http://doi.org/10.23925/2179-3565.2024v15i4p58-71

RISUS - Journal on Innovation and Sustainability
volume 15, número 4 - 2024
ISSN: 2179-3565
Editor Científico: Arnoldo José de Hoyos Guevara
Editor Assistente: Vitória Catarina Dib
Avaliação: Melhores práticas editoriais da ANPAD

ANALYSING THE INTER-DEPENDENCIES BETWEEN SUSTAINABILITY PERFORMANCE INDICATORS OF SMES: AN EXPLORATORY APPROACH USING ISM

Análise das interdependências entre os Indicadores de Desempenho em Sustentabilidade das PME: uma abordagem exploratória utilizando o ISM

Ayswer A.S
Noorul Islam Centre for Higher Education
Email: scholar.aysweras123@gmail.com

ABSTRACT

The primary objective of this research is to analyze the interconnections among sustainability performance indicators within mining industries operating as Small and Medium Scale Enterprises in Kerala, India. The study introduces a hierarchical model for performance metrics. Initially, performance indicators are identified through a comprehensive literature review. Subsequently, a thorough questionnaire-based survey is conducted within the mining and mineral industries in Kerala to pinpoint the significant indicators relevant to the sector. The research employs Interpretive Structural Modelling (ISM) and MICMAC techniques to construct a hierarchical structure, illustrating the complex relationships among these pivotal performance metrics. Input from department managers in the industry is gathered through interviews to contribute to the development of the ISM. The findings reveal that a majority of the indicators in this category exhibit substantial driving and influencing power while maintaining independence. Organizations can leverage the proposed model for policy formulation, enabling them to manage their resources more effectively and efficiently by following a coherent roadmap.
Keywords: Key performance indicators, Sustainability, Mining & Mineral Industries, Interpretive Structural Modelling, ISM, MSMEs, SMEs.

ACEITO EM: 25/09/2024
PUBLICADO EM: 30/12/2024

RISUS - Journal on Innovation and Sustainability
volume 15, número 4 - 2024
ISSN: 2179-3565
Editor Científico: Arnoldo José de Hoyos Guevara
Editor Assistente: Vitória Catarina Dib
Avaliação: Melhores práticas editoriais da ANPAD

ANÁLISE DAS INTERDEPENDÊNCIAS ENTRE OS INDICADORES DE DESEMPENHO DE SUSTENTABILIDADE DAS PME: UMA ABORDAGEM EXPLORATÓRIA UTILIZANDO O ISM

Analysis of the interdependencies between SME Sustainability Performance Indicators: an exploratory approach using the ISM

Ayswer A.S
Noorul Islam Centre for Higher Education
Email: scholar.aysweras123@gmail.com

RESUMO

O objetivo principal desta pesquisa é analisar as interconexões entre os indicadores de desempenho de sustentabilidade nas indústrias de mineração que operam como pequenas e médias empresas em Kerala, Índia. O estudo apresenta um modelo hierárquico para métricas de desempenho. Inicialmente, os indicadores de desempenho são identificados por meio de uma ampla revisão da literatura. Posteriormente, uma pesquisa completa baseada em questionário é realizada nas indústrias de mineração e minerais em Kerala para identificar os indicadores significativos relevantes para o setor. A pesquisa emprega técnicas de Modelagem Estrutural Interpretativa (ISM) e MICMAC para construir uma estrutura hierárquica, ilustrando as relações complexas entre essas métricas de desempenho fundamentais. A contribuição dos gerentes de departamento do setor é coletada por meio de entrevistas para contribuir com o desenvolvimento do ISM. Os resultados revelam que a maioria dos indicadores nesta categoria exibe um poder substancial de condução e influência, mantendo a independência. As organizações podem aproveitar o modelo proposto para a formulação de políticas, permitindo-lhes gerenciar seus recursos de forma mais eficaz e eficiente, seguindo um roteiro coerente.
Palavras-chave: Indicadores Chave de desempenho; Sustentabilidade; Mineração e Indústrias Minerais; Modelação Estrutural Interpretativa, ISM, MPMEs, PMEs.

INTRODUCTION

Small and Medium-sized Enterprises (SMEs) are becoming more and more significant in both developed and developing nations. Manuf

acturing SMEs face numerous challenges on their path to success in today's world. SMEs are the backbone of many economies, driving both production and consumption sustainably. In India, they contribute 45% of the total industrial production, 40% of the total exports, 42% of the total employment, and create 1 million jobs annually. They also produce more than 8000 quality products for both domestic and international markets. They play a major role in the development of the Indian economy. As a result, they have a significant environmental impact (SME chamber of India,2024). On their own, SMEs may have a small environmental impact, but taken as a whole, they are considered to have a significant one. Companies are facing more and more pressure to think about how their operations and products will affect society and the environment. The most prevalent form of business organization, SMEs are essential to the development of economies in both developed and developing nations. They are critical for reducing poverty, creating jobs, and developing technological manufacturing capabilities.

