rewarding scheme for the employees to motivate them to be held responsible for protecting the environment. The roles, responsibilities and authority of the staff are neither properly defined nor communicated to all organizational members which is important in obtaining commitment of the workforce for successfully carrying any business activities and the same is also a prerequisite for green supply chain

management[25]. This leads to confusion among staffs regarding their responsibilities and poor motivation towards environmental protection practices

J. Lack of Awareness

Poor awareness regarding environment among the politicians, citizens, and bureaucracy is compounded by the low levels of literacy and the poor mass media concern [24]. Regulators at all levels are severely limited by lack of adequate and usuable information as also clarity and definition on several aspects pertaining to mining operations. This creates the necessary gaps for illegal operations to function and flourish unchecked [32]. Another serious problem in this regard is the veil of secrecy maintained by the Government departments and the general non-availability of information on environmentally sensitive issues [31]. Workers and trade union leaders are generally not aware of occupational health problems. Managements also are unaware of opportunities for cost savings in the areas of waste reduction or elimination of pollution, energy efficiency and prevention and mitigation of accidents.

K. Inappropriate Approach to Implementation

Many enterprises mistakenly begin implementation immediately following an initial environmental diagnosis without critically reviewing objectives and policies [38]. Top management often ignores refining pertinent environmental objectives and actions, and conduction of multiple environmental reviews before implementing the environmental management practices. Indian mining sectors lack effective monitoring system, whose primary purpose is to assess the mine's actual environmental performance against the stated environmental policies, objectives and targets. Administrative delays, apathy and inadequate personnel training and lack of inter-departmental co-ordination during implementation prevent environmental protection and improvement. Short term focus is another contributing factor in failing to achieve the desired environmental culture [36].

VI. Discussion

Sustainable development of supply chains stretches the concept of traditional supply chain management to look at optimizing operations from a broader perspective, the entire production system and postproduction stewardship as opposed to just the production of a specific product. In doing so, the focus on environmental management and operations is moved from local optimization of environmental factors to consideration of the entire supply chain during the extraction, production, consumption, customer service and post-disposal disposition activities [39], which is in accordance with the philosophy of Green Supply Chain Management.

It is claimed that the way of operation of mining industries are not meant for long-term economic sustainability. Due to irresponsible operations in social and environmental segment, mining industries are losing trust in their organization and damaging their reputations and ultimately fail to attract investors which harm their investment potential. Relationship between environmental management and reduced corporate cost has been explained by many researchers. Environmental awareness programs and trainings, a part of GSCM practices, are keys to preventing costly environmental accidents. Integrating various Green supply chain activities into its operations , a mining operation puts itself in a better position to anticipate problems with waste, avoid unnecessary cleanup costs and regulatory fines, reduce its discharges of toxic effluent, avoid tailings pond spills and leaks, and minimize usage of raw materials[2]. For mines, such a shift can play a pivotal role in improving relations with regulatory bodies, community groups, and other external stakeholder parties, which often demand a strong corporate commitment to environmental issues. Interestingly, there is evidence that courts, regulatory agencies, enforcement groups, municipalities, lending institutions, and financial groups view activity that responds to EMS conformance requirements as an indication of diligence [2].

In the social segment, the industry is seeking to meet challenges regarding worker and community safety, poor working conditions and associated accidents coupled with various occupational health hazards, which are the causes of poor quality of work force, shortage of work force and reduced productivity. GSCM practices emphasizes on reduction of harmful gaseous emissions, reduction in waste generation and safe disposal of waste produced leading to reduction of environmental pollution and reduction of associated health hazards thus improving employee morale and productivity.

In other words by following GSCM practices mining companies are able to attract investors, reduce regulative fines and penalties and reduce wastage which in turn increases economic benefits. Similarly due to reduction in environmental degradation, environmental accidents and healthier working environment, GSCM practices help mining companies to obtain license to operate easily.

VII. Conclusion

Economic perspective is the basic motivation for any organization. Every organization wants to generate more and more profit. Consideration of only economic perspective may give good results in short run but for long run balance between Economic, Social and Environmental perspective is needed which will lead to sustainable development. This study identifies various challenges to the implementation of green management practices in Indian mining industries. Identification of potential barriers can help a manager develop strategies to minimize the impact of those barriers, which in turn will improve social and economic performance of the organisation leading to sustainable development. The barriers that have been identified and discussed earlier can help managers evaluate the degree to which these barriers are present in their organization. Furthermore, it is reasonable to consider that all barriers may not be equally applicable to each and every organization. Managers may also review the barrier that may be appropriate to their organization so that they can pay more attention to this as compared to others on the list. At present mines in India confronted by these barriers remain heavy polluters, or, at best, stagnant in terms of environmental performance. Regional governments must

play an expanded role in disseminating valuable information and technology to mines. Governments has also an important role to play in providing training opportunities and in ensuring that safety and health regulations are appropriate and are observed.

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