Empirical Investigation of the Barriers of Green Supply Chain Management (GSCM) Implementation in Indian Mining Industries

Kamalakanta Muduli, and Dr. Akhilesh Barve

Abstract—The present study aims to provide reliable and valid factors that hinder green supply chain management (GSCM) implementation in Indian mining industries. Four major barriers of GSCM were identified based on a thorough and detailed analysis of relevant literature. An instrument measuring these barriers was developed. To test the validity of the instrument data collected through a questionnaire survey from mining industries operating in Odisha was used. A total of 300 questionnaires were mailed out and 72 valid responses were received. Statistical tests imply that the four barriers, ‘information gap’, ‘lack of social concerns’, ‘poor legislation’ and ‘capacity constraints’ were valid. The validated GSCM barriers, in the present research can help organizations to identify the weaker areas in their organization needing improvement for effective GSCM implementation.

Keywords—Empirical Study, GSCM, Measurement, Mining Industry.

I. INTRODUCTION

MINERALS play an important role in the economic development of the country for being the basic raw materials in a large number of industries, including ceramics, construction, cosmetics, detergents, drugs, electronics, glass, metal, paint, paper and plastics. Nearly every item we use or encounter in our day to day lives is mined or contains mined products. Without the excavation of such materials things like computers, televisions, large building structures, electricity, and cars would not be possible. Virtually every technological and medical advance uses mined materials, without which millions would suffer. Though mining activities are responsible for technological advancement, economic development and employment generation, yet the environmental damages caused by them cannot be ignored. Acid mine drainage (AMD), chronic soil erosion, tailings contamination, heavy metals overloading, air and water pollution are some of the environmental impacts of mining[1], which are responsible for a large number diseases for the local residents, employees as well as for the nearby residents.

Gradually public awareness regarding mining environmental issues is growing. Consequently, pressure is mounting on mining industries to address their environmental impacts. Accordingly mining industries have started implementing GSCM practices that emphasizes on minimizing waste production as well as material and energy usage at each and every stage of a product’s life cycle starting 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 [2]. This study aims at finding and validating the barriers of GSCM implementation in Indian mining industries.

II. LITERATURE REVIEW

Quazi [3], identified eight factors that offer resistance to environmental management system implementation in companies operating in Singapore. Later, Walker et al., [2], in their study proposed five barriers to GSCM implementation. They categorized these barriers as internal and external barriers. Study by Mudgal et al. [4], in Indian manufacturing industries identified fifteen barriers to GSCM implementation. They developed a hierarchical ranking of these barriers using interpretive structural modeling(ISM). Similar kind of study by Luthara et al. [5] in Indian automobile industry, explored eleven barriers to GSCM implementation.

Review of literature shows that literature on GSCM implementation in mining industries is scarce. Moreover, there is not much empirical studies on GSCM barriers. In this regard this study by providing an empirical analysis of GSCM barriers can bridge the gap.

III. BARRIERS TO GSCM IMPLEMENTATION

Following barriers to GSCM implementation are identified based on literature survey and expert consultation.

A. Information Gap (IG)

Lack of awareness of managers either regarding advanced technologies or, appropriate areas of application of these technologies has been one of the major barriers of GSCM, as observed in case of Indian mining industries. Managers are often unaware of the fact that social and environmental responsibility can yield financial rewards in terms of waste reduction, improved energy and material efficiency, prevention...
and mitigation of costly environmental accidents etc. Besides, poor awareness among politicians, local residents and policy makers about mining environmental issues compounded by insufficient information regarding various mining issues develops gaps for illegal operations to function and flourish unchecked [6]. 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 [7]. Moreover, neither the workers nor the leaders of the trade unions have awareness regarding occupational health hazards related to the mining sector [8].

B. Lack of Social Concerns

Walker et al. [2], reviewed the literature and identified that pressure from various societies such as NGOs, environmental advocacy groups force companies to seriously think about their environmental management programs. But Indian mining industries face very little pressure from such communities; NGOs that take a special interest in mining environmental issues are very rare in India. As long as there is no counterbalance on the conservation side, any environmental management measure that are adopted will provide only short-term gains [8],[9]. Additionally, fear among employees of getting obsolete due to the adoption of new technologies drives them to offer resistance towards increased mechanization. Therefore activities in most of the Indian mining sites remain highly rudimentary and continue in unhealthy and unsafe manner.

C. Poor Legislation

Environmental policies and regulations keep on changing with the change of regulatory climates, which happens frequently in India. Accordingly, mining industries respond by adopting environmental strategies that are in line with compliance requirements, and change operations whenever there is a requirement, instead of establishing an environmental management system proactively. Corruption and a lack of political will also contribute significantly to the non-performance of the environmental and related pollution control measures [7]. 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 plaguing the sector today [6] Small scale mines are not subjected to regulation under mines act [10], and as much of small scale mining activities are carried out illegally, is thus difficult to monitor and control [7].