According to data from the Micro, Small and Medium Enterprises (MSME) (Ministry's udyam registration platform), there are around 5,767,734 MSMEs registered in India as of November 26, 2021. They account for 37.54 percent of total GDP in India. 7.09 percent of GDP is accounted for by the MSME manufacturing sector. They also account for 30.50 percent of services, although mining is more frequent in India, accounting for 10% to 11% of GDP and 6% of total production(msme.gov.in 2024). Small-scale mines are expected to account for around one-sixth of non-fuel mineral production worldwide

Approximately 5% of India's total fuel mineral production comes from approximately 3000 small-scale mines (Ghose, 2003). Although the mining and mineral industries in India have contributed significantly to the country's economy recently (K Govindan et al., 2017), they are also governed by several laws from the government and foreign customers. SMEs play a critical role in GDP and employment creation in any economy. SMEs prioritize economic performance over environmental and social considerations to remain competitive, sustainability remains a significant concern. SMEs, especially those in the manufacturing industry, contribute to a country's GDP, but they also have a detrimental effect on the environment, as most of them do not incorporate environmentally sustainable practices into their processes, strategies, and long-term vision (Chrisovalantis et al, 2020).

It is widely accepted that environmental practices in SMEs are expensive and challenging to implement. According to Hillary, 2017, SMEs are responsible for up to 70 percent of global pollution. In particular, manufacturing SMEs are estimated to be responsible for 64 percent of air pollution. Only 0.4 percent of SMEs comply with an environment management system. Consequently, SMEs need to adopt more environmental-friendly practices to guarantee a brighter future for generations to come. Nevertheless, due to the presence of numerous competitors, SMEs face significant challenges from both the supply and demand sides.

There has been a lot of emphasis in recent years on the concept of sustainability, which includes the integration and harmonization of a business's environmental, economic, and social components. The economic front and the social and environmental components are the primary components of supply chain sustainability; however, they often conflict with one another (Tajbaksh et al., 2015). Scholars and researchers suggest that the long-term sustainability of the supply chain is only achievable when the environmental and social components of the business are taken into account. Sustainability is composed of three fundamental components: ecology, economy, and social affairs. (Cetinkaya et al., 2011). A lot of SMEs are exempt from environmental regulations because of their small size, even though they consume a lot of energy.

Manufacturing companies are under more internal and external pressure to implement supply chain and manufacturing strategies that satisfy the demands of different value chain participants. The manufacturing sector has been reluctant to adopt sustainable practices, especially SMEs, despite the positive correlation between firm performance and sustainable development plans. Research indicates that the biggest obstacle preventing SMEs from completely benefiting from sustainability is their inability to recognize and rank critical elements for the development and application of strategies. (Khatri and Metri,2016).

Globally, businesses are becoming interested in environmentally friendly manufacturing projects. Nonetheless, Lewis et al. (2014) argue that adopting sustainable practices is not seen as a win-win tactic when it comes to SMEs. SMEs have not been able to attain the appropriate degree of sustainable SC performance due to several factors, such as inadequate funding and innovation, outdated processes and technologies, low-quality fuels, inappropriate transportation infrastructure, lack of highly skilled labour at competitive prices, as well as poor information quality, awareness of, and responsiveness to environmental concerns (Meath et al., 2015).

SMEs must innovate and stay current with manufacturing procedures. Sustainability is crucial for long-term competitiveness. In today's world, thinking long-term and making sure to update their manufacturing systems is a crucial factor. An SME must be aware to remain competitive and achieve long-term success. It is recommended to concentrate on three areas of sustainability: economic, social, and environmental. (Matinaro et al., 2019).

The objectives of the present paper are as follows:

- Identify the key indicators to evaluate the sustainability performance of SMEs.
- Investigate the inter-relationships between the key performance indicators by developing a hierarchical model

The paper is further organized as follows Literature related to SMEs in Section 2. The methodology used in the research is described in Section 4. Result of this research are presented in Section 5 followed by Conclusion.

1 LITERATURE REVIEW

Previous studies have shown that the development of entrepreneurial skills, partnership and collaboration, internationalization, and the chance for innovation are some of the key elements that, in addition to government intervention, help SMEs grow sustainably.

To begin with, there is a substantial research void in this field. The majority of research on sustainability performance and business performance relationships has been conducted on large corporations in developed countries (Goyal, et al., 2015). Second, despite their huge contribution to a country's economy, a large proportion of in most countries, SMEs stagnate on a small scale of operation or fail within a few years of incorporation. (Reeg, 2013). SMEs account for almost 90% of worldwide firms and produce 50-60% of total global employment. As a result, it is vital to assess the long-term viability of this enormous sector with potential for expansion.

This study conducts a thorough literature search to find articles on SME/MSME performance analysis. A total of 4997 articles were chosen from the keyword search between 2013 and 2022 based on the evaluation of the abstract and title. Furthermore, the inclusion and exclusion criteria are applied to the 4997 search results to emphasize the literature related to the research issue. After carefully reviewing the remaining articles, the researchers selected 53 for the final analysis. According to the review of literature, the majority of papers in the mining industry focus primarily on the KPI that assesses process performance (Elevli and Elevli 2010). However, the chosen KPI should be capable of tracking and comparing the performance of the company's strategic and operational goals. To make the best use of existing infrastructure and achieve specified organizational goals, relevant measurements, indices, and methods for measuring the efficacy of industrial processes must be developed. Like other efforts to enhance productivity, implementing lean transformation necessitates strong support from top management to cultivate self-reinforcing human resources. Efficient and effective backing from top-level executives is essential to align unpredictable mining activities with proactive anticipation and the implementation of mitigation measures (Khaba,2020).

