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Do Sustainable Supply Chain Practices Really Matter to the Environment? An Empirical Investigation in the Context of Bangladesh

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1. Introduction

Sustainable Supply Chain Management Practices (SSCMPS) have become a mainstream research topic within the past few decades. The research on sustainable practices in the supply chain was taboo not long before, simply because sustainability costs extra (Pagell and Shevchenko, 2014). While firms aim to maximize wealth and profit, consideration for the environment and implementation of environment-friendly equipment and use of eco-friendly manufacturing materials curtails the profit margin that organizations so much want to enjoy (Mugoni et al., 2023). However, the increasing concern over the climate in recent times has made sustainable supply chain practice a buzzword and is forcing the hands of corporations to implement sustainable and eco-friendly supply chain practices (Chowdhury et al., 2023). Skepticism is seeping in among professionals over the effectiveness of the "so-called sustainable practices" that they are practicing at the expense of profit.

Some recent academic literature is fueling the cynicism of supply chain managers and making them question whether what they do has actually any benefit to the environment.

For example, one highly cited article by Pagell and Shevchenko (2014) claimed that even though the current sustainable practices are positive tokens towards a better world that surely deserve appreciation, in all practicality these activities are not "truly sustainable". The current level of knowledge is not adequate enough to make the supply chain truly sustainable. However, there have been quite a few researches in the past advocating that SSCMPS have a positive impact on the environment (Zhu et al., 2008; Green et al., 2012; Schmidt et al., 2017). Yet, the room for question is still there. The impact of supply chain practices may differ in different contexts. There has been a scarcity of empirical tests on whether SSCMPS really has any positive environmental performance in the context of Bangladesh.

The objective of this research is to empirically test whether the sustainable supply chain practices adopted by the companies of Bangladesh have any positive effect on the environment or not. The research uses a self-reporting Likert scale as a research instrument to collect empirical evidence on the research objective. Green Purchasing (GP), Green Manufacturing (GM), Green Product Design (GPD), Green Distribution (GD), Green Information System (GIS), and Reverse Logistics (GL) are six constructs used to measure the latent variable SSCMPS.

As a country with political and economic turmoil, it is critical for Bangladeshi firms to use the best strategies and practices available to survive and thrive. It is also important for Bangladeshi companies to understand the proper impact of their actions. Many of the companies of Bangladesh are adopting sustainable supply chain practices like reducing carbon footprints, reusing building materials, and recycling industrial waste. There is not enough empirical study on the impact of these activities on the environment in the context of Bangladesh (Chowdhury et al., 2023). As a result, this research can bridge the existing gap in the literature and provide the firms with critical insight into the actions and activities they are doing.

2. Literature Review and Hypothesis Development

A score of relevant literature has been consulted for developing the hypotheses for the study. Two primary variables can be deduced from the research aim: environmental performance and sustainable supply chain management practices. Environmental performance is the response factor; whereas various sustainable supply chain techniques comprise explanatory factors. This section aims to identify sustainable supply chain practices and their relationships with environmental performance from existing literature.

2.1 Environmental Performance (EP)

Environmental performance (EP) is defined as the outcome of the strategic efforts of a company to control its influence on its natural surroundings (Green et al., 2012). In other words, EP is the ability of a firm to control hazardous gas emissions, manage effluent and solid wastes, reduce consumption of environmentally harmful products, and minimize ecological accidents. Environmental performance is negatively related to the damage a company incurs on nature. The less a company harms the environment, the better its environmental performance is (Eltayeb et al., 2011). Notwithstanding this, EP measures may vary depending on the nature of the firms and industries. EP is more critical for some industries and can have different sets of standards across different industries (Bocken et al., 2013). Zailani et al. (2012) Postulated that environmental performance can be a source of competitive advantage for firms and can affect the whole organizational performance positively.

2.2 Sustainable Supply Chain Practices (SSCMPS)

Sustainable Supply Chain Management Practices (SSCMPS) include the management of the supply chain of firms intending to maintain environmental, economic, and social stability (Hong et al., 2018). The stability and robustness of the industry linkage depend on the SSCMPS to be functional (Adam et al., 2019) as sustainable supply chain processes and activities contribute to mitigating the adverse effects of business operations on the

environment and society, all while boosting financial, and operational performance (Acquah et al., 2020; Panigrahi et al., 2018).

