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Managing Environmental Pollution of Sugar Companies in Western Kenya: A Supply Chain Integration Approach

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A B S T R A C T

The sugar processing industry has a considerable impact on society, the environment, and the economy, offering chances for individuals to contribute to sustainability efforts. However, a lack of coordination and cooperation among supply chain players can hinder these efforts. In western Kenya, the establishment of sugar factories provides opportunities, but the locals cannot take full advantage due to ongoing conflicts arising from the firms' industrial processes leading to soil and water pollution. Despite the sugar firms' efforts to reduce pollution, the results have not been satisfactory. Research has however revealed that environmental degradation cannot be reduced effectively without supply chain integration, which involves coordination, cooperation, and collaboration among supply chain players. The purpose of the study was to analyse the effect of SCI on environmental performance of sugar firms in Western Kenya. The study used explanatory research design and was grounded in Stakeholder theory. The reliability of the instrument was assessed by Cronbach's alpha coefficient, and the results showed that all the coefficients for SCI constructs were 0.747, which exceeded the standard threshold of 0.7. The R2 for SCI was found to be 0.211, which was significant and indicated that SCI could explain 21.1% of the sugar companies' environmental performance. The study concluded that if the supply chain of sugar firms worked collaboratively, it could significantly contribute to positive environmental outcomes of the processing activities.

Keywords: Cooperation, Collaboration, Integration, supply chain

1. INTRODUCTION

Sahin and Robinson (2002) define supply chain integration (SCI) as a series of actions that involve organizing the movement of goods between supply chain partners through transactions, materials movements, procedures, and optimization processes, while considering the information flows that underlie these activities. In contrast, operational integration involves the cooperative creation of activities, collaborative work processes, and coordinated decision-making among supply chain partners. On the other hand, information exchange refers to the coordination of communication and information flow. Improving cross-departmental cooperation, encouraging employee participation in environmental efforts, and expanding environmental competencies are the key areas of focus for internal integration, according to Wu (2013).

Kim (2009) describes supply chain integration as a complex process that links the movement of goods and information from suppliers to end consumers through various organizational units. On the other hand, Flynn *et al.* (2010) define supply chain integration as the extent to which a producer collaborates strategically with its supply chain partners by managing inter-organizational processes collaboratively. Their objective is to create efficient flows of products, services, information, money, and decisions and to provide cost-effective and timely products to the consumer.

Frohlich and Westbrook (2001) define supply chain integration as an organizational procedure that brings together suppliers, customers, and internal units, aiming to enhance the overall performance of all participants of the supply chain. Swink (2007) adds that this process involves sharing and combining strategic information and knowledge with external partners. Rosenzweig, Roth, and Dean (2003) describe supply chain integration as the interconnection of various segments of the supply chain.

According to Jespersen and Larsen (2005), supply chain integration encompasses both internal linkages between departments and external linkages with suppliers and customers. Achieving supply chain integration requires the dominant partner to recognize the importance of information exchange and mobilize all partners. Sarkis and Dou (2017) propose that advancements in technology, such as the internet and real-time news, have made communication and information sharing easier for organizations. They suggest that environmental communication should be a priority for organizations seeking to protect their image and reputation. Fabbe-Costes and Jahre (2008) propose that the integrated SCM concept involves merging various SCM functions into a single program, which is then coordinated and streamlined to create a seamless process. This approach involves all participants in the supply chain, including vendors, carriers, third-party companies, information systems providers, and internal departments.

According to Lee (2000), there are four dimensions of supply chain integration that impact the level of integration: information sharing (Exchange), coordination, resource sharing, and organizational relationship linkage. Simatupang *et al.*, (2002) expand on this concept by identifying the different types of coordination required to integrate the supply chain processes of various parties. These include logistics synchronization, information sharing,

incentive alignment, and collective learning, all of which indicate a higher level of collaboration and integration in the supply chain. Zailani and Rajagopal (2005) suggest that integrating with partners and suppliers, using online capabilities to bring products and services to market more quickly, and developing new sales or distribution channels can lead to new opportunities.