A literature analysis on KPIs in SMEs indicates the significance of them in monitoring and enhancing business performance. SMEs contribute significantly to the global economy, and their success is contingent on competent management and performance evaluation. KPIs, according to (Gackowiec et al., 2020), are quantifiable and essential instruments for identifying whether an organization's goals have been accomplished or not. Finding the KPIs that are pertinent to the industry under study is, therefore, essential. KPIs are important for SMEs, according to the experts, because they provide a disciplined means to measure, track, and assess many elements of the firm. KPIs help SMEs link their goals with performance indicators, which is important for decision-making and long-term success.

Financial KPIs (e.g., revenue growth, profitability, cash flow), operational KPIs (e.g., inventory turnover, production efficiency), customer-related KPIs (e.g., customer satisfaction, retention), and employee-related KPIs (e.g., productivity, turnover) are all highlighted in the literature. SMEs are encouraged to tailor their KPIs to their industry, size, and strategic objectives. One-size-fits-all KPIs may not be appropriate for all SMEs. KPIs should be aligned with the vision and goals of the organization. Benchmarking against peers and competitors in the sector is a frequent practice among SMEs to acquire insights into how they compare to others. External benchmarking can help SMEs set realistic targets and find areas for growth.

The adoption of technological innovations assists mining companies in cutting costs, minimizing environmental impact, boosting production, and enhancing mineral recovery. Recognizing the obstacles and facilitators of technology adoption is crucial for the success of technology implementation initiatives and the long-term sustainability of the mining sector (Ediriweera, et al.,2021). Assessing environmental sustainability poses a challenge as it involves choosing methods and metrics for measurement across various spatial scales and time periods, a task that is far from straightforward. An alternative approach involves the use of Environmental Sustainability Indicators (ESIs), offering specific and accurate information regarding environmental conditions, trends, and changes. The increasing significance of environmental sustainability has led to the emergence of a considerable number of indicators. (Fuentes, et al., 2021)

Identifying and examining KPI correlations would initially help an organization minimize the number of KPIs it monitors. As a result, there is a substantial study gap in analysing KPI, and no research has been undertaken to identify the interdependence of this KPI in the Indian mining and mineral industries. The purpose of this research is to determine the dominant KPI in mining MSMEs and to look into the important and mutual relationship of the 14 KPIs for measuring industry performance. Performance indicators in the mining industry were discovered after a review of the literature. Following talks and questionnaire responses from industry experts and an academic specialist, fourteen industry indicators were identified. Expert advice and a literature review were used to build the relationship matrix. Using Interpretive Structural Modelling (ISM) approach, the driving and driven powers of obstacles were found. ISM can be used to look at the direct and indirect links between different organizational aspects.

2 CASE STUDY

India is rich in minerals. As a result, mining is a big industry in India. It only opened to foreign investment in the 1990s, and the quantity of foreign investment in the sector has been very limited due to constraints. Furthermore, in India, this industry is dealing with a variety of difficulties. One of the most difficult challenges for mining firms to face to remain competitive in the global market is meeting high production and productivity targets. When business processes are successfully managed, they become an execution of business strategy as well as a source of revenue. Control and monitoring of processes are critical components of enterprise process management. It is critical to identify the Key Performance Indicators (KPIs) that pertain to the processes under consideration. Process observation can be conducted at several levels of management and from a range of perspectives, including strategic, tactical, operational, financial, and security/maintenance.

The research was conducted at the world's first factory to mine kaolin resources, a clay mining enterprise in southern India. The company mines and processes clay for sale to paper and paint producers in India and around the world. Because of Covid's financial impact and the temporary halt of clay mining, a key raw material for its operations. The company's market share and sales have declined significantly, resulting in a considerable financial loss. To break into the worldwide market and establish a vital position for their products, the company has decided to implement an effective and efficient system for monitoring performance by selecting KPIs. Before making any more investments, the corporation wishes to discover the critical components in analysing the success of the mining industry. We investigated the company's problem and offered our hybrid model. Based on our interactions with the general manager, a decision-making committee comprised of three senior managers from the planning and buying departments, one industry expert, and two academicians was formed. To make management of the shortlisted indicators during the implementation phase easier, they are divided into three categories: Social, Economic, and Environment (Table 1).

Table 1 - Key Performance Indicators

Category	Key Performance Indicators	Source
Social	Customer Satisfaction On time Delivery Employee Training Employee Satisfaction	Dube and Gawande, 2016; Govindan et al., 2016; Mangla et al., 2017; Mathiyazhagan et al., 2013; Mittal and Sangwan, 2014; Teplická et al.,2021; Singh et al. 2015,Azadnia et al., 2015; Luthra et al., 2017; Bai and Sarkis ,2010, Badri Ahmadi et al., 2017
Economical	Sales Growth Defect Rate New Product development Labour Productivity Marketing of Products Equipment Maintenance Return on Capital Capacity Utilization	Bhanot et al., 2017; Dube and Gawande, 2016; Govindan et al., 2016; Li et al., 2015; Mangla et al., 2017; Mathiyazhagan et al., 2013; Lotfi et al. 2013; Zhang et al. ,2013
Environmental	Pollutant Released Recyclable Materials	Bhanot et.al 2017 ;Mangla et al., 2017; Govindan et al., 2016; Mathiyazhagan et al., 2014; Kumar,S 2006, Barve, A.2011; Nikolaou, I.E.2010

3 INTERPRETIVE STRUCTURAL MODELLING

The ISM approach comprises multiple systematic phases to get key insights into the relationships and interactions among relevant parts of a given problem. To begin, experts and stakeholders are asked to participate in surveys or group problem-solving procedures to identify key components. Contextual links between these components are then created, outlining which pairings will be examined for interdependence