Minimizing or eliminating various waste, and fossil fuel energy consumption, optimizing resource utilization, and reducing pollution are some of the core agendas of sustainability practices. SSCMPS tries to address these mandates by making the processes, activities, and materials more environmentally friendly (Adam et al., 2019).

Several empirical, theoretical, and bibliometric research have been found on different sustainable supply chain management practices (SSCMPS). The most common sustainable supply chain management practices according to the literature are discussed in the following subsections.

2.2.1 Green Purchasing (GP)

Green purchasing, known as green procurement as well, is a procurement method that maintains necessary performance criteria. It emphasizes waste reduction and the improvement of material recycling and recovery without sacrificing functionality. According to Narasimhan and Schoenherr (2012), this approach aims to reduce waste and promote material reuse and recycling without sacrificing functionality. GP includes environmental factors in procurement strategies (Balasubramanian and Shukla 2017). Green ideas for procurement may include setting guidelines incorporating environmental criteria for suppliers (Hu & Hsu, 2010). Green Procurement (GP) is identified by Younis et al. (2016) as a main instrument for promoting environmentally friendly approaches. Considering the associations found in the literature between GP and the environment, this study proposes that GP has a positive relationship with environmental performance

- **H1:** Green Purchasing (GP) has a positive relationship with environmental performance.

2.2.2. Green Manufacturing (GM)

Green manufacturing (GM), also labelled as green production, seeks to reduce the whole environmental effect of the manufacturing process at all levels of production (Mwaura, 2016). It entails using sustainable energy in the production process and reducing overall pollution and emissions. GM stresses the mantra of six Rs—recover, recycle, reduce, redesign, reuse, and remanufacture (Machingura & Zimwara, 2020), to mitigate the environmental impact ((Acquah et al., 2020). Green et al. (2012) postulate that using eco-friendly materials and minimizing waste in the manufacturing process can improve environmental performance. Research in different countries like Australia, China, Brazil, etc. yielded similar results, where GM positively affects environmental performance (Mugoni et al., 2023). On a similar note, this study theorizes that GM in the context of Bangladesh, positively correlates with environmental performance.

- **H2:** Green Manufacturing (GM) has a positive relationship with environmental performance.

2.2.3 Green Information Systems (GIS)

Gholamia et al. (2012) explained green information systems (GIS) as a possible tool for solving environmental problems. Information systems can be used to monitor and control consumption and waste levels. Information systems, an integral part of modern supply chain management, can provide cross-departmental cooperation for the proper implementation of SSCMPS in organizations (Green et al., 2012). Several studies proposed that green information system contributes to the sustainability of the environment (Melville, 2010; Watson et al., 2010). Echoing the literature support, this paper hypothesized that green information system affects environmental performance positively.

- **H3:** Green Information Systems (GIS) have a positive relationship with environmental performance.

2.2.4 Green Product Design (GPD)

Green product design, alternatively referred to as eco-design, indicates developing the prototype of a product in such a way that it reduces waste and pollution, or is easy to recycle (Al-Ghwayeen & Abdallah, 2018). Scholars have identified eco-design as a critical supply chain practice and advised that environmental implication needs to be considered at all the steps of a product design (Hu & Hsu, 2010). Zhu et al. (2005 & 2008) have proposed that GPD affects the operational, economic and environmental performance of a company and creates a competitive advantage for the company. This study suggests that green product design has a positive impact on environmental performance.

- **H4:** Green Product Design (GPD) has a positive relationship with environmental performance.

2.2.5 Green distribution (GD)

Green distribution or green logistics is described as minimizing ecological harm, including less carbon emission, in the process of transporting the final product to the consumers (Mwaura, 2016). GD practices encompass the entire process from storing the product in the warehouse till the product is delivered to the consumers. Mugoni et al. (2023) suggested that green distribution has a positive relationship with environmental performance. Adopting the proposition, this investigation has theorized that green distribution positively contributes to environmental performance.

- **H5:** Green Distribution (GD) has a positive relationship with environmental performance.

2.2.6 Reverse logistics (GL)

Reverse logistics (GL) entails the return, recovery, and reuse of a product from its touchpoint to the manufacturer. It is similar to product distribution, but the direction of product flow is completely opposite (Alkahtani et al. 2021). Researchers (Richn´ak & Gubova, 2021) noted that reverse logistics increases resource optimization, decreases material waste and boosts organizational performance. They postulated it as an integral part of the SSCMPS. To

measure the effect of GL on environmental performance, this paper has hypothesized a positive relationship between reverse logistics and environmental performance.