2. LITERATURE REVIEW

Numerous empirical studies have been done to examine the link between supply chain integration and environmental performance. Li, Qiao, Cui, and Wang (2020) proposed a strategy-structure-performance (SSP) paradigm to study how proactive environmental strategies increase the level of environmental protection by integrating green supply chains. To test the hypothesis, a structural equation model was developed based on survey responses from 252 Chinese manufacturing firms. The results showed that companies implementing a proactive environmental strategy are more apt to support internal green integration when it comes to suppliers' green integration, thus improving their level of environmental protection. The study found that supplier environmental cooperation can directly promote the environmental protection level of manufacturing enterprises, while supplier greening indirectly improves the environmental protection level of enterprises through supplier environmental cooperation, separating the two functions of green supplier integration (supplier-environment friendliness and environmental cooperation provider).

Researchers Tran, Phan, Ha, and Hoang (2020) looked at how supply chain quality integration affected a supply framework that is environmentally responsible and success in Vietnam's tourism sector. 568 Vietnamese tourist businesses in were examined. According to the results, sustainable financial and environmental management, as well as GSCM, benefited from integration of supply chain quality. It was prudent for the business's bottom line and the environment to manage a green supply chain. GSCM also played a full role in bridging the gap between financial performance and supply chain quality.

Han and Huo (2020) explored supply chain integration's effects on sustainability. The aim of this investigation was to examine how sustainable supply chain integration which considers environmental, social, and economic variables, affects long-term sustainability. The theoretical model, which relied on data from 206 Chinese manufacturers, was tested using maximum-likelihood estimation and structural equation modeling technique. The results showed that various GSCI variables exhibited various outcomes. Green internal integration provides the framework for integration of environmentally friendly suppliers and customers, both of which were linked to social and environmental performance.

Kang, Yang, Park, and Huo (2018) examined supply chain partnering and its impact on sustainability. The purpose of this study was to investigate the ways in which sustainability management practices and performance can be enhanced by supply chain integration (SCI). They used data from 931 manufacturing businesses in a variety of countries and regions and structural equation modeling to investigate the presented assumptions. According to the research, integration of suppliers and customers is an essential driver for sustainability management strategies both within and across organizations. It was discovered that sustainability performance—that is, economic, environmental, and social performance—is significantly and positively associated with both intra and inter organizational sustainability management practices, and they collaborate to enhance environmental and social performance.

Liu, Ke, Kee Wei, and Hua (2013) conducted research in China on the effects of market orientation and integration of the supply chain on business performance. The motivation behind this exploration was to investigate the effect of two distinct sorts of production network mix on two attributes of business execution in China's rising economy. It looked at how market orientation affected the connection between business performance and supply chain integration. Testing of the hypotheses was done using hierarchical regression analysis. Functional coordination was well connected with functional and business execution, as per the discoveries. Additionally, it was discovered that the sharing of information had no effect on business performance; It only had an impact on operational efficiency. The findings lend credence to the hypothesis that market orientation moderates the relationship between business performance and supply chain integration.

According to González-Benito, *et al* (2016), the effect of sustainable purchasing on the performance purchasing function of Portuguese businesses was moderated by long-term partnerships and strategic integration. The purpose of this article was to investigate the connection between company performance and environmental purchasing management. According to the findings, the effectiveness of the purchasing function is enhanced by using green purchasing management and has a greater impact when the company forms long-term alliances with its suppliers through coordination and information sharing.

Zu'bi, Tarawneh, Abdallah, and Fidawi (2015) assessed the impacts of integrating the supply chain on environmental performance in the food industry in Jordan. Pollution control and management were used to assess environmental success. To respond to the study's questions and confirm its theories, descriptive statistical techniques and simple regression tests were applied. This study revealed that supply chain integration improved environmental efficiency in terms of pollution control and prevention.

Dubey, Gunasekaran, and Ali (2015) delved into the links between leadership, operational procedures, institutional pressures, and environmental success using a paradigm for a green supply chain. In all, 174 Indian businesses that produce rubber products were investigated. The goal of this research was to determine how total quality management (TQM) and supplier relationship management (SRM) impacted environmental performance while being influenced by institutional pressures and leadership. Data was obtained using a split poll technique. The results proved that supplier merging had a positive effect on environmental performance.

Vachon and Klassen (2006) looked into how green production techniques affected the competitiveness of the package printing sector both in Canada and the United States of America.According to the results, technology integration with main suppliers and major consumers had a positive correlation with environmental monitoring and collaboration. The only connection for logistical integration that was found to be effective was environmental monitoring of suppliers. Finally, the scope of the environmental partnership with main suppliers diminished as the supply base did.

