

A STUDY OF SUSTAINABILITY ON CONSTRUCTION SUPPLY CHAIN MANAGEMENT

Abstract

Sustainable operations and Sustainable Supply Chain Management (SSCM) have become a topic of high relevance for scientific research and management, as well as policymaking practices. The construction industry is responsible for significant environmental impact. The research purpose is to comprehend the 'sustainable' component of SCM for the construction industry from multiple perspectives. To achieve corporate sustainability within any organisation, it is essential that the sustainability issues are addressed throughout the organization's Sustainable Supply Chain Management. Comparing two research fields in business manageability and SCM, the sustainability within a particular industry can be defined. These areas are examined through systematic literature review, primary research, secondary data analysis & hypothesis estimations. Through extensive literature review and detailed questionnaire, the research identified the Strategies, Challenges and Barriers for achieving Sustainable Supply Chain Management within construction organisations. The study was based on the perception and awareness of managers towards sustainability in the builder construction industry. The research result is an analysis of the study of various strategies, challenges and barriers pertaining to achieve SSCM. The study is restricted to prominent builder groups. The output of the research could give managers a better perspective to improve sustainability in construction industry with consideration of environmental, economical and social factors in more effective way thereby bringing value to the organisation as well as to the society.

Keywords: Sustainability, Supply Chain Management, Green construction, Managerial decisions, SSCM Strategies.

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I. INTRODUCTION

- 1. Background of the Study:** With an increasing environmental concern about global warming, depletion of natural resources, energy consumptions and others, the business environment has been facing a big challenge to tackle the issues. Many governmental and non-governmental acts have been made to reduce the impacts industries have on the environment. As a notable example, an International Government Agreement (IGA) was sealed in the Paris Climate Conference (2015) that incorporated commitments on emissions, adaptation, finance and transparency, demanding the signatory governments to provide legislatives or technical incentives for companies to implement sustainable practices into their operations. These sustainable practices require that suppliers, manufacturers and customers work together within the supply chain to develop and implement better and more sustainable solutions for companies. Within this idea, Sustainable Supply Chain Management (SSCM) is viewed as a concept of management practices aimed at integrating environmental thinking into all the stages of a supply chain, including inbound logistics, operations and reverse logistics. This research focuses on SSCM within the construction industry.

Other than improving performance, incorporating sustainable practices into an organization's operations can be viewed as a key business value, as it can help companies gain competitive advantage and increase their stock prices, making it more likely that construction companies will adopt sustainable practices as a strategic imperative. The concept of SSCM is wide enough to be used in different areas of business, however each area has its differences. In the construction industry, the complexity of the supply chain is different from the other areas, as it consists of a wide variety of stakeholders, as material suppliers, customer or user of the material, planner, contractor and owner, that are all involved somehow with the project, however a Sustainable Supply Chain Management aimed at the construction industry can help enhance efficiency and reduce costs and time. A successful Construction Supply Chain is the result of adopting strategies that take in consideration the differences from a traditional supply chain from the manufacture industry and the construction industry.

Therefore, this research is aimed at finding how the construction industry can implement a more sustainable supply chain in its operations, considering its differences from other industries.

- 2. Need & Significance of the Study:** The research paper aims to develop a theoretical understanding of SSCM with the intention of making an original contribution to the supply chain discipline within the construction industry. The research will also make a contribution to practice by offering strategies to manage, implement and integrate sustainability within decision processes.

The research paper also indicates the various theoretical concepts that can offer explanations to the complex and dynamic field of construction industry. However, there is a limited knowledge regarding the specific conditions that enable strategy selection, design and implementation by organizations and managers in light of the issues raised. Overall, this indicates an important research agenda for the development of a conceptual framework for understanding sustainability in SC strategy through the lenses of multiple theoretical concepts. The aim is to analyze and study these issues that could offer a

theoretical underpinning as well as valuable practical application for organizations and managers.

This study helps for academics & research scholars for further study on this industry. It will provide valuable input to policy makers for improvement in the operating & marketing strategy for the companies within the construction industry.

