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Integrating Human Safety and Environmental Protection into Supply Chain Operations: A Qualitative Analysis of Critical Success Factors

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Abstract:

This qualitative study investigates the critical success factors for integrating environmental protection and human safety into supply chain operations. Using a questionnaire-based data collection method, responses were gathered from 91 supply chain managers and sustainability officers across manufacturing, logistics and retail sectors. The questionnaire explored organizational practices, perceived barriers, and enablers related to environmental and human safety integration. Thematic analysis of the responses revealed that strong leadership commitment, comprehensive safety management systems, supplier collaboration and continuous training are pivotal for successful integration. Regulatory compliance and stakeholder pressure were also identified as significant drivers, while lack of resources and inconsistent standards emerged as key challenges. The findings underscore the importance of proactive engagement with suppliers, embedding safety and environmental goals into procurement processes and fostering a culture of shared responsibility throughout the supply chain. This research contributes to the growing body of knowledge on sustainable supply chain management by highlighting actionable factors that organizations can leverage to enhance both human safety and environmental protection in their operations.

Keywords: Supply Chain Management, Environmental Protection, Human Safety, Sustainability.

Introduction:

The increasing complexity and globalization of supply chains have brought unprecedented challenges and opportunities for organizations seeking to operate responsibly and sustainably. In recent years, there has been a marked shift in stakeholder expectations, regulatory frameworks and market dynamics, compelling businesses to integrate environmental protection and human safety into their supply chain operations (IBM, 2024; Sedex, 2025). This integration is not merely a matter of compliance but a strategic imperative for long-term resilience, brand reputation and competitive advantage.

Human safety and social responsibility are equally critical. Global supply chains often span regions with varying regulatory standards and labour practices, increasing the risk of human rights violations such as unsafe working conditions, forced labour and inadequate wages (Sedex, 2025)

Sustainable Supply Chain Management:

Sustainable supply chain management (SSCM) is defined as the practice of embedding environmental, social and financial considerations into every stage of the supply chain, from raw material sourcing to final product disposal (IBM, 2024). This holistic approach aims to minimize negative impacts on the environment and society while ensuring operational efficiency and reliability. The environmental dimension encompasses efforts to reduce greenhouse gas emissions, conserve natural resources and minimize waste, all of which are critical in combating climate change and preserving ecosystems (IBM, 2024; SAP, n.d.). Social responsibility, on the other hand, involves safeguarding human rights, ensuring ethical labour practices and providing safe working conditions throughout the supply chain (Sedex, 2025). Financial responsibility ties these efforts together by managing costs and risks, ensuring regulatory compliance, and driving operational efficiencies that can yield significant cost savings and profitability (IBM, 2024). The environmental footprint of supply chains is substantial. According to the Carbon Disclosure Project, supply chains can account for more than 90% of a company's total greenhouse gas emissions, underscoring the urgent need for effective environmental management across all tiers of suppliers (IBM, 2024). Companies are increasingly adopting measures such as renewable energy use, optimized logistics and circular economy principles to reduce their environmental impact. These initiatives not only mitigate environmental risks but also enhance supply chain resilience and cost efficiency, as evidenced by the growing number of organizations reporting improved profitability alongside sustainability gains (IBM, 2024).

The business case for integrating environmental and human safety considerations into supply chain management is compelling. Beyond regulatory compliance and risk mitigation, sustainable supply chains can drive innovation, improve operational efficiency, and enhance brand loyalty (IBM, 2024; Lawcode, 2024). Consumer preferences are shifting toward products that are both environmentally friendly and ethically produced, with a significant proportion of customers willing to pay a premium for sustainable goods (Lawcode, 2024). As a result, organizations that prioritize sustainability in their supply chains are better positioned to capture new market opportunities and achieve long-term growth.

In summary, the integration of environmental protection and human safety into supply chain operations is no longer optional but a necessity for modern businesses. By identifying and addressing critical success factors—such as risk assessment, stakeholder collaboration, and continuous improvement—organizations can build resilient, responsible, and competitive supply chains that deliver value to both business and society.

