Mathematical Statistician and Engineering Applications
ISSN: 2094-0343
2326-9865

An investigation on the barriers in the Implementation of Sustainable Supply Chain Management in Indian Construction Industry

[1]Aditya Mudigonda
[1]Research Scholar, Department of Civil Engineering, College of Engineering Osmania University, Hyderabad, Telangana-500007, India
Email: aditya_ouce@outlook.com
[2]M. Gopal Naik
[2]Professor, Department of Civil Engineering, College of Engineering Osmania University, Hyderabad, Telangana-500007, India
Email: mgnaikc@osmania.ac.in
[3] T. Dhilip
[3]Research Scholar, Department of Civil Engineering, College of Engineering Osmania University, Hyderabad, Telangana-500007, India
Email: togitidhilip@gmail.com

Article Info
Page Number: 867 – 878
Publication Issue:
Vol. 71 No. 3s (2022)

Article History
Article Received: 22 April 2022
Revised: 10 May 2022
Accepted: 15 June 2022
Publication: 19 July 2022

Abstract

In terms of supply chain adoption, present construction industry practises lag. While the use of sustainable supply chain management principles in manufacturing has yielded great success, construction firms are constrained by age-old processes. A study was conducted to determine the main barriers to implementing sustainable supply chain practises in the construction industry. The questionnaire survey was designed to synthesise and inherit previous findings and required replies from industry participants. This study, using a sample of 279 replies, determines the challenges to the implementation of sustainable supply chain practises in the construction sector. The critical impediments are assessed and ranked using the Relative Importance Index approach.

Keywords: Sustainable, Supply Chains, Barriers

Introduction

Construction is gaining prominence in the Indian economy and has begun to play a significant role. The government of India is assisting the construction industry with significant tax breaks, bank loan subsidies, and other incentives. The Indian construction sector meets the country's rising infrastructure demands as well as the need for houses, commercial complexes, hotels, and industrial structures.

The construction industry is crucial to the Indian economy, accounting for 8.2 percent of GDP and employing around 12 percent of the workforce. After agriculture, construction is the country's second largest job, and it is predicted to grow by 30% between 2018 and 2028. The following are the primary drivers of this tremendous growth:

- Significant infrastructure development in the form of roads, bridges, tunnels, and buildings being constructed across the country.
- The expansion of the real estate industry in both rural and urban locations.
- The expansion of infrastructure sectors such as power generating, petroleum refining, and the petrochemical industry, among others.
- Spending by the government on infrastructure projects such as expressways, rural electrification programmes, Pradhan Mantri Gram Sadak Yojana (PMGSY), National Highways Development Project (NHDP), National Infrastructure Pipeline, and so on.
- The National Infrastructure Pipeline (NIP) is a five-year collection of social and economic infrastructure projects in India with a total sanctioned value of 102 lakh crore (US$1.3 trillion).
- Increased private-sector investment as a result of public-private partnerships (PPP).

Few construction firms have recognised the value of the supply chain in their business strategy, and many have constructed weak links in the chain at the business model level. There are examples of huge organisations that have been in business for decades and are still trying to locate a good group of architects, consultants, suppliers, and subcontractors that can be depended on to deliver timely, cost-effective, and efficient project support. This applies not only to Project Development firms, but to the entire eco-system.

The following are the most major obstacles we face now in incorporating SCM into existing practises:

- Uncertainty about the effectiveness or implementation.
- The absence of a proven model of cost, quality, or other improvement through SCM implementation in our industry.
- Inadequate top-level management buy-in, resulting in insufficient resource allocation.
- Opposition to web-enabled technology.
- Resistance to incorporating the far more transparent, value-driven SCM method into present intuitive, person-driven practises.
- Our inability to move our attention from managing day-to-day challenges to investing time and resources to give decision makers and users with a long-term strategy shift.

Aim and Objective

The main aim of this research is to identify the barriers in the implementation of sustainable supply chain practices in Indian construction industry.

- To identify and assess the challenges to the implementation of sustainable strategies in the Indian construction industry.

Literature Review

According to William J. O'Brien et al. (2002), construction supply chain management research is influenced by a variety of fields. The basic point of this paper is that a supply chain research and modelling methodology that blends aspects of process modelling with market dynamics and limitations is required. Study industrial organisation economics to gain a better knowledge of market structure and pressures. Supply chain analytical modelling to improve supply chain performance in terms of parameters such as speed, cost, reliability, and quality. Future study, according to the researchers, may include supply chain optimization, allowing for more serious debates about the merits of various types of networks, clusters, or chains. Industrial organisation modelling and analytical modelling are two methods.