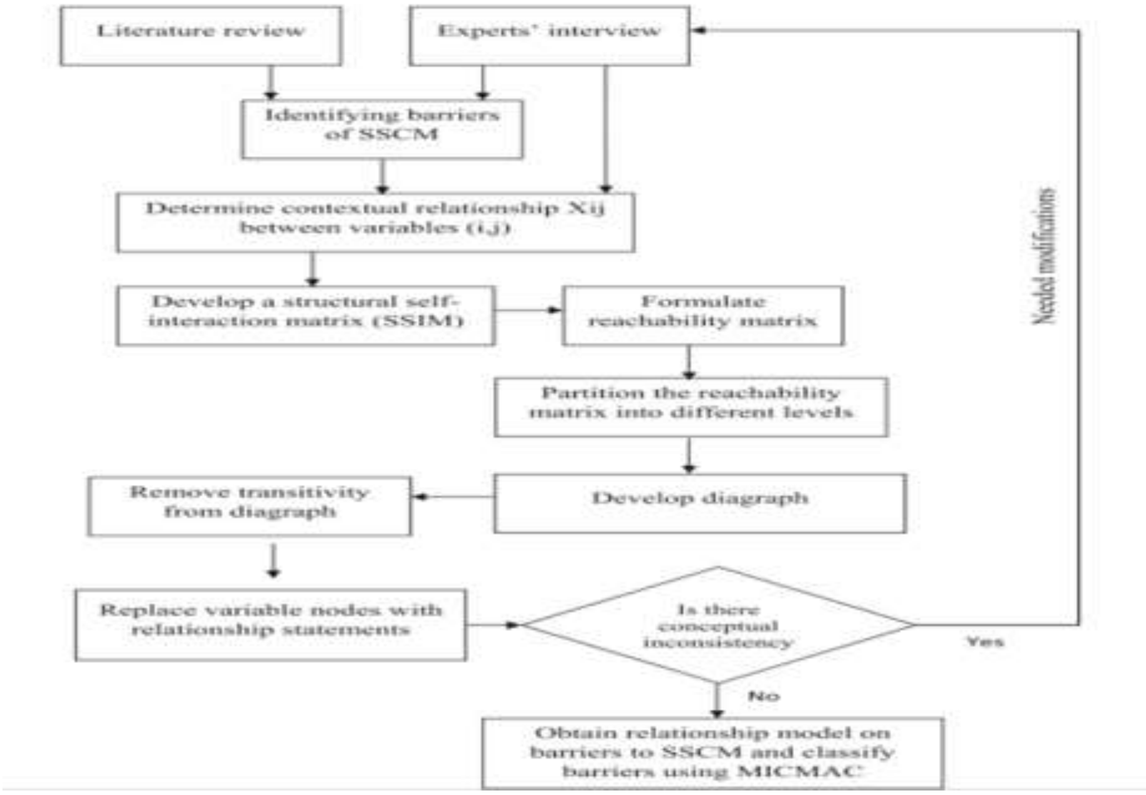
ISM is used to build structural linkages among different components or elements in a system or situation. The fundamental output of ISM is a hierarchical structure in which items are organized into tiers based on their driving and dependent relationships. The strongest or reliant parts are often found at the highest levels. In the hierarchy, there are driving elements (those that impact other elements) and dependent elements (those that are influenced by others).

The various steps of ISM modelling are as follows (Figure 1):

- Identify the components that are pertinent to the issue.
- Create a context for the relationship between the elements that will be used to compare pairs of elements.
- Create an elemental structural self-interaction matrix (SSIM). This matrix shows the pair-wise relationships between system components.
- Using the SSIM, create a reachability matrix.
- Divide the reachability matrix into various categories

A Structural Self-Interaction Matrix (SSIM) is constructed after capturing the pairwise interactions and completing transitivity checks to ensure consistency. The SSIM is used to generate a reachability matrix, which indicates the reachability of one system element from another. The matrix's elements are then classified into different levels based on how interrelated they are. By following these clearly defined processes, ISM modelling becomes a powerful tool for comprehending complex systems, assisting decision-making, and determining the dynamics of various interrelated factors in a given problem.

Figure 1 - Flow diagram for ISM Model



To indicate the direction of the relationship between two factors (i and j), the following four symbols are used:

- V for the relation from factor i to factor j (i.e., factor i will influence factor j)
- A for the relation from factor j to factor i (i.e., factor i will be influenced by factor j)
- X for both direction relations (i.e., factors i and j will influence each other)
- O for no relation between the factors (i.e., barriers i and j are unrelated).

The SSIM is built around contextual relationships. A group of specialists should continue to debate the SSIM to reach an agreement. Based on their responses, the SSIM must be completed (Table 2).

3.1 Reachability Matrix

The next step in the ISM approach is to use the SSIM to create an initial reachability matrix (Table 3). For this, the four symbols of SSIM (V, A, X, or O) are replaced by 1s or 0s in the initial reachability matrix, converting SSIM into the initial reachability matrix.

The rules for this substitution are as follows:

- If the (i, j) entry in the SSIM is V, then the (i, j) entry in the reachability matrix becomes 1 and the (j, i) entry becomes 0.
- If the (i, j) entry in the SSIM is A, then the (i, j) entry in the matrix becomes 0 and the (j, i) entry becomes 1.
- If the (i, j) entry in the SSIM is X, then the (i, j) entry in the matrix becomes 1 and the (j, i) entry also becomes 1.
- If the (i, j) entry in the SSIM is O, then the (i, j) entry in the matrix becomes 0 and the (j, i) entry also becomes 0.

