

## Investigating the impact of sustainable supply chain management for soil conservation in Iran's mining sector

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### Abstract

This article investigates the impact of sustainable supply chain management (SSCM) practices on soil conservation within Iran's mining sector. As mining activities pose significant threats to soil health and environmental stability, implementing SSCM has emerged as a viable strategy to mitigate these effects. The study employs a mixed-methods approach, combining quantitative data from a questionnaire distributed to industry experts with qualitative insights gathered through in-depth interviews. Findings indicate that the adoption of key SSCM practices—including resource efficiency, effective waste management, and supplier collaboration—leads to measurable improvements in soil conservation outcomes. However, the study also identifies challenges such as regulatory inadequacies, financial constraints, and a lack of awareness among stakeholders that hinder effective implementation. Despite these obstacles, opportunities for advancement are present, particularly through government incentives and partnerships between mining companies and local communities. The results underscore the importance of integrating sustainable practices within the mining sector to enhance soil protection efforts. This research contributes to the broader discourse on sustainable mining practices, highlighting the need for a transition toward environmentally responsible operations that prioritize both economic and ecological sustainability.

**Keywords:** Sustainable Supply Chain Management (SSCM), Soil Conservation, Mining Sector, Environmental Sustainability.

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### 1. Introduction

The mining sector is a pivotal component of the global economy, contributing significantly to resource extraction for various industries. In Iran, the mining industry plays a crucial role in economic development, particularly in the extraction of non-metallic minerals, which are utilized across a range of applications from construction materials to industrial inputs (Kazemi et al., 2021). However, the rapid expansion of mining activities has raised considerable environmental concerns, particularly regarding soil degradation. Soil is a vital resource that supports ecosystems, agricultural productivity, and biodiversity, and its conservation is crucial for sustaining human livelihoods (Blum, 2005). The historical practices within the mining sector have often prioritized economic gains over environmental considerations. As a result, soil erosion, contamination, and habitat destruction have become prevalent issues,

leading to significant ecological imbalances. According to the United Nations Environment Programme (UNEP, 2019), unsustainable mining practices could exacerbate soil degradation, threatening food security and increasing vulnerability to climate change impacts. The urgent need to address these issues has led to the emergence of sustainable supply chain management (SSCM) practices aimed at integrating environmental concerns into mining operations.

Soil conservation is an integral aspect of sustainable development, particularly in regions heavily reliant on agriculture and natural resources. In Iran, soil fertility is declining due to excessive mining activity, which disrupts soil layers and contributes to erosion. The consequences of soil degradation extend beyond the mining sector; they adversely affect agriculture, leading to lower crop yields and increased vulnerability to food insecurity (Mousavi

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et al., 2021). The gradual loss of soil is recognized as a pressing issue that requires urgent interventions and the implementation of sustainable practices.

Soil conservation efforts in the mining sector should focus on preventing further degradation through various strategies, including soil stabilization, rehabilitation of mined areas, and minimal disturbance mining practices (Rico et al., 2015). The adoption of SSCM can play a vital role in reinforcing these conservation strategies, as it encourages collaboration between stakeholders, including government, industry, and local communities. Moreover, SSCM frameworks can facilitate the development of policies that promote soil conservation initiatives while balancing economic interests.

In light of these challenges, sustainable supply chain management (SSCM) has emerged as a vital approach to mitigating environmental harm while ensuring the economic viability of mining operations. The concept of SSCM integrates environmental, social, and economic dimensions into traditional supply chain management. This approach emphasizes the need for businesses to adopt practices that not only enhance efficiency and profitability but also reduce their environmental footprint. In the context of the mining sector, SSCM involves the adoption of green technologies, waste reduction strategies, and the implementation of practices that conserve natural resources, including soil (Yu et al., 2022). Moreover, SSCM practices emphasize the importance of collaboration among stakeholders, including mining companies, government agencies, local communities, and non-governmental organizations (NGOs). Such collaboration is crucial for the successful implementation of soil conservation measures, as it ensures that the interests and concerns of all parties are taken into account.

Sustainable supply chain management encompasses the strategies and practices that organizations implement to minimize their environmental impact while fulfilling their economic goals. SSCM emphasizes the need for a holistic approach that considers the entire lifecycle of products, from resource extraction to product delivery and disposal. By adopting SSCM principles, mining companies can enhance operational efficiency, reduce waste generation, and promote the ethical use of natural resources (Zhu et al., 2013). The integration of SSCM within the mining sector is particularly significant in developing countries like Iran, where regulatory frameworks may be underdeveloped, and environmental impacts are often

overlooked (Ali et al., 2021).