According to Eleni Papadonikolaki et al. (2016), the most promising and seamless way to realising the full potential of SCM techniques is to use BIM with central coordination from design through operation. Although BIM was being used as a platform for inclusive design and information, it had not yet reached its full socio-technical maturity. BIM is quickly becoming the industry standard in Architecture, Engineering, and Construction. BIM was used in construction, and some SCM projects allegedly permitted BIM-based operations. 52 Dutch construction experts participated in the study. The researchers acknowledge that the most significant limitation of their research is that they are solely interested in Dutch projects. The study also identified a misalignment between BIM cooperation and SCM maturity. It is observed that the combination of which might be improved with more frequent utilization of the model. Overall, BIM was used as an inclusive design and information platform; however, because it has not yet reached its full socio-technical maturity, it can only be used and supported in teams that have already established trust, such as SCM environments.

Darko et al. (2017) assessed the major risks in Ghana's construction supply chain. Price variations, interest rate changes, material shortages, frequent changes in supply chain inputs, and unanticipated changes in demand are all identified as potential main dangers. There was no statistical difference in the perceptions of suppliers and contractors on the likely threats in the construction SC. The goal of this article is to identify potential main hazards in the construction supply chain (SC) to improve risk management activities. There have been identified 11 risk indicators that may affect the construction SC. This danger is most likely to be greatest when a single organised entity or supplier is in charge of supplying the business with critical raw materials.

Lars Bankvall et al. highlighted interdependence in supply chains and construction projects (2010). Economies of scale in construction material manufacturing facilities, resulting from pooled reliance, contribute to the sequential interdependencies commonly discussed in supply chain management literature. Where supply networks meet the construction project, different styles of reasoning conflict. SCM has been offered as a technique of improving construction performance. The core assumption is that supply chain activities should be integrated to provide higher value to customers. They address supply chain integration and coordination in relation to the project using the framework, taking into account the interdependencies.

The construction supply chain is important in the construction industry and is vital to the success of large-scale construction projects in developing countries. Supply chain integration, according to Ghaith Al-Werikat (2017), enhances efficiency and streamlines the goals of all parties involved. SCM enables the construction industry to have greater control over projects, increase profits, and reduce time, cost, and waste. Contracts geared toward SCM have increased the use of SCM practises in the building industry. They argue that Cox, Ireland, and Townsend's work demonstrates demand and supply concerns in the construction industry. Demand concerns include incorrect selection criteria, discontinuous and low demand issues, ineffective risk allocation, and rapid changes in specifications. According to the study, if all parties in the supply chain are addressed, including the main contractor, subcontractor, and suppliers, overall construction costs will be decreased. Furthermore, early subcontractor and supplier involvement is equally as vital as early contractor involvement. This early involvement of all parties would allow for the exchange of experience, which could help to reduce costs. In addition, early engagement integration would enable suppliers to become service providers rather than product providers.

According to Pham & Pham (2021), supply chain integration can increase the green performance of construction projects. Researchers have been paying special attention to the integration of environmental activities into supply chain management since the early 1990s (SCM). The goal of the study was to create and test a GSCI framework that demonstrates the links between environmental knowledge, green integration, and green performance in construction projects. The findings indicate that environmental knowledge is a necessary prerequisite for green supply chain integration. Supplier and customer integration were discovered to have a direct impact on green performance. There were 477 people in the study. According to the participants' perspectives, internal integration is a significant driver of supplier integration development. Green integration has been found to reduce the negative environmental consequences of the construction process. This integration is achieved by environmental practises implemented at both the corporate and SC levels.

According to Studer and De Brito Mello (2021), construction supply chains (CSCs) involve all construction activities, from initial demands, design, and construction, to maintenance, replacement, and final demolition of buildings and other structures. To encourage SCM adoption, it is recognised that a proper and holistic grasp of context-specific fundamental concepts and practises supporting SCM is essential. To improve supply chain efficiency, the construction industry has steadily adopted lean thinking, a management style influenced by the Toyota production system and well recognised in many other industrial contexts. Environmental policies and customer concerns are energising the entire building supply chain, which is a big polluter. The researchers looked at 321 articles. According to the authors, the evidence suggests that there is no one-size-fits-all approach to supply chain relationship management. This implication is consistent with previous study, which discovered that in order to properly capitalise on collaborative potential, each connection must be handled based on specific circumstances. They contend that these limits could pave the way for future study. Empirical data can be used to assess and validate replications of this study. Other research

directions could include exploring the cause–effect relationships between the revealed fundamental elements and developing instruments to assess the elements' maturity level.