The final reachability matrix (Table 5) is prepared by incorporating the transitive relationships (1*).

3.2 Level Partitions

The reachability set and antecedent sets for each factor are computed using the final reachability matrix. The reachability set consists of the criterion itself and other criteria that aid in its achievement, whereas the antecedent set consists of the criterion itself and other criteria that aid in its achievement. For each criterion, the intersection of these sets is calculated (Table 5). The top-level criteria in the ISM hierarchy are those for which the reachability and intersection sets are the same. By definition, top-level criteria do not help achieve any other criteria above their level in the hierarchy. The top-level criteria are separated from the other criteria once they have been identified. The process is then repeated to find the next level of criteria. These identified levels aid in the construction of the digraph and final model (Figure 2).

3.3 MICMAC Analysis

Matriced' Impacts croises-multipication applique' and classment (cross-impact matrix multiplication applied to classification) is abbreviated as MICMAC. The purpose of MIC-MAC analysis is to determine the interdependence of factors or elements and classify them according to their influence and reliance. Analysing the driving and dependency power is the aim of MICMAC analysis. Based on their drive power and dependence power, the elements have been divided into four groups: autonomous factors, linking factors, dependent factors, and independent factors (Figure 3).

1. Autonomous factors: These elements have a weak tendency to drive and depend. They have few links to the system, which they are relatively disconnected from but which they may be strong. It is, therefore, believed that they have no bearing on the process and can be disregarded or neglected.

2. Linkage factors: These elements exhibit both strong drive and strong dependence power. These variables are unstable because any action taken in response to them will have an impact on others and a knock-on effect on themselves.

3. Dependent variables: These variables have strong dependence power but weak drive power.

4. Independent variables: These variables have a strong driving force but a weak dependence power. Independent or linkage factors include a factor known as the "key factor" that has a very high drive power.

Table 2 - Structural Self Interaction Matrix (SSIM)

	14	13	12	10	9	8	7	6	5	4	3	2	1
1.Customer Satisfaction	O	A	V	O	O	O	X	O	X	A	O	O	V
2.Sales growth	X	X	V	O	O	V	A	O	X	A	O	O	
3.Employee Satisfaction	O	X	V	O	O	O	O	V	A	O	V		
4.Defect rate	O	A	V	A	A	O	O	A	V	O			
5.Ontime Delivery	O	O	V	O	O	O	X	O	O				
6.New product development	X	A	A	O	O	O	X	A					
7.Labour productivity	V	A	V	A	A	O	O						
8.Marketing of product	O	V	V	O	O	O							

9.Pollutant released amount	A	A	V	O	O								
10.Equipment maintenance	A	A	A	O									
11.Recyclable materials	O	A	V										
12.Return on capital	A	X											
13.Employee Training	V												
14.Capacity Utilization													

Table 3 - Initial Reachability Matrix

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1.Customer Satisfaction	1	1	0	0	0	1	0	1	0	0	0	1	0	0
2.Sales growth	0	1	0	0	0	1	0	0	1	0	0	1	1	1
3.Employee Satisfaction	0	0	1	1	0	0	1	0	0	0	0	1	1	0
4.Defect rate	0	0	0	1	0	1	0	0	0	0	0	1	0	0
5.Ontime Delivery	1	1	0	0	1	0	0	1	0	0	0	1	0	0
6.New product development	1	1	1	0	0	1	0	1	0	0	0	0	0	1
7.Labour productivity	0	0	0	1	0	1	1	0	0	0	0	1	0	1
8.Marketing of product	1	1	0	0	1	1	0	1	0	0	0	1	1	0
9.Pollutant released amount	0	0	0	0	0	0	0	0	1	0	0	1	0	0
10.Equipment maintenance	0	0	0	1	0	0	1	0	0	1	0	0	0	0
11.Recyclable materials	0	0	0	1	0	0	1	0	0	0	1	1	0	0
12.Return on capital	0	0	0	0	0	1	0	0	0	1	0	1	1	0
13.Employee Training	1	1	1	1	0	1	1	0	1	1	1	1	1	1

14.Capacity Utilization	0	1	0	0	0	1	0	0	1	1	0	1	0	1

Table 4 - Final Reachability Matrix

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	Driver power
1.Customer Satisfaction	1	1	1*	0	1*	1	0	1	1*	1*	0	1	1*	1*	11
2.Sales growth	1*	1	1*	1*	0	1	1*	1*	1	1*	1*	1	1	1	13
3.Employee Satisfaction	1*	1*	1	1	0	1*	1	0	1*	1*	1*	1	1	1*	12
4.Defect rate	1*	1*	1*	1	0	1	0	1*	0	1*	0	1	1*	1*	10
5.Ontime Delivery	1	1	0	0	1	1*	0	1	1*	1*	0	1	1*	1*	10
6.New product development	1	1	1	1*	1*	1	1*	1	1*	1*	0	1*	1*	1	13
7.Labour productivity	1*	1*	1*	1	0	1	1	1*	1*	1*	0	1	1*	1	12
8.Marketing of product	1	1	1*	1*	1	1	1*	1	1*	1*	1*	1	1	1*	14
9.Pollutant released amount	0	0	0	0	0	1*	0	0	1	1*	0	1	1*	0	5
10.Equipment maintenance	0	0	0	1	0	1*	1	0	0	1	0	1*	0	1*	6
11.Recyclable materials	0	0	0	1	0	1*	1	0	0	1*	1	1	1*	0	7
12.Return on capital	1*	1*	1*	1*	0	1	1	1	1*	1	1*	1	1	1*	13
13.Employee Training	1	1	1	1	0	1	1	1*	1	1	1	1	1	1	13
14.Capacity Utilization	1*	1	1*	1*	0	1	1*	1*	1	1	0	1	1*	1	12
Dependence power	11	11	10	11	4	14	10	10	11	14	6	14	13	12	