Green technologies—such as waste recycling, clean production techniques, and sustainable land use—can mitigate the detrimental effects of mining on soil resources (Waqas et al., 2022). This understanding presents an opportunity for mining companies in Iran to reassess their operational practices and adopt more sustainable approaches to soil conservation.

Despite the recognized importance of SSCM and its potential to mitigate environmental impacts, there is a lack of comprehensive studies examining its specific effects on soil conservation in the mining sector, particularly in the context of Iran. While SSCM has been widely adopted in various industries, its application in the mining sector, especially concerning soil conservation, remains underexplored.

This research seeks to address this gap by investigating the impact of SSCM on soil conservation in Iran's mining sector. The study aims to assess how the adoption of SSCM practices can reduce soil degradation, improve soil quality, and contribute to the sustainable development of mining regions in Iran. By focusing on the intersection of SSCM and soil conservation, this research will provide valuable insights for policymakers, industry leaders, and researchers seeking to promote sustainable mining practices in Iran and other similar contexts. This study is significant for several reasons. First, it addresses a critical environmental issue—soil degradation—in a sector that is vital to Iran's economy. By exploring the role of SSCM in mitigating soil degradation, the study contributes to the broader discourse on sustainable mining practices and environmental conservation. Second, the research provides empirical evidence that can inform policy decisions and industry practices, helping to promote the adoption of SSCM in Iran's mining sector. Finally, the study adds to the growing body of literature on SSCM and its environmental impacts, offering insights that could be applicable to other regions and industries facing similar challenges.

The primary objective of this research is to investigate the impact of sustainable supply chain management on soil conservation in Iran's mining sector. The study will be guided by the following research questions:

1. How does the adoption of SSCM practices in the mining sector affect soil conservation efforts in Iran?
2. What are the key SSCM practices that contribute to soil conservation in mining regions?
3. What challenges and opportunities exist for implementing SSCM in Iran's mining sector to promote soil conservation?

**Table1: The Role of Mines and Factories in Soil Erosion over the Last Two Decades(authors,2024)**

Soil Erosion(tons/ha/years)	Year
24.0	2004
16.5	2009
16.5	2014
16.5	2019

2004: Soil erosion was estimated at 24 tons per hectare per year<sup>1</sup>.

2009 and 2014: The mean annual soil erosion remained consistent at 16.5 tons per hectare per year<sup>2</sup>.

2019: Iran’s soil erosion rate was approximately 2.5 times higher than the global average, reaching 16.5 tons per hectare per year<sup>3</sup>.

**2. Literature Review**

Sustainable supply chain management encompasses the planning, implementation, and control of supply chain operations with the goal of promoting environmental, social, and economic benefits. According to Sarkis (2017), SSCM not only aims to minimize environmental impacts but also seeks to enhance the resilience and efficiency of supply chains. The integration of sustainability into supply chain practices has gained traction, especially in resource-intensive industries such as mining, where environmental degradation is a significant concern.

Mining activities have a well-documented impact on soil health, contributing to erosion, contamination, and loss of biodiversity. A study by Hossain et al. (2019) underscores that non-sustainable mining practices can lead to severe soil degradation, affecting both agricultural productivity and ecosystem stability. This recognition has fueled calls for the adoption of more sustainable practices that mitigate these detrimental effects.

**Resource Efficiency and Waste Minimization:**

Research by Ali et al. (2020) indicates that efficient resource utilization and waste management are pivotal in reducing the ecological footprint of mining operations. Implementing recycling processes and reducing material consumption can help preserve soil integrity.

**Technological Innovations:** Innovations in technology, such as precision mining and automated processes, are highlighted by Wang et al. (2021) as effective means to minimize soil disturbance during extraction. These technologies can significantly enhance the precision of resource extraction while reducing the volume of waste generated, thereby contributing to soil conservation efforts.

**Rehabilitation and Land Restoration:** The

rehabilitation of mined lands is essential for soil conservation; Ahmad et al. (2020) stress the importance of integrating restoration plans into the mining supply chain. This involves creating strategies for re-vegetation and soil stabilization post-mining, ensuring that the land can support ecosystems and agricultural activities once again.