Dubey, Gunasekaran, and Ali (2015) delved into the links between leadership, operational procedures, institutional pressures, and environmental success using a paradigm for a green supply chain. In all, 174 Indian businesses that produce rubber products were investigated. The goal of this research was to determine how total quality management (TQM) and supplier relationship management (SRM) impacted environmental performance while being influenced by institutional pressures and leadership. Data was obtained using a split poll technique. The results proved that supplier merging had a positive effect on environmental performance.

Yu, Zhang, and Huo (2019) developed a model to examine the links between two components of sustainable supply chain management, i.e green purchasing and consumer green partnership, quality integration in supply chain, and environmental prosperity. The model was experimentally tested using data from 308 Chinese manufacturing companies. According to the research, integrating supplier and customer quality had a positive influence on environmentally friendly buying and customer cooperation, which led to better environmental performance. It was discovered that supplier and customer quality integration through green buying and customer green cooperation had an indirect impact on environmental performance. The study illuminated both the complex interactions between SCQI and GSCM as well as the mechanisms by which SCQI impacts environmental performance.

In Kenya, Mose (2015) examined the impact of supply chain integration methods on the success of Rwanda's pig processing sector. The study adopted a quantitative research methodology to fulfill its research objective. Questionnaires were used to investigate the integration of internal resources, supplier integration, customer integration, and company performance. The results showed a strong and positive relationship between company performance and integration within the organization, supplier integration, and customer integration. The study recommended identifying the challenges and impediments to the adoption of supply chain integration.

Supply chain integration is clearly a crucial factor for achieving positive environmental performance of enterprises, as all supply chain stakeholders are involved in sustainability practices both upstream and downstream, as evidenced by the reviewed studies. Local researchers, on the other hand, have made no attempt to explore this relationship in our local manufacturing enterprises in Kenya, despite the fact that the local manufacturing sector's environmental footprints are expanding and becoming difficult to control. Supply chain integration is positively and significantly connected to environmental performance, according to the findings of the evaluated studies.Tran, *et al*, (2020), Han & Huo, (2020), Kang, *et al*, (2018), Zu'bi, Tarawneh, Abdallah & Fidawi,(2015), Li *et al*.,(2020). These findings highlight the importance of supply chain integration in promoting environmental performance and sustainability. However, the validation of the above findings is lacking in the Kenyan sugar industry context.

3. METHODOLOGY

3.1 Research Design

The research philosophy employed in the study was positivism, which aims to establish causal or explanatory relationships to enable prediction and management of a phenomenon. The study aligns with this philosophy as it sought to determine the connections between SCI, and environmental performance of firms. In positivist experimentation, the primary goal is to isolate and control all factors, focusing only on the key variables of interest, as noted by Park, Konge, and Artino (2020).

To establish correlations between variables, a study requires an explanatory research design. This design is the most appropriate for determining both direct and indirect causal links among variables, as explained by Bairagi and Munot (2019). Explanatory studies aim to justify and explain descriptive data by answering "why" and "how" questions, whereas descriptive studies only explore "what" questions (Baskerville & Pries-Heje, 2010). Unlike descriptive and exploratory research, explanatory studies aim to identify and document connections between various components of a phenomenon, and ultimately pinpoint its true causes. By seeking out causes and motivations, explanatory studies can provide data that either confirms or refutes an explanation or prediction. (Rahi, 2017)

3.2 Area of Study

The study was conducted in Western Kenya, where most of the sugar mills are situated. It encompassed eight sugar companies. These companies were Chemelil Sugar Company, West Kenya Sugar Company, Nzoia Sugar Company, Sony Sugar Company, Kibos Sugar and Allied Industries, Butali Sugar Mills Limited, Sukari Company, and Busia Sugar Company. The study assessed the sugar mills that are presently operational and have an established environmental management system.