Table 5 - Level Partitions for Indicators

Indicators	Reachability set	Antecedent set	Intersection set	Level
1	2,3,5,8,14	2,3,4,5,7,8,14	2,3,5,8,14	I
2	3,8	3,5,8	3,8	VI
3	2	2,8	2	VI
4	2,3,8	2,3,7,8,11	2,3,8	IV
5	8	8	8	VII
6	1,2,3,4,5,7,8,9,10,12,13,14	1,2,3,4,5,7,8,9,10,11,12,13,14	1,2,3,4,5,7,8,9,10,12,13,14	I
7	2,3,8	2,3,8	2,3,8	V
8	5	5	5	VII
9	13	1,2,3,5,7,8,13,14	13	II
10	4,6,7,12,14	1,2,3,4,5,6,7,8,9,11,12,13,14	4,6,7,12,14	I
11	7	2,3,7,8	7	V
12	1,2,3,4,6,7,8,9,10,11,13,14	1,2,3,4,5,6,7,8,9,10,11,13,14	1,2,3,4,6,7,8,9,10,11,13,14	I
13	1,2,3,4,7,8,9,11,14	1,2,3,4,5,7,8,9,11,14	1,2,3,4,7,8,9,11,14	II
14	1,2,3,4,7,8,	1,2,3,4,5,7,8	1,2,3,4,7,8	III

Figure 2 – ISM – based Model for Indicators

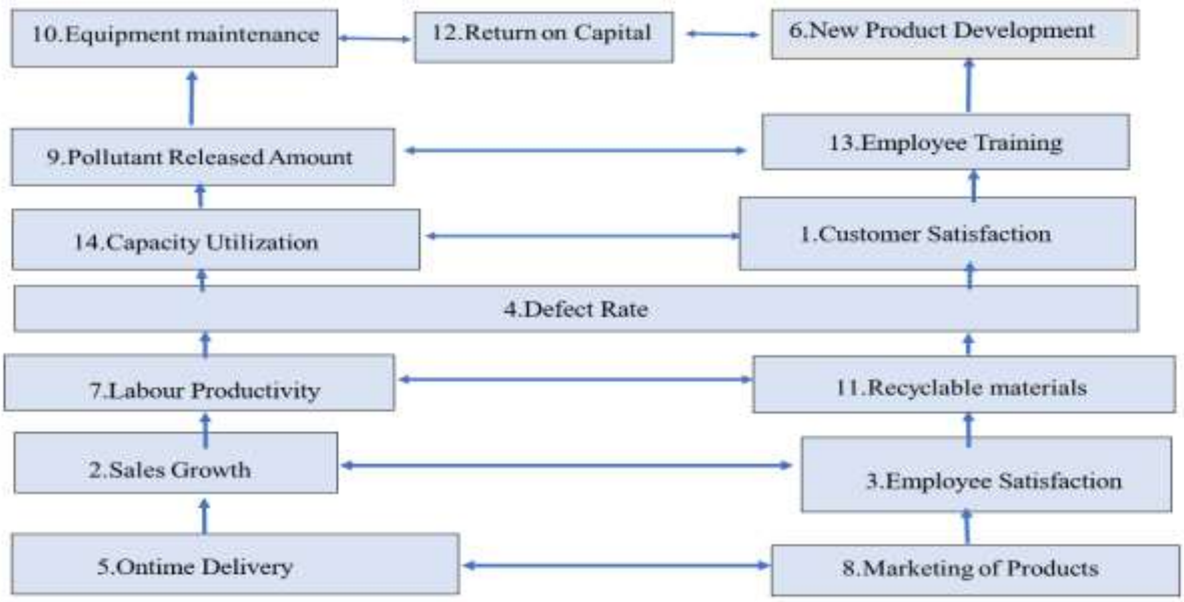
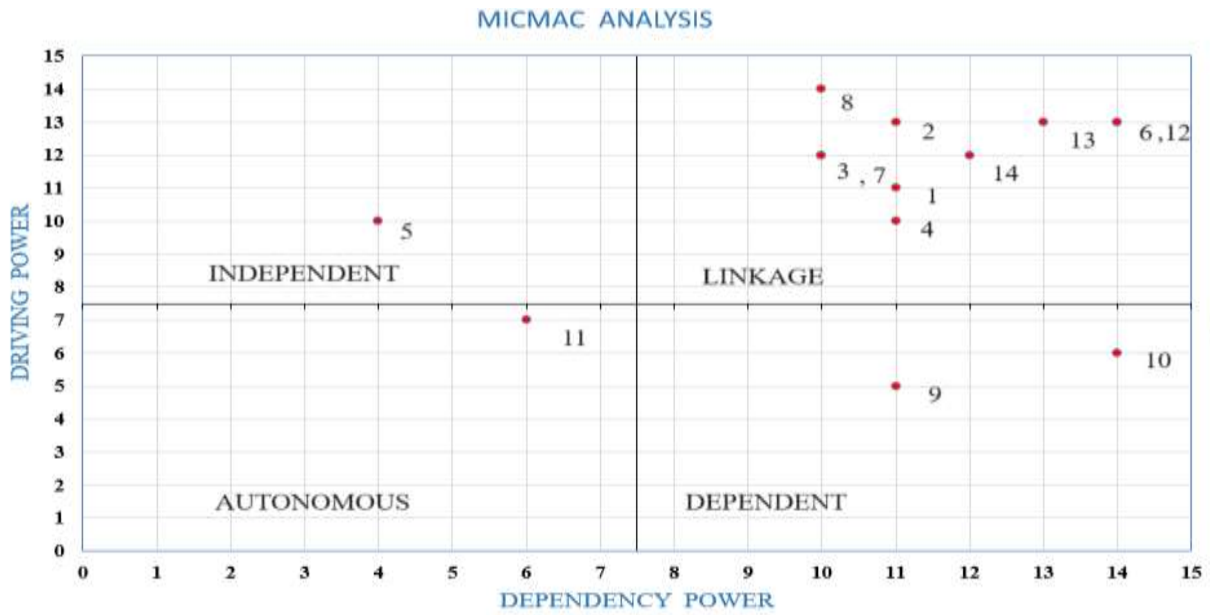