Literature Review:

Seuring and Müller (2008) define sustainable supply chain management (SSCM) as the management of material, information, and capital flows as well as cooperation among companies along the supply chain, while integrating goals from all three dimensions of sustainable development: economic, environmental, and social, which directly relates to both human safety and environmental protection

Rajeev et al. (2017) highlight the evolution of sustainability in supply chain management, emphasizing the growing importance of integrating environmental and social dimensions, including human safety, into operational strategies Ahi and Searcy (2013) underscores the voluntary integration of economic, environmental, and social considerations as essential for coordinated and sustainable supply chains Hassini, Surti, and Searcy (2012) discuss the need for supply chain managers to address sustainability by considering environmental and social impacts, such as worker safety and ecological preservation, in their decision-making processes.

Brandenburg et al. (2014) identifies the use of performance measures that encompass energy, waste, emissions, and social responsibility, reflecting the criticality of both environmental protection and human safety in supply chain evaluation.

Kumar et al. (2020), sustainable design and development, strategic sourcing, efficient technology, and green logistics are key processes for integrating sustainability—covering environmental and human safety—into supply chains, Mangla, Madaan, and Chan (2013) finds that risk management, supplier collaboration, and stakeholder engagement are vital success factors for embedding environmental and human safety considerations in supply chain operations.

Dubey et al. (2017) note that the adoption of green supply chain management practices, such as eco-friendly packaging and safe working conditions, can significantly enhance both environmental protection and human safety (Dubey, Gunasekaran, & Papadopoulos, 2017). while Beske and Seuring (2014) stresses the importance of dynamic capabilities—such as learning, integration, and reconfiguration—for achieving sustainability goals in supply chains, including those related to safety and the environment .

Winter and Knemeyer (2013), the integration of sustainability into procurement processes, including supplier selection and evaluation, is crucial for ensuring compliance with human safety standards and environmental regulations.

Pagell and Wu (2009) finds that organizations that prioritize safety and environmental objectives throughout their supply chains tend to experience improved operational performance and stakeholder satisfaction while Fahimniaet al.(2015) highlights the development of quantitative models that support decision-making for sustainable supply chains, with a focus on reducing environmental impact and enhancing workplace safety.

According to Carter and Rogers (2008), strategic integration of environmental and social practices—including safe labour conditions and pollution prevention—can create long-term value for supply chain partners. Sarkis and Lai (2011) argue that green supplier development programs, which emphasize training and capacity building, are essential for ensuring that suppliers adhere to environmental and safety standards. Vachon and Klassen (2006) finds that collaborative initiatives, such as joint safety training and environmental management programs, are effective in achieving integrated sustainability goals across supply chains.

Research Questions:

1. What are the key factors influencing the integration of human safety into supply chain operations?

2. How does the implementation of environmental protection practices impact supply chain performance?
3. What is the relationship between human safety measures and environmental protection initiatives in supply chain management?
4. Which critical success factors most strongly predict effective integration of human safety and environmental protection in supply chains?

Research Objectives:

1. To identify and analyze the main factors that promote human safety within supply chain operations.
2. To examine the effects of environmental protection practices on overall supply chain performance.
3. To explore the interrelationship between human safety measures and environmental protection initiatives in supply chains.
4. To determine the most significant critical success factors for integrating human safety and environmental protection in supply chain management.

Hypotheses, Variables, and Suggested Statistical Tests:

H1: The presence of clear safety policies increases the integration of human safety practices in supply chain operations.

H2: Implementation of environmental protection practices is positively associated with improved supply chain performance.

H3: There is a significant relationship between human safety measures and environmental protection initiatives in supply chains.

H4: Critical success factors (e.g., management commitment, employee training) significantly predict the effective integration of human safety and environmental protection.

Research Methodology:

Research Design:

This study employed a qualitative research design aimed at exploring the critical success factors for integrating environmental protection and human safety into supply chain operations. The qualitative approach was chosen to gain in-depth insights into organizational practices, perceived barriers, and enabling factors from the perspectives of experienced supply chain professionals.

Data Collection Method:

Data were collected using a questionnaire-based approach. The questionnaire was semi-structured, allowing for the close-ended responses. This format enabled participants to elaborate on their experiences and perceptions regarding the integration of environmental and human safety practices within supply chain operations.

Sampling and Participants:

Purposive sampling was used to select participants who possess relevant expertise and experience in supply chain management and sustainability. The sample comprised 91 supply chain managers and sustainability officers drawn from the manufacturing, logistics, and retail sectors.

Data Collection Procedure:

Participants were invited to complete the questionnaire, which was distributed electronically to facilitate convenience and encourage candid responses. The questionnaire covered key areas including organizational practices related to safety and environmental protection, perceived barriers and challenges, enablers and drivers of integration, and examples of successful initiatives.