D. Capacity Constraints

Infrastructural, informational and manpower requirements of GSCM activities demand substantial amount of fund [4]. Accordingly, over one fifth of the total revenue invested by a significant number of organizations is devoted towards environmental training of their employees, securing equipments and adopting other environmental management measures [11]. 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 [10]. Besides, Studies point out that low investment capacity and poor working conditions of Indian mining industries constrains the firms to accumulate skilled human resources [12]. Administrative delays, apathy, poor quality of human resources, use of traditional primitive technologies and inadequate personnel training prevent environmental protection and improvement. Additionally, 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 [13].

IV. METHODOLOGY

A. Development of Survey Instrument

Extensive review of the relevant literature is conducted with a view to develop a tentative list of GSCM barriers. Expert consultation and input from researchers was used to validate the tentative list of GSCM barriers. A total of twenty elements were identified under four critical factors on the basis of literature review and consultation with experts from the industry, academics as well as government organizations like directorate of mines, Indian bureau of mines and state pollution control board.

B. Data Collection

Questionnaires were sent to mining companies operating in Odisha through email. Besides, some questionnaires are sent through post along with a self addressed stamped envelope. Most of the questionnaires were addressed to the environmental officers, and in case of absence of environmental department the questionnaires were sent either to the quality control officer or, to the project manager. In this process 300 questionnaires were sent to various mining industries. It was found that 72 responses were valid out of the 75 received responses. This represents a 24 percent response rate which we consider reasonable in this case as response rate for the study conducted by Wee and Quazi [14], on development and validation of critical factors of environmental management was 21.9 percent.

V. RESULT ANALYSIS

This section will summarize the methods followed for the evaluation of reliability and validity of the instrument.

A. Reliability

Reliability refers to the degree to which an experiment, test or any measuring procedure yields the same results on repeated trials [14],[15]. It is a statistical measure of the data reproducible capability of the survey instrument [16]. Reliability measurements of the items were conducted by internal consistency method using Cronbach’s alpha. Internal
consistency analysis was performed using reliability analysis option of SPSS software package for each item of the four critical factors separately. Cronbach’s alpha values for each item are listed in Table-I. Reliability coefficients (Cronbach’s alpha values) of 0.7 or higher are generally considered good [17],[18]. Accordingly, the four critical factors developed can be considered to be reliable.

### TABLE I

<table>
<thead>
<tr>
<th>Barriers</th>
<th>Initial values of Cronbach’s alpha</th>
<th>Total number of items</th>
<th>Items deleted</th>
<th>Final number of items</th>
<th>Final Values of Cronbach’s alpha</th>
</tr>
</thead>
<tbody>
<tr>
<td>Information Gap</td>
<td>0.669</td>
<td>5</td>
<td>3</td>
<td>4</td>
<td>0.803</td>
</tr>
<tr>
<td>Lack of Social Concerns</td>
<td>0.817</td>
<td>4</td>
<td>none</td>
<td>4</td>
<td>0.817</td>
</tr>
<tr>
<td>Poor Legislation</td>
<td>0.607</td>
<td>5</td>
<td>11</td>
<td>4</td>
<td>0.819</td>
</tr>
<tr>
<td>Capacity Constraints</td>
<td>0.739</td>
<td>6</td>
<td>19</td>
<td>5</td>
<td>0.838</td>
</tr>
</tbody>
</table>

### B. Item Analysis

Item analysis was developed by [17] to evaluate the assignment of items to scales by considering the correlation of each item with its scale. Correlations of item-score to scale-score are used to determine whether the items had been assigned appropriately to their respective scales or not [18]. Table-II shows correlation matrix for the four scales and their items. Items having values lower than 0.5 do not share enough variance with rest of the items in that scale, hence should be omitted [19]. It can be observed from the table that item3 of scale IG, item 2 of scale PL and item 5 of scale CC should be omitted from their scales. Reliability analysis was performed again after dropping the above items. A significant improvement in reliability scores were obtained after dropping the above mentioned items from their respective scales.

### TABLE II

<table>
<thead>
<tr>
<th>Scale /Item</th>
<th>IG</th>
<th>LSC</th>
<th>PL</th>
<th>CC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Item1</td>
<td>.832</td>
<td>.833</td>
<td>.667</td>
<td>.834</td>
</tr>
<tr>
<td>Item2</td>
<td>.729</td>
<td>.909</td>
<td>.251</td>
<td>.751</td>
</tr>
<tr>
<td>Item3</td>
<td>.214</td>
<td>.686</td>
<td>.773</td>
<td>.851</td>
</tr>
<tr>
<td>Item4</td>
<td>.749</td>
<td>.805</td>
<td>.833</td>
<td>.659</td>
</tr>
<tr>
<td>Item5</td>
<td>.722</td>
<td>.706</td>
<td>.217</td>
<td>.672</td>
</tr>
<tr>
<td>Item6</td>
<td></td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

### C. Validity

Validity is defined as the extent to which any measuring instrument measures what it is intended to measure [18]. Content validity, criterion-related validity and construct validity are the three most popular methods used for the evaluation of the scales [15].