Figure 3 - Driving and Dependence Power Diagram



4 RESULTS AND DISCUSSION

In the current study, some of the indicators were included, and their interactions were investigated using ISM. An SSIM was built based on expert feedback, and it served as the foundation for ISM. In this model, fourteen indicators are divided into seven stages. The ISM model obtained in Fig. 2 organizes and depicts the indicators in SMEs into seven tiers. Lower-level indications drive higher-level indicators. Product marketing and on-time delivery are key indicators and have the greatest influence since they are at level 7, the lowest level in the ISM model, indicating that they have a substantial impact on the system as it forms the foundation of the ISM hierarchy. Level 1 includes equipment maintenance, return on capital, and new product development, while level 2 includes pollutant emissions and personnel training. This implies that on-time delivery and product marketing influence sales growth and employee satisfaction.

It has been discovered that a variable with a high driving power, known as a key variable, falls into the category of independent or linkage criteria. Table 5 displays the driver and dependent power of each of these indicators. Periodic maintenance and inspection of machinery, revenue returns, and new product design and development are the indicators on which the effectiveness of SMEs' performance is dependent. These indicators have appeared at the top of the hierarchy. The indicators at lower levels drive the indicators at higher levels.

Autonomous factors have a low drive power and a low reliance power. They are relatively detached from the system, with which they have limited but potentially very powerful linkages.

Linkage factors have a high driving power as well as a high reliance power. These factors are unstable in the sense that every action on them has an effect on others as well as a feedback effect on themselves. Strong driving variables, sometimes known as key variables, have been found to fall into this category

Dependent factors have a low driving power but a high dependence power.

Independent factors have a high drive power but a low dependence power. A factor with a high drive power, known as the 'key factor,' belongs to the group of independent or linked factors.

CONCLUSIONS

Indian SMEs are less aware of technical and financial capabilities for proper exploitation, mining development, mineral extraction, and processing, it is more difficult for these firms to get a clear idea about analysing the sustainable issues in the industries. Nonetheless, the goals of improving environmental performance and lowering pollution are critical. Perhaps the most difficult problem for Indian mining and mineral industries is an effective analysis of sustainable practices.

The study takes into account some of the major indicators and analyses their interactions using ISM. Based on expert input, an SSIM was created, which served as the foundation for the Interpretive Structural Modelling (ISM). ISM was used to create a structural model in which the indicators of periodic maintenance and inspection of machinery, revenue returns, and new product design and development appeared at the top of the hierarchy. These are the indicators that are affected at a lower level, and they also have a lower impact than the remaining indicators. The following indicators like the amount of pollutants released from SMEs, adequate employee training, effective utilization of plant capacity, satisfied customers, and decreased defective rate are available at the next level. According to the ISM diagram equipment maintenance, return on capital, and new product development occupy the top of the hierarchical ladder. The MICMAC analysis provides valuable insights into the relative importance and interdependence of the 14 indicators. The relative significance and interdependencies between these indicators are revealed by the driver and dependence power diagram that was produced by the analysis.