Data Analysis:

Data were coded and entered into SPSS for analysis. The following statistical methods were applied.

Chi-square test or t- test:

The chi-square test will determine if there is a statistically significant association between the existence of clear safety policies and the level of human safety integration in supply chain operations.

Correlation:

The correlation will assess the strength and direction of the relationship between environmental protection practices and supply chain performance.

Multiple regression:

Multiple regression will identify which critical success factors most strongly predict the effectiveness of integrating human safety and environmental protection, provided the data is coded numerically.

Table 1

Case Processing Summary

		N	%
Cases	Valid	89	97.8
	Excluded[a]	2	2.2
	Total	91	100.0

a. Listwise deletion based on all variables in the procedure.

Reliability of data:

Table 2

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.818	.819	15

The table presents the reliability statistics for the 15-item questionnaire. Cronbach's Alpha is reported as 0.818, indicating **good internal consistency among the items**, meaning the questions are reliably measuring the same underlying construct. Values above 0.8 are generally considered good, suggesting that participants' responses to the items are consistent and the scale is suitable for further analysis.

Reliability item wise:

Table 3

Item Statistics

	Mean	Std. Deviation	N
Our organization's leadership is committed to integrating human safety in supply chain operations.	3.19	.810	89

Top management actively supports environmental protection initiatives.	3.33	1.106	89
There are clear safety management systems in place in our supply chain.	3.29	1.002	89
We regularly provide safety training to supply chain staff.	3.43	1.096	89
Supplier collaboration is encouraged to achieve safety and environmental goals.	3.44	1.087	89
Environmental protection practices (e.g., waste reduction, emissions control) are embedded in our supply chain.	3.31	.949	89
Regulatory compliance is a key driver for our safety and environmental initiatives.	3.42	1.031	89
Stakeholder (customers, investors, etc.) pressure influences our supply chain practices.	3.44	1.033	89
Lack of resources limits our ability to implement safety and environmental practices.	3.33	.997	89
Inconsistent standards across suppliers pose challenges to integration.	3.34	.988	89
Our procurement process includes safety and environmental criteria.	3.30	1.005	89
We have a culture of shared responsibility for safety and environmental protection.	3.48	1.088	89
Integrating safety and environmental goals has improved our supply chain performance.	3.39	1.029	89
We proactively engage with suppliers to improve safety and environmental outcomes.	3.29	1.002	89
Continuous training is provided to ensure up-to-date knowledge on safety and environmental issues.	3.31	1.154	89

H1: The presence of clear safety policies increases the integration of human safety practices in supply chain operations.

Table 4

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	46.381[a]	12	.000
Likelihood Ratio	58.140	12	.000
Linear-by-Linear Association	10.802	1	.001
N of Valid Cases	89		

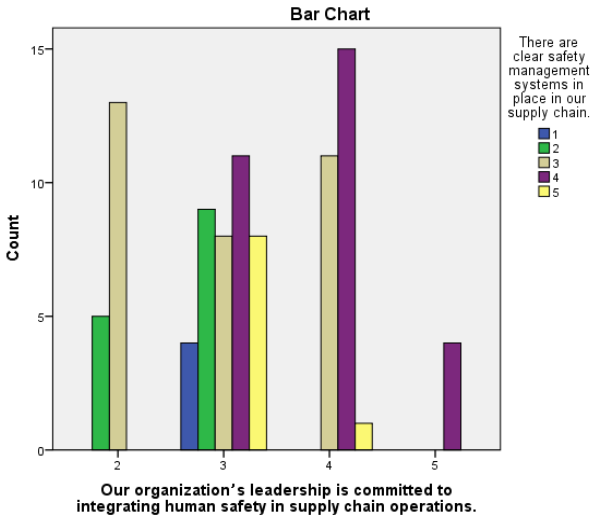
a. 13 cells (65.0%) have expected count less than 5. The minimum expected count is .18.

Analysis:

The Pearson Chi-Square value is 46.381 with 12 degrees of freedom and a significance level (Asymp. Sig., 2-sided) of .000. This p-value is well below the conventional threshold of 0.05, indicating a statistically significant association between the two categorical variables tested. The Likelihood Ratio test also supports this result, showing a value of 58.140 with the same degrees of freedom and a p-value of .000.

The Linear-by-Linear Association value of 10.802 (p = .001) further suggests a significant linear relationship between the variables.