- 3. Statement of Problem:** Sustainable development is a very important requirement to cope with the negative effects of COVID-19 pandemic crisis. Sustainable Development seeks to achieve the optimal use of resources in a manner that serves the members of society and that guarantees the rights of future generations and work to address all areas within society (water, health, food, services, education, income, awareness, institutional building, good governance, etc.)

In India around 80% of the estimated buildings by the year 2025 are yet to be constructed. This shows that the market growth potential for the Indian construction industry is huge. However, the sustainability component in SCM is overlooked in construction industry due to varying factors related to project costs, suppliers, transportation, policy regulations and certifications, etc.

The research purpose is to comprehend the 'sustainable' component of SCM for the construction industry from multiple perspectives, thereby studying the possible strategies that could be adopted as well as reducing the barriers and overcoming the challenges for integrating sustainability with supply chain management in the construction industry.

4. Limitations of the Study

The present study is subject to the following limitations:

- The study is restricted to prominent builder groups
- The sample size has been restricted. (Only 60 samples has been considered).
- The sample was confined to employers & managers of the builder groups.
- The findings of the study cannot be generalized to other industries.

- 5. Scope of the Study:** This research paper could be particularly valuable in working alongside and gaining a deep understanding of the challenges faced by builders in trailing insights from theory and research in practical implementation of Sustainable Supply Chain Management.

In the construction industry, creativity and innovation is often seen to be underpinned by effective communication and collaboration among the diverse, multidisciplinary, and multi skilled project actors. This issue is solved by integrating the results of the research in the development of sustainable buildings and in the introduction of innovative environmental technologies due to the need for effective expertise for environmental optimization. So, it's clear that this research will help in managerial decision making for sustainable Supply Chain within the construction industry. Substantial theory for this area is not developed till date. Therefore, this research promises

result oriented approach to derive the conclusions which can be beneficial for the implementation too.

II. LITERATURE REVIEW

The term sustainability is defined as meeting today's needs without compromising the future generation needs (Bruntland commission, 1987). Sustainability encompasses all three dimensions (3 BL), such as economic, environmental and social. United Nations Conference on sustainable Development emphasized social sustainability aspects in its agenda-21 that described the promotion of economic growth, creation of productive employment, achieving equality, and reduction of nature use and protection of the natural environment (UNCSD, 1998). Many authors explored social sustainability, according to Beatley (1997) equity is an important dimension of social sustainability that enables equal access and social justice for all economic and social groups (Beatley, 1997). There were several researches on social sustainability, and we acknowledge earlier contribution on social sustainability from Sachs (1999), Godschalk (2004). They distinguished the components of social sustainability and its relationship to the overall growth of the society.

Sachs (1999) discussed various social elements that include social homogeneity, equitable income, access to goods and services and employment for social sustainability. Some scholars defined social sustainability as "ethical code of conduct for human survival and outgrowth and it needs to be accomplished in a mutually inclusive and prudent way" (Lafferty and Langhelle, 1999; Sharma and Ruud, 2003). Polese and Stern (2000) posit social sustainability as development that is compatible with harmonious evolution of civil society, fostering an environment conducive to the compatible cohabitation of culturally and socially diverse group, while at the same time encouraging social integration and quality of life for all segments of the population.

United Nations Division for Sustainable development (UNSD) in its framework via sustainable indicators classified, within the social dimension of sustainable development, are equity, education, health, housing, security and population under the main theme (UNSD, 2001).

Ojo identified drivers and barriers of GSCM practices adoption in Nigerian construction firms by using the ISM approach. The study showed that the lack of public awareness, lack of knowledge and environmental impacts, poor commitment by the top management and lack of legal enforcement and government represented the main barriers facing adoption of GSCM practices. Balasubramanian presented a hierarchical sustainability framework by using ISM technique for evaluating the 12 barriers to the adoption of GSCM in the United Arab Emirates (UAE) construction sector. Shortage of resources and lack of understanding among stakeholders were found to have the highest driving dependence power.