3.3 Reliability of data Instrument

Reliability refers to the consistency and accuracy of results obtained from multiple trials of an experiment, test, or measuring process. The aim is to ensure the stability of the instrument and assess the dependability of responses. Conducting two surveys with the same instrument is an effective way to achieve this, but it can be challenging when dealing with high-level executives. In this particular study, Cronbach's Alpha was used to gauge reliability (Cronbach, 1951). The dependability coefficient should be greater than 0.7 for a study to be considered appropriate, as noted by Ercan *et al*. (2007). The constructs of the study were tested for reliability and the outcomes are as presented in the table below:

Table 1: Measure of Cronbach's Alpha(α)Coefficients

	Cronbach's Alpha	**Cronbach's alpha based on standardized items**	**No. of items**
Supply chain coordination	.823	.822	3
Supply chain cooperation	.716	.718	3
Supply chain collaboration	.702	.701	3
Average	**0.747**	**0.747**	

Source: Survey Data, (2021)

The table indicates that the data collection tool received a favorable rating since all of its Cronbach's alpha coefficients were above 0.70. This suggests that the data obtained is internally consistent and can be generalized to represent the views of the target group, as per Thompson's (2003) criteria. The instrument was double-checked to identify any potential issues. The pilot study revealed that most of the questions were unambiguous and pertinent.

3.4 Regression Model

The model proposed for the study was: $Y= \beta_0+\beta_1X_{1i} + \beta_2X_{2i}+ \beta_3X_{3i} +\varepsilon$

Where:

X_1= Supply Chain Coordination**,**

X_2=Supply Chain Cooperation

X_3=Supply Chain Collaboration

Y= Environmental Performance

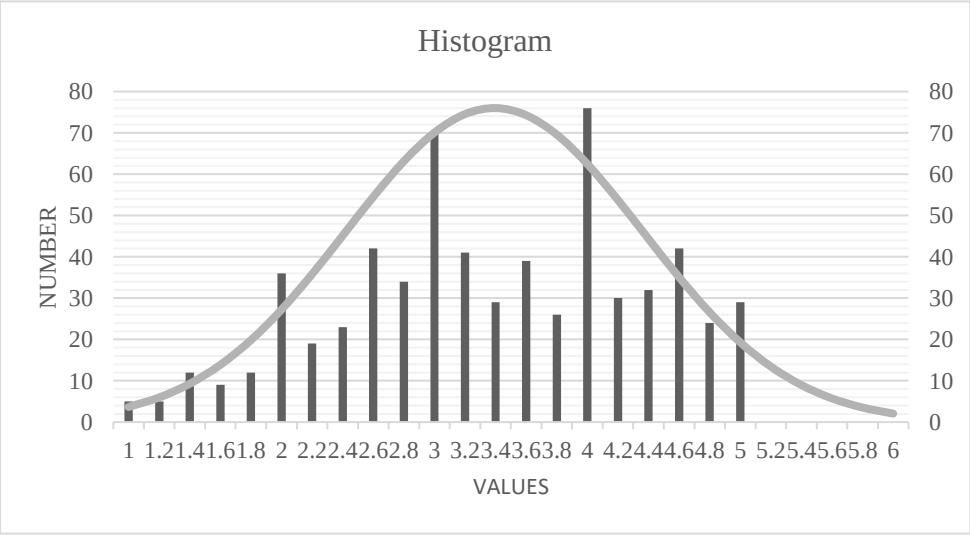
3.5 Regression Model Diagnostics

Regression diagnostics are utilized to confirm the model assumptions and detect any data that may have a notable negative impact on the analysis. The hypotheses of normality, linearity, and error uncorrelation are necessary for multiple regression analysis, and are therefore checked before proceeding with the analysis.

3.5.1 Testing for Normality Requirements

Normality was tested using a histogram which showed a normal distribution with skewness of -0.221 and kurtosis of -0.772 which falls within the range of -0.5 and 0.5, which showed the distribution was symmetric as indicated in the figure 2 below:

Fig 1: Normality Test Using Histogram



Source: Survey Data, (2021)

3.5.2 Testing for Independence of Errors

In order to assess the correlation of dependent errors, the Durbin-Watson statistic was utilized. If the Durbin-Watson statistic falls within the range of 1.50 to 2.50 or 1.0 to 3.0, the errors are deemed uncorrelated. The Durbin-Watson statistic for the errors was calculated to be 1.338 as indicated in table below, which means that the errors were uncorrelated.