Simon Croom et al. (2016) undertook an exploratory study to provide an overview of the environmental impact of food and beverage supply chains and how they are controlled. This paper describes a pilot study aiming to classify the extent to which the sustainability goal is visible throughout supply chain strategies and actions. The participating organisations were chosen after reviewing the 2007 and 2008 Waste Reduction and Diversion award winners from the City of San Diego. The study examined inside and across case analysis to identify the key criteria of sustainable supply chain management. The goal of this article, according to Croom and colleagues, is to investigate how environmental issues are incorporated into supply chain strategic and operational management.

According to the UN Global Compact's 2013 Global Corporate Sustainability Report, companies are increasingly discussing supply chain sustainability and making substantial progress in establishing supplier expectations. According to the researchers, the last two proxy seasons saw a record number of shareholder resolutions on supply chains. A supplier code of conduct is a critical step in establishing and communicating expectations. Peer companies with similar supply chains might collaborate to develop common standards and best practises. While more firms are include suppliers in their sustainability strategies, implementation remains a difficulty.

According to Mokhtar et al. (2016), around 68 percent of the top 250 global firms released a separate annual report on sustainability in 2004. Supply chain issues were cited in 80% of these studies. Human rights and occupational and safety safety are the most important concerns for businesses. Product Utilities is given less consideration than other social issues. The goal of this research was to investigate the projected SCS issues for social and economic issues from the CSR 2013/2014 session.

Suppliers, according to Sarkar and Mohapatra (2006), contribute to a supply chain's overall success. They draw attention to the important distinctions between supply base rationalisation and supply base reduction. The team uses a fuzzy set technique to address the problem of measurement imprecision. Poor supplier performance has repercussions throughout the supply chain. Creating a strong buyer–supplier relationship is an effective approach to improve supplier performance. The authors propose a supply-base reduction strategy based on long-term capability aspects as well as a set of short-term performance variables.

Methodology

The questionnaire responses from suppliers, logistics teams, and end users such as architects, engineers, and execution teams are used in this study. Following a review of the literature, a standardised questionnaire was constructed. The questionnaire was designed to incorporate the observed Economic, Social, and Technological constraints in order to generalise the context-specific data and achieve the study's objectives. A 5-point Likert scale rating was used in the current study, with the third point denoting a neutral opinion toward that particular Likert item.

The Relative Importance Index approach is used to evaluate survey replies. The Relative Relevance Index (RII) is a measure used to determine the relative importance of certain quality characteristics. The number of Likert scale points utilised equals the value of W, the respondent's weighting of each element. The equation below can be used to determine the Relative Importance Index (RII).

$$\mathrm{RII} = \frac{\sum \mathrm{W}}{\mathrm{A} \,.\, \mathrm{N}}$$

Where, W is the respondent weighting for each item

A is the highest weight

N is the total number of responses

Survey Design

Based on the literature survey, the survey was designed to incorporate the required items in the various categories of issues connected to the implementation of sustainable supply chains in the Indian construction industry. Table 1 displays the survey questions that were developed.

Table 1 Barriers in the Implementation of Sustainable Supply Chains in Indian Construction

Question	**Code**
High investments required to implement sustainable strategies	EC1
Initially high operational costs to comply with sustainability standards	EC2
High costs for purchasing environmentally friendly materials	EC3
High costs in adapting sustainable and environmentally friendly norms	EC4
High impact of environmentally friendly and sustainable practices on the final cost of product in the market	EC5
High demand for cheaper products rather than sustainable products	EC6
Lack of commitment from participants in the supply process (ie manufacturers, suppliers, and end users)	S1
Lack of proper information sharing between different competitors in the industry	S2
Lack of proper customer feedback regarding the need for sustainability in the supply chains	S3
Lack of remedial measures and innovations based on customer feedback	S4
Lack of strict regulatory enforcement	S5

Question	Code
Reluctance to explore diverse supply chains beyond their personal networks and relationships	S6
Employees recognise and support the company's environmental and social responsibility initiatives.	S7
Environmental protection and social responsibility measures have been incorporated into the management policies of the majority of competitors.	S8
If a company/supplier fails to demonstrate environmental and social responsibility, consumers will report it.	S9
Lack of trained and skilled resources	T1
Lack of tailored support and training regarding implementation strategies with respect to construction industry	T2
Lack of knowledge about their (ie manufacturers, suppliers, and end users) impact on environment	T3
No proper long-term strategies in place towards a sustainable development	T4
Not willing to learn from past experiences which caused disruptions in supply chains.	T5

Using Microsoft forms, an online form was created to collect replies from survey participants. Based on the results of the pilot study, it was determined that direct interviews from manufacturers and logistics teams would be conducted to gather information for the survey.