REFERENCES

Azadnia AH, Saman MZM, Wong KY 2015 Sustainable supplier selection and order lot-sizing: an integrated multi-objective decision-making process. *Int. J. Prod. Res*. 53(2).
Badri Ahmadi H, Hashemi Petrudi SH & Wang X 2017 Integrating sustainability into supplier selection with analytical hierarchy process and improved grey relational analysis: a case of telecom industry. *Int. J. Adv. Manuf. Technol*. 90: (9–12).
Bai C, Sarkis J 2010 Integrating sustainability into supplier selection with grey system and rough set methodologies. *Int. J. Prod. Econ*. 124(1).
Barve A, Muduli K 2011 Challenges to Environmental Management Practices in Indian Mining Industries. *In: Proceedings*.
Behjati S 2017 Critical Remarks about Environmentalism Implication by Iranian SMEs. *European Journal of Sustainable Development* 6(3): 209
Bhanot N, Rao PV, Deshmukh SG 2017 An integrated approach for analysing the enablers and barriers of sustainable manufacturing. *J. Clean. Prod*. 142.
Cetinkaya B, Cuthbertson R 2011 Sustainable Supply Chain Management: Practical Ideas for Moving Towards Best Practise. *Springer*.
Chan F, Qi HJ 2003 An innovative performance measurement method for supply chain management. *Supply chain management* 154.
Chrisovalantis M, Moursellas MM, Prasanta KD 2021 Sustainability performance analysis of small and medium sized enterprises: Criteria, methods and framework. *Socio-Economic Planning Sciences* 75: 100993
Dube AS, Gawande RR 2016 Analysis of green supply chain barriers using integrated ISM-fuzzy MICMAC approach. *Benchmarking Int. J.* 23.
Ediriweera A, Wiewiora A 2021 Barriers and enablers of technology adoption in the mining industry. *Resource Policy* 73: 102188.
Elevli S, Elevli B 2010 Performance Measurement of Mining Equipment by Utilizing OEE.AMS.
Fuentes M, Negrete M 2021 Classification of indicators measuring environmental sustainability of mining and processing of copper. *Minerals Engineering* 170: 107033
Gackowiec P, Staniec P 2020 Review of Key Performance Indicators for Process Monitoring in the Mining Industry. *MDPI*
Ghose MK 2003 Indian small-scale mining with special emphasis on environmental management, *Journal of Cleaner Production*.
Govindan K, Muduli K, Devika K, Barve A 2016 Investigation of the influential strength of factors on adoption of green supply chain management practices: an Indian mining scenario. *Resour. Conserv. Recycl*. 107.
Goyal P, Rahman Z 2015 Identification and prioritization of corporate sustainability practices using analytical hierarchy process. *Journal of Modelling in Management*
Hillary R 2017 Small and Medium -Sized Enterprises and Environment.Green Leaf Publishing Limited.
https://entomo.co/blog/what-are-the-important-kpis-to-track-in-indian-mining-industries/
https://udyamregistration.gov.in/Government-India/Ministry-MSME-registration.htm

https://www.smechamberofindia.com/about-msme-in-india.php

Journeault M, Levant Y 2021 Sustainability performance reporting: A technocratic shadowing and silencing. *Critical Perspectives on Accounting*

Khaba S, Bhar C 2020 Study on key lean enablers of the coal mining sector using ISM, MICMAC and SEM. *TQM Journal*

Khatri JK, Bhimaraya M 2016 SWOT-AHP Approach for Sustainable Manufacturing Strategy Selection: A Case of Indian SME, *Global Business Review* 17(5): 1211-1226.

Kumar S, Kumar R, Bandopadhyay 2006 A. Innovative methodologies for the utilisation of wastes from metallurgical and allied industries. *Resour.,Conserv. Recycl*.

Lewis KV, Cassells S 2014 SMEs and the Potential for A Collaborative Path to Environmental Responsibility. *Business Strategy and the Environment*.

Li J, Pan SY, Kim H, Linn JH, Chiang PC 2015 Building green supply chains in eco-industrial parks towards a green economy: barriers and strategies. *J. Environ. Manag* 162.

Lotfi MR, Ghadikolaee MH, Hemmati K 2013 Measuring the relative performance in mining industry: a case study of cooperative Seif mining company. *Manag. Sci.Lett*.

Luthra S, Govindan K, Kannan D, Mangla SK, Garg CP 2017 An integrated framework for sustainable supplier selection and evaluation in supply chains. *J. Clean. Prod*. 140.

Mangla SK, Govindan K, Luthra S 2017 Prioritizing the barriers to achieve sustainable consumption and production trends in supply chains using fuzzy Analytical Hierarchy Process. *J. Clean. Prod* 151.

Mathiyazhagan K, Govindan K, Noorul Haq A, Geng Y 2013 An ISM approach for the barrier analysis in implementing green supply chain management. *J. Clean. Prod* 47.

Matinaro V, Liu Y 2019 Extracting key factors for sustainable development of enterprises: Case study of SMEs in Taiwan. *J. Clean. Prod* 209.

Meath C, Linnenluecke M 2016 Barriers and motivators to the adoption of energy savings measures for small- and medium-sized enterprises (SMEs): the case of the ClimateSmart Business Cluster program. *J. Clean. Prod* 112.

Mittal VK, Sangwan KS 2014 Development of a model of barriers to environmentally conscious manufacturing implementation. *Int. J. Prod*. Res 52. msme.gov.in

Nikolaou IE, Evangelinos KI 2010 A SWOT analysis of environmental management practices in Greek Mining and Mineral Industry. *Resour.Policy* 35(3).

Reeg, Caroline 2013 Micro, small and medium enterprise upgrading in India: learning from success cases. *Bonn*.

Singh S, Olugu EU, Musa SN, Mahat AB 2015 Fuzzy-based sustainability evaluation method for manufacturing SMEs using balanced scorecard framework. *J. Intell. Manuf*.

Sotilia CM, Paulo Nocera AJ 2023 Do We Consider Sustainability When We Measure Small and Medium Enterprises' (SMEs') Performance Passing through Digital Transformation? Circular Economy and Sustainable Business Performance Management

Tajbakhsh A, Hassini 2015 A data envelopment analysis approach to evaluate sustainability in supply chain networks. *J. Clean. Prod* 105.

Teplická K, Hurná S 2021 New approach of costs of Quality according their trend of during long period in industrial enterprises in SMEs, *Management Systems in Production Engineering.*

Zhang H, Calvo-Amodio J, Haapala KR 2013 A conceptual model for assisting sustainable manufacturing through system dynamics. *J. Manuf. Syst* 32(4).