- **H6:** Reverse Logistics (GL) has a positive relationship with environmental performance.

3. Methodology and Research Design

The research in question has followed a post-positivistic paradigm and deductive reasoning style. Six hypotheses were developed through a literature review and were tested via a quantitative method. The research used primary data collected from supply chain professionals in various manufacturing firms within Bangladesh. Google Forms has been used as the main data collection instrument which was circulated through emails and other digital platforms. Depending on the sensitive nature of the information all the responses were collected anonymously. The respondents were selected through convenient sampling. After collecting the data, Microsoft Excel has been used to clean it. To test the model, SPSS version 25 has been employed.

The research framework, measurement items and respondent demographics are broken down into finer details in the following subsections.

3.1 Research Framework

The framework of the research is developed based on the suggestion of Mugoni et al. (2023). The model of the research aims to examine the relationship between sustainable supply chain management practices and environmental performance. Six exogenous factors are

introduced to measure SSCMPS. Environmental performance is the endogenous factor of the model. It is illustrated in **Figure 1**.

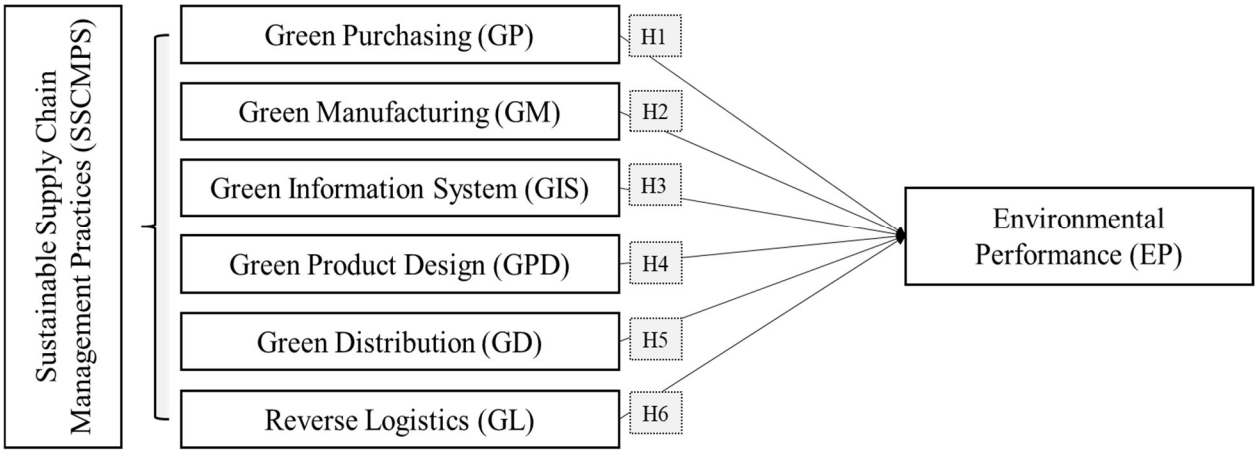

Figure 1 Research Model

Source: Mugoni et al. (2023)

The six hypotheses are:

H1: Green Purchasing (GP) has a positive relationship with environmental performance.

H2: Green Manufacturing (GM) has a positive relationship with environmental performance.

H3: Green Information Systems (GIS) have a positive relationship with environmental performance.

H4: Green Product Design (GPD) has a positive relationship with environmental performance.

H5: Green Distribution (GD) has a positive relationship with environmental performance.

H6: Reverse Logistics (GL) has a positive relationship with environmental performance.

3.2 Measurement Items

A 22-item measurement scale has been developed to measure the 7 constructs: EP, GP, GM, GIS, GPD, GD, and GL. Measurement items for each of the constructs were adopted from previous studies. The list of the sources from where the items were adopted is depicted in Table 1. To avoid the questionnaire getting too big, some items were dropped from the

original scales. For better understanding, some of the questions were rephrased. The language of the survey form was kept in English, as most of the supply chain professionals in Bangladesh have at the very least basic proficiency in English.