**3. Research Method**

**3.1. Research Design**

This study adopts a mixed-methods approach, combining quantitative analysis and qualitative insights to comprehensively explore the impact of sustainable supply chain management (SSCM) on soil conservation in Iran's mining sector.

**4. Quantitative Research**

**4.1 Sampling and Data Collection**

A structured questionnaire was distributed to collect quantitative data from mining companies in Iran. The sampling involved a stratified random selection to ensure representation of various company sizes and operational practices.

**4.2 Key Variables**

**Independent Variables (IV):** Practices of SSCM (measured by specific practices implemented).

**Dependent Variables (DV):** Soil conservation indicators (measured by changes in soil quality metrics, erosion rates, etc.).

**4.3 Data Measurement and Questionnaire Content**

The questionnaire was structured into sections, with respondents rating the implementation level of SSCM practices and perceived impacts on soil conservation on a Likert scale (1-5, where 1 = Not at all, 5 = Very High). Below is a sample table summarizing the variables measured:

**Table2: Variables Measured (Authors, 2024)**

Variable Category	Variable	Rating Scale
SSCM Practices	Resource Efficiency	1-5
	Waste Management	1-5
	Supplier Collaboration	1-5
	Training and Awareness Programs	1-5
Soil Conservation	Soil Erosion Rates	1 (High) - 5 (Low)
	Soil Quality Index	1 (Poor) - 5 (Excellent)

**4.4 Data Analysis**

Quantitative data analysis will be performed using statistical software (eg, SPSS). Descriptive statistics summarize the responses, while inferential statistics (regression analysis) evaluate the relationships between SSCM practices and soil conservation indicators. A significance level of  $p < 0.05$  will be used.

**5. Qualitative research**

**5.1 Participant selection**

In-depth interviews were conducted with selected stakeholders in the mining sector, including managers and environmental experts.

**6. Demographics of Participants**

**Table3: Summarizing the Demographic Profile of the Questionnaire Respondents (Authors, 2024)**

Demographic Factor	Categories	Sample Size (N)	% of Total
Company Size	Small	15	30%
	Medium	20	40%
	Large	15	30%
Region	North	12	24%
	South	13	26%
	East	10	20%
	West	15	30%

**7. Discussion and Result**

Findings from a distributed questionnaire regarding the impact of sustainable supply chain management (SSCM) on soil conservation in Iran's mining sector yield several critical conclusions that reflect both quantitative data and qualitative insights gathered from industry experts.

**7.1. A little insight into SSCM practices:**

Analysis of data collected through questionnaires shows a statistically significant positive relationship between specific SSCM practices - such as resource efficiency, effective waste management, and increased stakeholder participation - and soil conservation improvement measures in the mining sector. Respondents strongly acknowledged that adoption of SSCM practices is associated with reduced soil erosion rates and increased soil quality indicators.

**5.2 Data collection approach**

Semi-structured interviews were used to gather qualitative insights related to:

- Understanding of SSCM practices.
- Experiences with soil conservation initiatives.
- Challenges in implementing sustainable practices

**5.3 Data Analysis**

Qualitative data are analyzed and coded using thematic analysis to identify recurring themes related to SSCM and its impact on soil conservation. NVivo software may help in this process.

**7.2. Perceptions of stakeholders:**

Qualitative responses indicate a deep awareness among stakeholders of the importance of sustainable practices in mining operations. Many experts emphasized that integrating environmental considerations into supply chain management not only benefits soil protection but also increases the overall sustainability of mining activities. Narratives provided insights into personal experiences and highlighted the challenges companies faced in effectively implementing these practices.

**7.3. Implementation obstacles:**

Despite recognizing the benefits of SSCM, participants identified several barriers that hinder effective implementation. Key challenges included inadequate training on sustainable practices, lack

of regulatory support, and budget constraints. Many experts noted that there is a gap between awareness of sustainable practices and actual application in mining operations, indicating a need for increased training programs and resources.

**7.4. Recommendations for improved actions:**

Based on the collected data, the experts recommended the development of comprehensive training programs aimed at equipping employees with the necessary skills and knowledge to effectively implement SSCM. Additionally, participants suggested that mining companies foster greater collaboration with local communities and stakeholders, as community participation is critical to the success of soil conservation initiatives.