Luthra identified 11 barriers in implementing GSCM practices in Indian automobile industries and contextual relationship among these barriers was established. A hierarchy structural model was prepared using the ISM technique, lack of government support policies, and market competition and uncertainty had the highest driving and dependence power. Sandeep identified 15 important enablers to implement green concepts in the Indian automobile supply chain by using ISM. Government support and regulation and relative advantage had the highest driving and dependence power. In the area of implementation of

renewable energy projects, Eswarlal analyzed 14 critical factors associated with sustainable development in India, using the ISM methodology.

III. THEORETICAL FRAMEWORK

Sustainable Supply Chain Management, Sustainable construction and supply chain management (SSCM) have been becoming two of the most important performance- related issues within the construction industry. To achieve corporate sustainability within any organization, it is essential that sustainability issues are addressed throughout the organization's whole supply chain, a process referred to as sustainable supply chain management.

Sustainable supply chain management in construction includes not only sustainable construction but also incorporating sustainability in the entire life cycle of the construction design, sustainable material sourcing and Construction and Demolition (C&D) waste management. "It aims to conserve natural resources, reduce generated waste through reusing, recycling and remanufacturing the material and reducing pollution.". Sustainable SCM practices are considered as material management, green purchasing, green manufacturing, green design, reverse logistics and green distribution/marketing Hervani (2005) and Srivastava (2007) Sustainable Design includes various disciplines in its wide scope - occupational health safety, product safety, resource conservation, environmental risk management, pollution prevention, and waste management. According to a report published by UNEP (2012): Greening the building delivery and management process, the definition of 'green' includes finding sustainable solutions in five environmental aspects: energy, carbon, material, waste and water.

The traditional design practices are replaced by green design practices by including the green design principles to reduce consumption of the following aspects.

- 1. Green Procurement and Purchasing:** Green procurement is a kind of environmental purchasing that involves reduction, reuse, and recycling of materials.
- 2. Reverse Logistics:** The definition of reverse logistics from an environmental perspective focuses primarily on the return of recyclable or reusable products and materials into the forward supply chain.

Many recent technologies developed by BMTPC have shown successful utilization of C&D waste in lieu of traditional building material. Environmental restrictions such as sand mining etc. have forced Indian construction industry to search for a substitute of naturally sourced building materials.

- 3. Manpower Sustainability:** Urgent steps are to be initiated to reverse the trend of severe shortage of technical manpower and for sustainable human resource development.
- 4. Economic Sustainability:** This outlines the various government objectives that need to be achieved alongside sustainable construction. It highlights the difficulty of managing an economy and the need for professionals working in the construction industry to acquire economic stability.

5. Construction Project Management approach for effective SCM / Drivers of Construction Supply Chain:

- **Facilities:** It is the place such as warehouse for precast or pre fabrication, distribution centers as Steel Service centers, or transforming the inventory into another state (fabrication or assembly plants of metro coaches or shipyard) in the supply chain where inventory is stored, assembled, or fabricated.
- **Inventory:** All the raw material, work in progress and finished goods at a site. The uncertainty will dramatically alter Quantity, Quality, Costs and Delivery time. An automated alert such as email, message to the concerned person for the low inventory and thus need for a new order is recommended.
- **Transportation:** There is widespread restriction in material movement as due to the oversized dimension of consignment, heavy loaded trucks there is lack of infrastructure at remote sites.
- **Information:** Implementation of IT in materials management could facilitate the effective and efficient control of materials on site, reducing the human efforts. It includes construction materials planning system, material handling equipment selection advisor, construction materials exchange, wireless communication system and bar-code system. Radio Frequency Identification (RFID) needs to be adequately used on site to overcome human error and needs to be well integrated with project management systems on construction projects.
- **Sourcing:** Early purchase of material means capital tied up and excess interest rate to be paid. Material may damage during storage or be stolen unless special care is taken some companies have centralized procurement for Bulk material for cost advantage which may result in delay in supply. The periodic demand and supply is both a boon and bane.
- **Pricing:** Minimizing the procurement costs presents important opportunities for reducing costs. The strategic supplier choice is impacted by the Clients who have a say on the procurement route. To measure the inventory holding costs, opportunity costs due to capital invested in material that is being stocked. On account of the above discussed factors it can be concluded that the construction supply chain is relatively unstable, and is still evolving. Unlike the manufacturing industry it is not repetitive or generic. It is rather unique, project specific and temporary in nature. All this has an impact on organizational SCM as project relationships are short term are usually informal focused on the project not the business.