Table 1 Measurement Items

Construct	Items	Source
Environmental Performance (EP)	EP1	Zhu et al. (2008)
	EP2	
	EP3	
	EP4	
Green Manufacturing (GM)	GM1	Li et al., 2022
	GM2	
	GM3	
Green Purchasing (GP)	GP1	Zhu et al. (2008)
	GP2	
	GP3	
Green Information System (GIS)	GIS1	Gholamia et al. (2012)
	GIS2	
	GIS3	
Reverse Logistics (GL)	GL1	Gholamia et al. (2012)
	GL2	
	GL3	
Green Distribution (GD)	GD1	Mwaura et al. (2016)
	GD2	
	GD3	
Green Product Development (GPD)	GPD1	Chen & Cheng (2013)
	GPD2	
	GPD3	

3.3 Sample Size

It is a challenge to reach all the supply chain professionals in Bangladesh. So those of the professionals in the manufacturing industries who can be easily accessible were preferred as respondents. The Google Form containing a 5-point Likert scale (Agree/Disagree) was circulated via Email and WhatsApp. For better connectivity, some esteemed supply chain institutes were also reached. The questionnaire reached around 350 people, from which 196 responses were received. 25 responses were deleted as they were incomplete or

inappropriate, e.g., not answering all the questions, answering neutral for all the questions, etc. The final response count is 171.

3.3.1 Demographic Profile

Among the 171 respondents, 86.5% were male and only 12.9% were female. This can be attributed to the fact that the supply chain professionals are mostly male.

Table 2 Gender Frequency of the Respondents

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Female	22	12.9	12.9	12.9
	Male	148	86.5	86.5	99.4
	Prefer not to say	1	.6	.6	100.0
	Total	171	100.0	100.0	

Source: Primary Data

According to Table 3, 39.2% of the respondents were between the ages of 20 and 30, representing the largest respondent group. Second come the respondents aged between 31 and 40, with a percentage of 32.7%. Only 15.2% of the respondents were aged between 41 and 50. The number is still smaller (8.2%) for professionals who are 51-60 years old. Less than 5% of the respondents were aged above 60. It is apparent that the majority of the respondents were young. This can be because senior professionals are fewer in number and are harder to reach. The dominance of youth in respondents may influence the perspective of the research.

Table 3 Age Frequency of the Respondents

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	20-30 Years Old	67	39.2	39.2	39.2
	31-40 Years Old	56	32.7	32.7	71.9
	41-50 Years Old	26	15.2	15.2	87.1

	51-60 Years Old	14	8.2	8.2	95.3
	60+ Years Old	8	4.7	4.7	100.0
	Total	171	100.0	100.0	

Source: Primary Data

Similarly, the work experience of the respondents has also been captured. The work experience denotes the years a professional is involved in the supply chain work. A majority of the less experienced opinions may not capture the main essence of the study. So, it is important to ensure that the responses are coming from different experience backgrounds. Table 4, shows a diversity in the experience of the sample, which is likely to ensure that the findings represent the whole picture.

Table 4 Work Experience of the Respondents

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Less than 1 Year	40	23.4	23.4	23.4
	1-3 Years	30	17.5	17.5	40.9
	3-10 Years	54	31.6	31.6	72.5
	10-20 Years	32	18.7	18.7	91.2
	20 Years+	15	8.8	8.8	100.0
	Total	171	100.0	100.0	

Source: Primary Data

4. Data Analysis and Hypothesis Testing

4.1 Reliability Testing

Testing the reliability of the items is necessary before further analyses are conducted. Cronbach Alpha is the most widely used method for checking whether the measurement items are reliable or not. The accepted threshold for Cronbach Alpha is 0.70 (Saha et al., 2023). Values higher than that are considered better (Hair et al., 2017). The Cronbach Alpha for the measurement items of this study is 0.929, which is higher than the recommended threshold. It means the items used in the study are reliable.

Table 5 Reliability Testing (Cronbach Alpha)

Cronbach's Alpha	N of Items
.929	22

4.2 Descriptive Analysis

The descriptive analysis of SPSS indicates the minimum, maximum, mean and standard deviation of the responses. The means of all the items were closer to 3.5. Indicating that on average, the responses ranged between neutral (3) and agree (4). However, the standard deviations of the responses are all around 1. It indicates moderate variation among the responses, signifying that the opinions of the respondents differed to some extent from each other.