### D. Content Validity

A measure has content validity if there is general agreement that the measure has items that covers all aspects of the variable being measured [14]. It cannot be evaluated numerically, it is a subjective measure of how appropriate the items seem to various reviewers who have some knowledge of the subjective-matter [18]. The content validity of our questionnaire is based on extensive survey of relevant literature as well as detailed evaluation by six experts comprising of two academicians, three administrators from government organizations and a senior manager from a mining company. In this context we assume the instrument developed has content validity

### E. Criterion Validity

Criterion-related validity, also called predictivity validity is concerned with the extent to which a measuring instrument is related to an independent measure of relevant criterion [20],[21]. No criterions were designed in this study that related to an independent measure of relevant criterion. Exploratory factor analysis (EFA) and confirmatory factor analysis (CFA) are two forms of factor analysis. In our study EFA is used as links between the observed and latent variables are unknown or uncertain. EFA helps to assess the unidimensionality of factors by identifying whether selected items cluster on one or, more than one factor [18]. Barlett’s test of sphericity and Kaiser-Meyer-Olkin(KMO) measure of sampling adequacy were employed to test the appropriateness of the data for factor analysis [21],[25], [26].

### F. Construct Validity

Construct validity measures the extent to which the items in a scale all measure the same construct [18]. Factor analysis is used to identify items, which should be included in a consistent measuring instrument [22],[14]. It addresses the problem of analyzing the relationships among a large number of variables and then explaining these variables in terms of their common underlying dimensions (factors) [18]. Factor analysis is primarily a data reduction technique, based upon principal component analysis with varimax rotation and intends to identify the items under each critical factor [23],[24]. Exploratory factor analysis (EFA) and confirmatory factor analysis (CFA) are two forms of factor analysis. In our study EFA is used as links between the observed and latent variables are unknown or uncertain. EFA helps to assess the unidimensionality of factors by identifying whether selected items cluster on one or, more than one factor [18]. Barlett’s test of sphericity and Kaiser-Meyer-Olkin(KMO) measure of sampling adequacy were employed to test the appropriateness of the data for factor analysis [21],[25], [26].

### G. Barlett’s test of Sphericity

Overall significance of the correlation matrix is assessed using Barlett’s test. If the value of test statistic for sphericity is large and associated significance level is small, it can be concluded that the variables are correlated(Wee and Quazi, 2005). The Barlett’s test of sphericity in this study demonstrated high value for all the four critical factors(p<=0.000).

### H. KMO measure of Sampling Adequacy

KMO measure of sampling adequacy were evaluated for testing the suitability of the data for factor analysis [24],[27]. The test results show KMO values for the four factors are 0.772, 0.746, 0.757 and 0.787, which are much above the
suggested minimum standard of 0.5 required for running factor analysis [14],[28],[29]

I. Factor Analysis

Factor analysis on items under each critical factor was performed. Total number analysis conducted were four as there are four critical factors. The number of factors to be extracted in each analysis was determined by the Eigen value over 1[14]. Next factor loadings of each item on their respective factors are analyzed. It represents the correlation between the variable and its respective [14]. Factor loading values equal to or, greater than 0.6 are considered to be high and the values of 0.3 or, above are considered to be moderately high[24]. Table-III shows factor loading values of the items under each of the barriers satisfies the minimum criteria. It can also be observed from Table-III, that the factors are unifactorial and variance explained by each other in the unifactoriality test is more than 60 percent. This indicates the construct validity of the instrument.

### Table III

<table>
<thead>
<tr>
<th>Barriers</th>
<th>Item Loading</th>
<th>Eigen Values</th>
<th>Variance Explained</th>
<th>KMO Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>IG</td>
<td>0.758-0.860</td>
<td>2.515</td>
<td>62.885</td>
<td>0.772</td>
</tr>
<tr>
<td>LSC</td>
<td>0.730-0.910</td>
<td>2.652</td>
<td>66.302</td>
<td>0.746</td>
</tr>
<tr>
<td>PL</td>
<td>0.728-0.857</td>
<td>2.596</td>
<td>64.894</td>
<td>0.757</td>
</tr>
<tr>
<td>CC</td>
<td>0.694-0.883</td>
<td>3.078</td>
<td>61.568</td>
<td>0.787</td>
</tr>
</tbody>
</table>

VI. CONCLUSION

GSCM for being a strategy that not only enables organizations to comply with legislative requirements but also to maintain a competitive advantage, is widely adopted by organizations including mining. However, GSCM implementation in Indian mining industries is hindered by a number of factors. In this context this study assumes importance by identifying and validating the GSCM barriers in the context of mining industries.

Empirical results of the present study demonstrate that the developed instrument is a reliable and valid measure of the GSCM barriers in Indian mining industries. These validated barriers to GSCM implementation can be helpful for organizations in assessing the greening effort of their supply chains. Additionally, by having a clear understanding of the barriers, organizations can identify the weaker areas and can formulate strategies to improve these areas that will ultimately improve the effectiveness of their GSCM implementation programs.

REFERENCES