**7.5. Implications of policy:**

These findings underscore the need for policymakers to develop regulations that not only promote sustainable mining practices, but also provide clear guidelines and incentives for companies committed to soil conservation efforts. Expert insights suggest that stronger government support could facilitate industry-wide adoption of SSCM practices.

**7.6. Directions for future research:**

Respondents expressed a desire for more

research to examine the long-term effects of SSCM on soil conservation and suggested that longitudinal studies would provide valuable insights into sustainability trends over time. There is also a request for comparative studies in different mining sectors in Iran and other countries to identify best practices and increase global understanding of the effectiveness of SSCM.

**7.7. General importance:**

The general results of the questionnaire emphasize the vital role of sustainable supply chain management in promoting soil protection in Iran's mining sector. Integrating quantitative evidence and qualitative perspectives highlights the multifaceted nature of sustainability challenges and provides a roadmap for future research and practical applications in sustainable mining practices.

As a result, the findings of this study not only confirm the positive impact of SSCM on soil conservation, but also emphasize the need for continuous dialogue and action among industry stakeholders and policy makers to advance sustainability plans in Iran's mining sector. Collective insights from experts provide a strong foundation for developing strategies that enhance both the health of the environment and the sustainability of mining operations.



**Figure1: Indiscriminate Harvesting of Soil from the Mountains to Produce Bricks in Mazandaran Province(isna,2018)**

## 8. Conclusion and Suggestions

The investigation into the impact of sustainable supply chain management (SSCM) on soil conservation in Iran's mining sector reveals significant insights into how these practices can be instrumental in enhancing environmental sustainability. Through a comprehensive analysis, this study provides answers to the critical questions surrounding the relationship between SSCM and soil conservation.

### Impact of SSCM Practices on Soil Conservation Efforts:

The adoption of SSCM practices within Iran's mining sector has a profoundly positive effect on soil conservation efforts. The findings indicate that when mining companies implement sustainable practices—such as responsible resource management, effective waste handling, and continuous environmental monitoring—the resulting practices significantly improve soil quality and reduce erosion. By prioritizing environmental sustainability alongside operational efficiency, mining companies contribute to the preservation of topsoil and the overall health of the surrounding ecosystem. This synergistic relationship fosters a sustainable mining environment that not only aims for profit but also emphasizes ecological responsibility.

### Key SSCM Practices Contributing to Soil Conservation:

Several SSCM practices emerge as particularly beneficial for soil conservation in mining areas. These include:

**Resource Efficiency:** Optimizing the use of raw materials minimizes waste and reduces degradation of soil and landscape.

**Waste Management:** Implementing techniques for proper disposal and recycling of mining by-products helps maintain soil integrity and prevents pollution.

**Supplier Collaboration:** Engaging with suppliers who prioritize sustainable practices ensures that all aspects of the supply chain contribute positively to environmental conservation.

**Training and Awareness Programs:** Continuous education of employees about sustainable practices leads to better implementation and adherence to soil conservation measures.

**Restoration Projects:** Actively investing in land rehabilitation and restoration post-mining operations mitigates past environmental damage and improves long-term soil quality.

## Challenges and Opportunities for Implementing SSCM:

Despite the clear benefits, the implementation of SSCM in Iran's mining sector faces several challenges. Key obstacles include:

**Lack of Regulatory Support:** Insufficient government legislation and support for sustainable practices can hinder effective implementation.

**Financial Constraints:** Many mining companies face budgetary limitations that prevent them from investing in sustainable technologies and practices.

**Awareness Gap:** There remains a significant gap in awareness and understanding of SSCM benefits among industry stakeholders.

However, these challenges also present unique opportunities. An increasing global emphasis on environmental sustainability creates a favorable environment for adopting SSCM practices. The potential for government incentives for companies pursuing sustainable practices offers a pathway for growth and development in the sector. Additionally, fostering partnerships between mining companies, local communities, and environmental organizations can lead to cooperative efforts that enhance soil conservation initiatives.

In summary, the findings of this investigation underscore the vital role of sustainable supply chain management in promoting soil conservation within Iran's mining sector. By overcoming existing challenges and actively pursuing key SSCM practices, the mining industry can make significant strides toward environmental stewardship, contributing to the preservation of Iran's valuable soil resources for future generations. The insights from this study advocate for a more integrated and sustainable approach to mining, ensuring that ecological concerns are placed at the forefront of industry practices.

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