Table 6 Descriptive Statistics of the Measurement Items

	N	Minimum	Maximum	Mean	Std. Deviation
EP1	171	1	5	3.35	1.071
EP2	171	1	5	3.39	1.087
EP3	171	1	5	3.53	.990
EP4	171	1	5	3.58	.919
GP1	171	1	5	3.56	.901
GP2	171	1	5	3.36	.981
GP3	171	1	5	3.21	1.086
GM1	171	2	5	3.57	.901
GM2	171	1	5	3.52	.990
GM3	171	1	5	3.56	.902
GIS1	171	1	5	3.46	.947
GIS2	171	1	5	3.49	.916
GIS3	171	2	5	3.65	.948
GPD1	171	1	5	3.61	.909
GPD2	171	1	5	3.52	.923
GPD3	171	2	5	3.58	.859
GD1	171	1	5	3.54	.953
GD2	171	1	5	3.61	.890
GD3	171	1	5	3.67	.861
GL1	171	1	5	3.53	.910

GL2	171	2	5	3.61	.835
GL3	171	1	5	3.51	.942
Valid N (listwise)	171				

4.3 Hypothesis Testing

The value of R for this model, 0.707, signifies a strong positive relationship between the predictors and the indicator. On the other hand, the R-square indicates that 50% of the variance in EP can be explained by the predictors.

Table 7 Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.707[a]	.500	.482	.58221

a. Predictors: (Constant), GL, GD, GIS, GPD, GP, GM

From Table 8, it can be noted that the F statistic for this research is quite high (F = 27.386). A higher F value means that the model is a good fit. The p-value is 0.000 ($p<0.05$), which means sustainable supply chain management practices have a statistically significant positive effect on environmental performance.

Table 8 ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	55.698	6	9.283	27.386	.000[b]
	Residual	55.592	164	.339		
	Total	111.289	170			

a. Dependent Variable: EP

b. Predictors: (Constant), GL, GD, GIS, GPD, GP, GM

Table 9 narrates the result of the multiple linear regression coefficients of the exogenous factors for the endogenous factors, pointing out the individual contribution of each of the predictors in the model. The p-value (sig.) for GP, GM, GIS, GPD, GD, and GL indicates the probability of the variables being statistically significant in the model. Only GP and GM have a p-value less than 0.05. All the other four variables have a p-value exceeding 0.05. It means

that on a 95% confidence interval, Green Purchasing (GP) and Green Manufacturing (GM) both have strong positive relationships with Environmental Performance (EP). On the contrary, there is not enough empirical evidence to support the other relationships hypothesized in the study.

Table 9 Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	.465	.275		1.689	.093
	GP	.274	.089	.268	3.082	.002<0.05
	GM	.448	.097	.404	4.608	.000<0.05
	GIS	.139	.083	.130	1.674	.096>0.05
	GPD	-.052	.092	-.046	-.566	.572>0.05
	GD	.045	.087	.041	.523	.602>0.05
	GL	.005	.097	.004	.049	.961>0.05

a. Dependent Variable: EP

5. Findings and Discussion

Table 10 shows the summary of the findings for the research. Among the six hypotheses proposed initially, only two are supported by the empirical test. It does not necessarily mean the other hypotheses are incorrect. Rather, in light of the available data, there is not enough evidence to accept the effect of the other four predictors on the indicator.

Table 10 Summary of the Findings

No.	Hypothesis	Result	Verdict
H1	GP → EP	Significant Positive Relationship	Accepted
H2	GM → EP	Significant Positive Relationship	Accepted
H3	GIS → EP	No Significant Relationship	Rejected
H4	GPD → EP	No Significant Relationship	Rejected
H5	GD → EP	No Significant Relationship	Rejected
H6	GL → EP	No Significant Relationship	Rejected

Source: Authors' Estimation

According to the result of the current study, some conclusions can be drawn. Green Purchasing initiatives taken by the companies significantly contribute to the environmental performance. Similarly, Green manufacturing practices reduce environmental harm and increase environmental performance. Green Information System does not have any clear connection with the environmental benefits. Green product development also lacks any direct association with environmental performance. On a similar note, Green Distribution as well as Reverse Logistics do not impact the environment in any meaningful way.

The findings of the study can contribute to the theoretical knowledge by providing a fresh perspective and context. It can guide policy-makers and corporate professionals to make practical decisions. It can as well provide future direction to the scholars. The following subsections are dedicated to discussing various practical and theoretical implications of the research along with supplying some possible research directions.