IV. RESEARCH METHODOLOGY

1. Objectives of the Study

- To study the various challenges and strategies in integrating sustainability to Supply Chain (SC) for Construction Industry.

- To find the implications of SSCM in business manageability within the construction industry.
- To study the influence of demographic factors on the perception regarding the strategies in integrating sustainability for Construction Industry.

2. Hypotheses of the Study

- There is no association between Experience of the respondents and respondent's opinion about Sustainable Supply Chain Strategies

3. Research Design: Data was collected from respondents using questionnaires, who constituted of managerial experts from various construction builders. The population of the study comprised of construction builders. Non Probabilistic judgemental sampling has been adopted for identification and selection of construction builders. For a known population of managerial experts, the sample size preferred is 80 samples computed using sampling equations.. A total of 80 was the required sample but only got 60 correct responses which were used for data analysis.

4. Sources of Data: Research would be done with the use of both primary and secondary data.

- **Primary Data:**
 - The study has made use of primary data collection through a survey questionnaire
- **Secondary data:**
 - Internet (for literature review & theoretical framework)
 - E- journals & articles (for preparing questionnaires)

5. Tools used for Data Analysis

- Factor Analysis (for extracting the principal components)
- Chi Square test of independence (for data analysis)

6. Sample Design

- The study employed non probabilistic judgmental sampling.
- From the population of managers, $z = 1.96$, $p = q = 0.5$ & $e = 0.05$.
- $n = 80$ samples

7. Sampling Method

$$n = \frac{z^2 p q N}{e^2 (N-1) + z^2 p q}$$

Is the sampling equation computed for identifying the samples for the research.

8. Drafting the Questionnaire: Data was collected by using questionnaires. The questionnaire was in four parts. Initial part covered information on the respondent. Part A was on the sustainable supply chain strategies and the respondents rated the factors on a likert scale of 1 to 5. Part B was on barriers in integrating sustainability to the Supply

chain and the respondent was asked to rate the barriers on a likert scale of 1 to 5. Part C which was the last one, was on the challenges in integrating sustainability to Supply chain and the respondent was asked to rate the challenges on a likert scale of 1 to 5.

V. DATA ANALYSIS AND INTERPRETATION

1. Chi-Square Test

Hypothesis 1

- **Null Hypothesis:** There is no association between Experience of the respondents and respondent's opinion about Sustainable Supply Chain Strategies
- **Alternative Hypothesis:** There is an association between Experience of the respondents and respondent's opinion about Sustainable Supply Chain Strategies

Table 1: Contingency Table

		Sustainable Supply Chain Strategies			Total
		Low	Medium	High	
Experience	Less than 1 year	0	4	2	6
	1-5 years	3	12	16	31
	5-10 years	2	5	2	9
	Above 10 years	1	1	12	14
Total		6	22	32	60

Table 2: Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	12.627(a)	6	.049
Likelihood Ratio	14.248	6	.027
Linear-by-Linear Association	1.731	1	.188
N of Valid Cases	60		

Analysis: From the above chi square analysis p-value (0.049) is less than Alpha value (0.05). Hence we reject the null hypothesis and therefore there is an association between Experience of the respondents and respondent's opinion about Sustainable Supply Chain Strategies

2. **Factor Analysis:** Factor analysis was done on the set of variables representing Challenges in integrating sustainability to Supply Chain; to extract the principal components. The SPSS output of the factor analysis is given in the following section

Factor Analysis of Challenges in Integrating Sustainability to Supply Chain;

- **Communalities**

Table 3: Communalities

	Initial	Extraction
The final customers still seldom want to pay for the more -expensive sustainable services	1.000	.663
Right taxation structure to encourage even better alignment -between environmental and economic interests	1.000	.567
Low-cost focus	1.000	.358
The operationalization of governmental regulations	1.000	.803
Negligence about the SSCM from all stakeholders	1.000	.586
Lack of educated and permanent employees (lack of knowledge)	1.000	.720
Poor organizational structure	1.000	.398
Customers unawareness of sustainable green products	1.000	.715
Extraction Method: Principal Component Analysis.		