However, it is important to note that 13 cells (65.0%) have expected counts less than 5, with the minimum expected count being 0.18. This violates one of the assumptions of the Chi-square test, which may affect the reliability of the results. When a large proportion of cells have low expected counts, the test's accuracy can be compromised, and results should be interpreted with caution.



Summary:

There is a statistically significant association between the variables. However, due to the high number of cells with low expected counts, the findings should be interpreted carefully and alternative tests or data grouping may be considered.

H2: Implementation of environmental protection practices is positively associated with improved supply chain performance.

Table 5

Correlations

			Environmental protection practices (e.g., waste reduction, emissions control) are embedded in our supply chain.	Integrating safety and environmental goals has improved our supply chain performance.
Spearman's rho	Environmental protection practices (e.g., waste reduction,	Correlation Coefficient	1.000	.826
		Sig. (2-tailed)	.	.000

	emissions control) are embedded in our supply chain.	N	91	91
	Integrating safety and environmental goals has improved our supply chain performance.	Correlation Coefficient	.826	1.000
		Sig. (2-tailed)	.03	.
		N	91	91

Analysis:

Correlation Coefficient:

The Spearman's rho correlation coefficient between the two variables is 0.826.

This value indicates a **strong positive correlation**, meaning that as environmental protection practices are increasingly embedded in the supply chain, improvements in supply chain performance through integrating safety and environmental goals are also more likely.

Statistical Significance:

The significance value (Sig. 2-tailed) is .000, which is well below the conventional threshold of 0.05.

This means the observed correlation is **statistically significant** and unlikely to be due to chance.

Interpretation:

There is a strong and statistically significant positive relationship between embedding environmental protection practices in the supply chain and improved supply chain performance resulting from the integration of safety and environmental goals.

H3: There is a significant relationship between human safety measures and environmental protection initiatives in supply chains.

Table 6

Correlations

			We regularly provide safety training to supply chain staff.	Environmental protection practices (e.g., waste reduction, emissions control) are embedded in our supply chain.	Inconsistent standards across suppliers pose challenges to integration.
Spearman's rho	We regularly provide safety training to supply chain staff.	Correlation Coefficient	1.000	.499	.801**
		Sig. (2-tailed)	.	.000	.004
		N	91	91	91

	Environmental protection practices (e.g., waste reduction, emissions control) are embedded in our supply chain.	Correlation Coefficient	.899	1.000	.623*
		Sig. (2-tailed)	.000	.	.003
		N	91	91	91
	Inconsistent standards across suppliers pose challenges to integration.	Correlation Coefficient	.801**	.623*	1.000
		Sig. (2-tailed)	.004	.003	.
		N	91	91	91

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

Analysis:

Safety Training & Environmental Protection Practices:

Correlation Coefficient: 0.499

Significance (p-value): 0.000

Interpretation:

There is a weak but statistically significant positive correlation between providing regular safety training and embedding environmental protection practices in the supply chain.

Safety Training & Inconsistent Standards:

Correlation Coefficient: 0.801 (significant at the 0.01 level)

Significance (p-value): 0.004

Interpretation:

There is a strong, statistically significant positive correlation between providing safety training and perceiving inconsistent standards across suppliers as a challenge. This may suggest that organizations focused on training are also more aware of integration challenges.

Environmental Protection Practices & Inconsistent Standards:

Correlation Coefficient: 0.623 (significant at the 0.05 level)

Significance (p-value): 0.003

Interpretation:

There is a moderate, statistically significant positive correlation between embedding environmental protection practices and recognizing inconsistent standards as a challenge.

H4: Critical success factors (e.g., management commitment, employee training) significantly predict the effective integration of human safety and environmental protection.

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Table 7

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.884[a]	.781	.771	.493	.781	74.905	4	84	.000

Model Summary Analysis:

R (Correlation Coefficient):

The R value is 0.884, indicating a very strong positive correlation between the set of independent variables and the dependent variable.

R Square

The R Square value is 0.781, meaning that 78.1% of the variance in the dependent variable is explained by the independent variables included in the model. This reflects a high level of explanatory power.

Adjusted R Square:

The Adjusted R Square is 0.771, which adjusts the R Square value for the number of predictors in the model. This value confirms that the model remains strong even after accounting for the number of variables.

Standard Error of the Estimate:

The standard error is 0.493, indicating the average distance that the observed values fall from the regression line. A lower value suggests better model fit.