Table 2: Independence of errors test Results

	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	.823[a]	.678	.665	.50700	1.765
a. **Predictors:** (Constant), Supply chain integration					
b. **Dependent Variable**: Environmental performance					

Source: Survey data, (2021)

3.5.3 Testing for Linearity

According to Harvey, Leybourne, and Xiao (2008), in order for there to be a linear relationship between multiple variables, the significance level associated with "Deviation from linearity must be larger than 0.05" must be less than or equal to 0. All five variables in the study were found to have a significance level greater than 0.05, indicating a linear association among the factors being examined. The results of the regression test are presented in table below:

Table 3: Test for Linearity Results

			Sum of Squares	**df**	**Mean Square**	**F**	**Sig.**
Environmental performance * Supply chain integration	Between Groups	(Combined)	11.618	14	.830	.866	.597
		Linearity	.048	1	.048	.050	.823
		Deviation from Linearity	11.569	13	.890	.928	.526
	Within Groups		107.364	112	.959		
	Total		118.982	126			

Source: Survey Data, (2021)

4. RESULTS AND DISCUSSIONS

4.1 Paired sample Correlations

Supply chain coordination, cooperation and collaboration were the three constructs that were used to assess SCI as an explanatory variable. A paired sample T-test study was used to determine the significance of the SCI constructs, The results showed that, at a significance level of $p < 0.05$, there was a positive and significant correlation between all indicators of supply chain Integration and environmental performance of the firms surveyed as indicated in the table below:

Table 4: Paired sample Correlation results

Correlations		N	Correlation coefficients	Sig.
Pair 1	Supply chain Coordination & Environmental Performance	127	.468	.000
Pair 2	Supply chain Cooperation & Environmental Performance	127	.516	.000
Pair 3	Supply chain Collaboration& Environmental Performance	127	.480	.000

Source: Survey Data, (2021)

4.2 Rating of Supply Chain Integration

Rating of supply chain integration was done in terms of the extent to which supply chain integration measures are applied by sugar firms in Western Kenya. The responses were tabulated descriptively and the results were as shown in the table below:

Table 4: Rating on Extent of supply Chain Integration by Sugar Firms

Measures of supply chain integration		**Supply chain integration**						
		Strongly disagree	Disagree	Neutral	Agree	Strongly agree	μ	SD
Open sharing of supply chain information with supply chain partners on environmental topics	**f**	16	23	30	35	23		
	%	12.6%	18.1%	23.6%	27.6%	18.1%		
	μ	2.5000	2.5072	3.2222	3.2667	3.9565	3.2047	1.2869
Providing green technological advice to supply chain players	**f**	15	32	19	42	19		
	%	11.8%	25.2%	15.0%	33.1%	15.0%		
	μ	2.2333	2.6198	3.1228	3.5833	3.8158	3.1417	1.2813
Joint and team problem solving on environmental issues	**f**	17	25	19	40	26		
	%	13.4%	19.7%	15.0%	31.5%	20.5%		
	μ	2.3824	2.4467	2.9825	3.3792	4.0833	3.2598	1.3464
Working together with suppliers and buyers to gain joint environmental benefits	**f**	14	34	27	34	18		
	%	11.0%	26.8%	21.3%	26.8%	14.2%		
	μ	2.1786	2.6422	2.9877	3.7206	4.0093	3.0630	1.2456
Being frank among supply chain partners in all the dealings for environmental gains	**f**	22	26	27	32	20		
	%	17.3%	20.5%	21.3%	25.2%	15.7%		
	μ	2.4545	2.6731	3.0926	3.5104	4.0167	3.0157	1.3392
Use of rapid, seamless communication to build direct relationships between customers and suppliers	**f**	15	31	18	40	23		
	%	11.8%	24.4%	14.2%	31.5%	18.1%		
	μ	2.5000	2.7688	3.2315	3.3333	3.6884	3.1969	1.3156
Average							**3.1470**	**1.3028**

Source: Survey data, (2021)

According to the above descriptive analysis, the individual mean response scores for each of the categories were above 3.0, and the mean score for all was 3.1470. According to this, both cases received "high" ratings on a scale of 1 to 5, with "strongly disagree" equaling "strongly agree," indicating that the respondents agreed that supply chain integration was prevalent among the companies in question. The findings also showed that the companies prioritized cooperative and team problem solving on environmental challenges over other activities.