Table 3 displays the communalities of the items of the CHALLENGES IN INTEGRATING SUSTAINABILITY TO SUPPLY CHAIN. It is extracted over Principal Component Analysis method displaying the communalities where in showing the correlation values of the items involved in the study.

Table 4: Total Variance Explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	1.954	24.430	24.430	1.954	24.430	24.430	1.677	20.962	20.962
2	1.621	20.257	44.687	1.621	20.257	44.687	1.611	20.138	41.100
3	1.235	15.435	60.122	1.235	15.435	60.122	1.522	19.023	60.122
4	.939	11.734	71.856						
5	.811	10.139	81.995						
6	.677	8.461	90.456						
7	.459	5.737	96.193						
8	.305	3.807	100.000						
Extraction Method: Principal Component Analysis.									

The table 4 illustrates the total variance explained from the above study is 60.122% which is above the Threshold of 60%.

- **Component Matrix(A)**

Table 5: Component Matrix^a

	Component		
	1	2	3
The final customers still seldom want to pay for the more -expensive sustainable services	.812	-.011	-.050
Right taxation structure to encourage even better alignment -between environmental and economic interests	.371	-.474	-.452
Low-cost focus	.360	-.282	-.386
The operationalization of governmental regulations	.617	-.405	.509
Negligence about the SSCM from all stakeholders	.487	.066	.587
Lack of educated and permanent employees (lack of knowledge)	.345	.749	-.200
Poor organizational structure	-.494	.206	.335
Customers unawareness of sustainable green products	.410	.738	-.043
Extraction Method: Principal Component Analysis.			
a. 3 components extracted.			

Table 5 portrays the component matrix of the Challenges in integrating sustainability to Supply chain

- **Inference:** From the output of the factor analysis, it is clear that there are 3 principal components which together explain 60% of the variance in the data. The variables which is having a value more than 0.5 in the component matrix is considered as part of that component. The components and their constituent variables are listed in the Table 6.

Table 6: Principal Components Extracted

No.	Component	Constituent Variables
1	Component 1	The final customers still seldom want to pay for the more expensive sustainable services
		The operationalization of governmental regulations
2	Component 2	Lack of educated and permanent employees (lack of knowledge)
		Customers unawareness of sustainable green products
3	Component 3	Negligence about the SSCM from all stake holders

From the above three principal components extracted, we can say the major factors for the Challenges in integrating sustainability with Supply Chain Management are:

- Expensive sustainable services and fluctuating governmental regulations
- Lack of knowledge and awareness of sustainable products
- Negligence for Sustainable environment

VI. FINDINGS

The following observations & conclusions were made from data interpretation & data analysis of the study:

- There is an association between Experience of the respondents and respondent's opinion about Sustainable Supply Chain Strategies
- From the factor analysis, the major challenges in integrating sustainability with Supply Chain Management among respondents are :-
 - Expensive sustainable services and fluctuating governmental regulations
 - Lack of knowledge and awareness of sustainable products
 - Negligence for Sustainable environment

VII. RECOMMENDATIONS

The findings of the study were able to provide recommendations in the areas of implications to theory, policy & practices which can be considered as futuristic for SSCM implementation within the construction industry.