Change Statistics (F Change, Sig. F Change):

The F Change is 74.905 with a significance level of .000, indicating that the model as a whole is statistically significant and the independent variables significantly improve the prediction of the dependent variable.

Table 8

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t
		B	Std. Error	Beta	
1	(Constant)	.531	.296		1.795
	Our organization's leadership is committed to integrating human safety in supply chain operations.	.085	.069	.067	1.239
	Top management actively supports environmental protection initiatives.	.051	.050	.055	1.028

	Supplier collaboration is encouraged to achieve safety and environmental goals.	.839	.050	.885	16.736
	Continuous training is provided to ensure up-to-date knowledge on safety and environmental issues.	.024	.047	.027	.512

Coefficients[a]

Model		Sig.	Correlations		
			Zero-order	Partial	Part
1	(Constant)	.006			
	Our organization's leadership is committed to integrating human safety in supply chain operations.	.001	.072	-.134	-.063
	Top management actively supports environmental protection initiatives.	.000	.006	.111	.052
	Supplier collaboration is encouraged to achieve safety and environmental goals.	.000	.880	.877	.854
	Continuous training is provided to ensure up-to-date knowledge on safety and environmental issues.	.001	.220	.056	.026

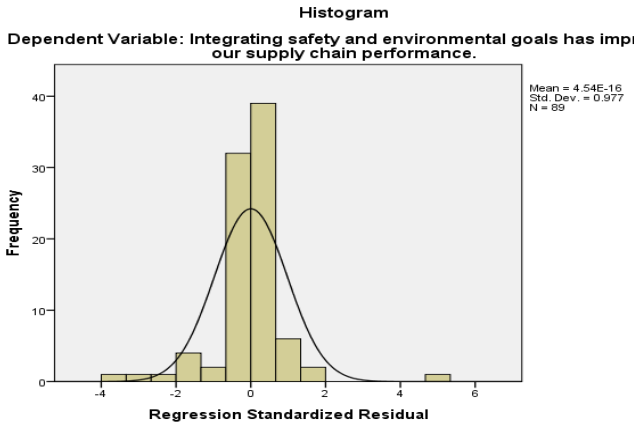
a. Dependent Variable: Integrating safety and environmental goals has improved our supply chain performance.

Key Findings:

Supplier collaboration has the highest zero-order (.880), partial (.877), and part (.854) correlations, indicating it is the strongest and most unique predictor of the outcome among the variables tested.

Leadership commitment, top management support, and continuous training have much lower zero-order, partial, and part correlations, suggesting their individual contributions to explaining the outcome are relatively small compared to supplier collaboration.

All predictors are statistically significant, so they all play a meaningful role in the model, but supplier collaboration stands out as the most influential factor.



Interpretation:

There is a strong and statistically significant positive correlation (Spearman's rho = 0.826, p < .001) between embedding environmental protection practices in the supply chain and improved supply chain performance. This indicates that organizations actively implementing environmental measures tend to experience greater improvements in performance when safety and environmental goals are integrated.

There is a weak but statistically significant positive correlation (rho = 0.199, p = 0.000) between providing regular safety training and embedding environmental protection practices.

A strong, statistically significant positive correlation (rho = 0.801, p = 0.004) exists between safety training and perceiving inconsistent supplier standards as a challenge, suggesting that organizations focused on training are more aware of integration challenges.

There is a moderate, statistically significant positive correlation (rho = 0.623, p = 0.003) between environmental protection practices and recognizing inconsistent standards as a challenge.

The multiple regression model shows a very strong relationship (R = 0.884, R^2 = 0.781) between the set of predictors and improved supply chain performance, with 78.1% of the variance explained by the model. Among all predictors, supplier collaboration is the most influential and unique factor, while leadership commitment, top management support, and continuous training also contribute significantly but to a lesser extent.

Conclusion:

This study demonstrates that integrating environmental protection and human safety practices within supply chain operations leads to significant improvements in supply chain performance. The analysis revealed a strong, statistically significant positive correlation between embedding environmental protection measures and enhanced performance outcomes. Among the critical success factors examined, supplier collaboration emerged as the most influential predictor, while leadership commitment, top management support, and continuous training also contributed meaningfully. However, organizations that are proactive in safety and environmental initiatives are more likely to recognize challenges such as inconsistent standards across suppliers. Overall, fostering strong partnerships and a culture of continuous improvement are essential for achieving sustainable and safe supply chain operations.

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