The standard deviation (SD) values in column 9 are quite low. Most scores had SDs that were lower than 1.33. This implies that supply chain integration activities were carried out with a similar priority because there were minimal variations in the answers to the items that were scored. With coefficients of 0.468,0.516,0.480 respectively and a p-value less than 0.05, the paired sample correlation test of supply chain integration and environmental performance demonstrated a positive and statistically significant connection between SCI and environmental performance. This suggests that the actions taken by the sugar companies to integrate their supply chains had a significant impact on their overall environmental performance. These results imply that supply chain integration is a focus for sugar firms in western Kenya, though in different ways based on their environmental management policies.

The significance of these findings stems from the fact that supply chain integration improves a company's environmental performance (Jayaraman). Vachon and Klassen (2008) claim that it is difficult to achieve environmental excellence because every associated supply chain operation necessitates some level of integration between the actors in the supply chain. Furthermore, supply chain quality integration improves both financial and environmental sustainability in addition to green supply chain management, as claimed by Tran *et al*., (2020).

These results were further supported by those of Han & Huo (2020), who found that green internal integration establishes the basis for green integration of suppliers and green integration of customers and is positively associated with both environmental and social performance. Yu, Zhang, and Huo (2019) determined that through sustainable purchasing and customer green cooperation, supplier and customer quality integration has an indirect effect on environmental performance. The results of this study were confirmed by Zu'bi *et al*. (2015), who found that supply chain integration improved the environmental sustainability of the Jordanian food sector. They looked at how integrating the country's supply chain helped its's food industry perform in terms of sustainability.

4.3 Effect of Supply Chain Integration on Environmental performance of Sugar Firms

The study hypothesized that supply chain integration is a predictor of environmental performance. Consequently, the construct scores were determined using the average answer score of all items per case for each construct of supply chain integration, which was then standardized to reduce the danger of multicollinearity. The variance in environmental performance explained by supply chain integration in the model is given by the change in R. The following table shows the results:

Table 5: Model summary of effect of SCI on Environmental Performance

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics					Durbin-Watson
					R Square Change	F Change	df1	df2	Sig. F Change	
1	.265[a]	.211	.209	.22786	.211	489.147	2	124	.000	1.973
a. Predictors: (Constant), Zscore (Supply Chain Integration)										
b. Dependent Variable: Environmental Performance										

Survey Data, (2021)

R^2 for SCI is 0.211 and is significant. Similarly, the adjusted R^2 is 0.209 and also significant. The shrinkage in this case is 0.02, (0.211-0.209). The shrinkage in this case is below the level of 0.5 implying that the model is valid and has the stability for predicting variance in performance. Supply chain integration therefore predicts variance of environmental performance at 0.211 or 21.1%.

The results align with Tran *et al.'s* (2020) research, which revealed that incorporating quality supply chain integration has a positive effect on the environmental performance of Vietnam's tourism sector. Additionally, Han & Huo (2020) showed that the integration of green suppliers and customers had a significant and favorable impact on the environmental performance of Chinese manufacturers. Li, *et al.* (2020) discovered that collaborating with suppliers to improve environmental practices can have an immediate and positive impact on the environmental performance of manufacturing companies. Furthermore, Kang *et al*. (2018) found that supplier-customer integration is a crucial element of organizational and inter-organizational sustainability management practices, and that operational alignment plays a key role in business and operational success.

Other studies that support the findings of this study include Mose (2015) who found a positive and significant relationship between internal, supplier, and customer integration, and firm performance in his investigation of effects of SCI on performance of Rwandan food processing industry. Additionally, the Jordanian food industry's environmental performance improved as a result of SCI., according to Zu'bi *et al.* (2015). Supplier integration, according to Dubey, Gunasekaran, and Ali (2015), had a positive impact on the environmental performance of rubber goods manufacturing enterprises in India. However, it's worth noting that the studies that agreed with the conclusions of this study looked at other SCI constructs other than the ones employed in this study.

CONCLUSION AND RECOMMENDATION

The study concludes that environmental sustainability can only be achieved by manufacturing firms if all the supply chain players coordinate, collaborate and cooperate, otherwise any effort will be in futility if the supply chain payers are not involved in environmental conservation initiatives. Supply chain integration should therefore every manufacturing company's strategic objective

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