- 1. Implications for the Theory:** The study provides an insight into challenges faced by the construction industry in implementing SSCM. The study is supported by the theory of comparative advantage where construction companies are known all over the world. There is thus a wide opportunity for the construction industry to get a global window for implementing more SSCM strategies thus reducing the barriers & overcoming the challenges.
- 2. Implication for the Policy:** From the policy makers in the construction sector the study reveals the growing importance of formulation of regulatory policy to protect our environment in a sustainable fashion. An analysis on challenges of SSCM in global networking and collaborating with the construction industry, and its impact in improvement of access to market and enhanced associations; bargaining power can be conducted further. The study recommends the government and other stakeholders to explore means of enhancing accessibility of credit facilities to the sustainable construction builders to enable them to expand their enterprises and reduce middlemen in order to maximize on their profitability. Regular marketing forums in the various export destinations can also be encouraged to promote SSCM strategies.
- 3. Implication for the practices**
 - Encourage the builders to adopt the modern technologies of production and marketing of the sustainable construction products to gain a competitive edge in the construction field.
 - Enhance togetherness in marketing and producing in bulk thus advantages of economies of scale. Competitiveness will be achieved when stakeholders participate in forums and join networks that enhance access of information on global markets and form a basis for better marketing strategies and improves sustainable product designs.
 - The modular building technique allows builders to create a structure offsite and later transport to the end location. This will reduce the time and use fewer materials to

complete a project with same high quality results which could be achieved by outsourcing this prefabrication to selected vendors who gives much emphasis to sustainable practices. Thus, builders could work with better efficiencies because they don't have to contend with weather delays or mishaps for such cases and could produce lesser waste and bring more energy efficiency to the building.

- Prefabrication makes more use of wood than traditional construction methods, which rely more on steel and cement. Wood represents a carbon storing material whose adoption alongside prefabrication techniques can help building's overall carbon footprint.
- Construction must be focused on achieving holistically green to be sustainable, ranging from air ventilation systems to the flooring by following strategies to bring sustainable component to their supply chain management.
- Sustainability can be improved by reducing energy consumption, greenhouse gas emissions, natural resource consumption, by increasing service life and by implementing more cost effective solutions.
- Considerable efforts should be made by builders to bring awareness among the customers for the benefits they could avail by occupying sustainable buildings which is the future of construction.
- Promoting and encouraging locally sourced materials and local manufacturers could help to develop suppliers with focus on products with sustainable design and capabilities.
- Builders should attempt to acquire Green Building certifications like IGBC, LEED, WELL which is increasingly becoming a norm for sustainability. And for that, emphasis has to be laid on bringing sustainability in construction supply chain through Net zero energy buildings, water conservation, waste to fuel, smart buildings coupled with distributed energy systems, climate change resistant buildings and alternative sustainable building materials.

VIII. CONCLUSION

Construction is a productive process that presents a high degree of fragmentation between participants. This fact gives rise to many problems originated mainly by the lack of coordination of these participants. SCM provides many principles to address this fragmentation and reduce it. However, those principles were developed in the manufacturing environment, which present conditions that are much more favorable for its application.

The terms Supply Chain Management (SCM) and Sustainable Supply Chain Management (SSCM) are evolving concepts. SSCM can be defined as the identification of problematic economical, social and environmental issues throughout the supply chain; assessment of their potential impact and risks and development of measures to enhance impact and mitigate the risks. Construction and realty sector is the future of growth within India. The pandemic created unprecedented social and financial issues to the economy. Taking all these factors into consideration, sustainability should clearly be given the emphasis in construction industry. Thus the builders should take the prompt initiative to adopt sustainable supply chain practices in their operations with a motive of creating energy efficient and safe buildings for the future. Special efforts need to be made for also bringing increased awareness among the customers to encourage demanding sustainability. At this situation builders have started to realize the fact that adopting sustainable supply chain

strategies in the construction industry need to be given bigger attention as the study observed the effect of sustainable supply chain strategies with the barriers and challenges in integrating sustainability with Construction Supply Chain Management.

Due to the nature and complexity of many construction processes, SCM relationships within the industry are, more often than not, based on dominance and power regime. Sustainable Supply Chain Management provides a rare opportunity to create value; however the construction industry needs to fully embrace SSCM if it is to achieve sustainable construction.

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