5.1 Theoretical Implication

The result of the research shows that all the components of SSCMPS do not have the same impact on the environment. While green manufacturing and green purchasing are critical for the SSCMPS, other components like GIS, GPD, GD, and GL are less important in terms of environmental impact. It also supports the existing literature by validating that SSCMPS has a strong positive impact on environmental performance.

From the perspective of the stakeholder theory, corporations are fulfilling their responsibility towards nature by adopting SSCMPS, as it affects the environment positively. The research can also be linked with the Resource Based View. Since green purchasing and green manufacturing are more important than the other components, companies can focus on these activities to develop a sustainable framework for competitive advantage.

The research also has implications for the “Three Zero Theory” of the Nobel Laureate Dr. Yunus. The empirical evidence presented here substantiates the third mandate of the theory, zero carbon emission. SSCMPS can very well be one of the critical steps towards building a world with three zeros.

5.2 Practical Implication

One of the major challenges in implementing SSCMPS lies in its expenses. Many small companies cannot afford sustainable practices and only large corporations can allocate more in SSCMPS (Tazneen et al., 2020; Noha et al., 2023). To solve the resource constraint problem, firms can prioritize green purchasing and green manufacturing practices. By allocating more to the procurement of eco-friendly resources, and using sustainable production systems, companies can still fulfil their environmental objectives. Investing in green manufacturing and purchasing can also enhance the reputation of the firms and earn them points for corporate social responsibility.

The impact of green purchasing emphasizes the necessity of collaboration with the suppliers. Collaboration with the suppliers is instrumental for the sustainability and robustness of a supply chain (Wieland, 2021). The results of the study reinforce the concept of collaboration for supply chain professionals. A firm cannot achieve optimum performance on its own. The traditional supply chain management concepts rotate around collaboration. This research confirms that collaboration is also crucial for SSCMPS.

However, overemphasis on green purchasing and green manufacturing only can have dire practical consequences. Sustainable supply chain practices do not operate independently. Thinking of them as isolated activities may harm companies in the long run. For example, green product design does not show a significant impact on the environment. But if a company discards it completely, green manufacturing will also be adversely affected. Similarly, ignoring green distribution can potentially hamper green purchasing (Chowdhury et al., 2023).

The bottom line is that while a company can focus more on critical activities like GP and GM, it should not completely ignore GIS, GPD, GD, and GL.

5.3 Limitation and Future Direction

Due to the difficulty in contacting targeted respondents, the sample size of this research has been moderately small. Larger sample size leads to a more accurate estimation of the model.

Further investigation can be done on this framework with a larger sample size. Future researchers can apply the model developed in this study to a larger sample, possibly in different contexts.

The research model of this study uses multiple linear regression with no partial relationships. This is a simple statistical model. Effects of mediating and moderating variables can be introduced in the model to make it more accurate and insightful. Future researchers can enrich this research model by incorporating higher-order constructs and exploring more relationships.

The research is not focused on any particular industry. Different industries have different supply chain practices. Future researchers can narrow down the scope of the research and apply this model to a specific industry.

6. Recommendation and Conclusion

Not long before, sustainable supply chain management practices were frowned upon. Firms were reluctant to accept the environment-friendly alternatives in terms of material or process. The alarming rate of climate change is fueling the importance of SSCMPS in business and literature. Literature on sustainable supply chain management is beginning to pile up. Corporations, including many firms in Bangladesh, are starting to practice various sustainable activities and initiatives in their supply chain management. Alternative perspectives still exist, cautioning the importance of rethinking. While SSCMPS is beneficial for the environment in theory, the empirical test may have something else to say.

The study on the supply chain professionals of Bangladesh shows that not all the SSCMPS have a similar kind of impact on the environment. Some factors like production or procurement prove to be more impactful on the environment than other factors like information systems, product design, distribution or reverse logistics.

These findings can provide a fresh perspective to the scholars and provoke new thoughts on SSCMPS theories. Based on this study, companies can emphasize more on sustainability in

manufacturing and purchasing. However, they are advised not to take it as an excuse to refrain from undergoing other sustainable practices.

While this research advocates that sustainable production and purchasing practices have a significant impact on environmental welfare, it does not claim that other components of sustainable supply chain management do not influence the environment. Firms can take this as a cue to reinvent their information systems, distribution, and design so that these factors may have a stronger impact on nature.

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