Data Collection

400 forms were delivered to various building supply chain partners as part of the study. During the study's course, a total of 279 replies were obtained, with 204 responses coming via the online form and 75 coming from interviews with industry players.

Reliability Analysis

The Jamovi toolbox is used to assess responses from manufacturers or suppliers, logistical teams, and end users. The questions asked of responders are recoded to aid calculation. Economic barriers are denoted by EC, social barriers by S, and technical hurdles by T. Table 3 demonstrates the reliability of survey responses.

Table 3 Reliability Analysis

	mean	sd	Cronbach's α	McDonald's ω
scale	3.74	0.452	0.805	0.824

Descriptive Analysis

The mean, median, standard deviation and variance of the collected data are displayed in table 4.

Table 4 Descriptive Analysis

Code	N	Missing	Mean	Median	SD	Variance	Min	Max
EC1	279	0	3.77	4	1.08	1.168	1	5
EC2	279	0	4.04	4	0.89	0.797	1	5
EC3	279	0	3.99	4	0.9	0.809	1	5
EC4	279	0	4.01	4	0.98	0.96	1	5
EC5	279	0	4.09	4	0.91	0.834	1	5
EC6	279	0	4.03	4	0.98	0.952	1	5
S1	279	0	3.79	4	0.93	0.858	1	5
S2	279	0	4.08	4	0.79	0.615	1	5
S3	279	0	3.85	4	0.89	0.8	1	5
S4	279	0	3.86	4	1.01	1.025	1	5
S5	279	0	3.96	4	0.88	0.779	1	5
S6	279	0	3.85	4	1	0.999	1	5
S7	279	0	3.44	4	0.98	0.96	1	5
S8	279	0	3.22	4	1.2	1.432	1	5
S9	279	0	3.27	4	1.16	1.334	1	5
T1	279	0	3.8	4	1.16	1.343	1	5
T2	279	0	3.96	4	0.75	0.56	1	5

Code	N	Missing	Mean	Median	SD	Variance	Min	Max
T3	279	0	3.84	4	1.13	1.27	1	5
T4	279	0	3.96	4	0.9	0.804	1	5
T5	279	0	3.77	4	0.95	0.895	1	5

In order to evaluate and rank the barriers to the implementation of sustainable building supply chain management, the questions asked in the areas of economy, social, and technology must be analysed using RII. The RII score and ranking of each economic criterion are shown in table 5.

Table 5. Barriers RII scores and Ranks – Economy

Questions	Code	RII	Rank
High investments required to implement sustainable strategies	EC1	0.75	6
Initially high operational costs to comply with sustainability standards	EC2	0.81	2
High costs for purchasing environmentally friendly materials	EC3	0.8	4
High costs in adapting sustainable and environmentally friendly norms	EC4	0.8	4
High impact of environmentally friendly and sustainable practices on the final cost of product in the market	EC5	0.82	1
High demand for cheaper products rather than sustainable products	EC6	0.81	2

The RII score and ranking of each social category parameter are shown in table 6.

Table 6 Barriers RII scores and Ranks – Social

Questions	Code	RII	Rank
Lack of commitment from participants in the supply process (ie manufacturers, suppliers, and end users)	S1	0.76	6
Lack of proper information sharing between different competitors in the industry	S2	0.82	1

Questions	Code	RII	Rank
Lack of proper customer feedback regarding the need for sustainability in the supply chains	S3	0.77	3
Lack of remedial measures and innovations based on customer feedback	S4	0.77	3
Lack of strict regulatory enforcement	S5	0.79	2
Reluctance to explore diverse supply chains beyond their personal networks and relationships	S6	0.77	3
Employees recognise and support the company's environmental and social responsibility initiatives.	S7	0.69	7
Environmental protection and social responsibility measures have been incorporated into the management policies of the majority of competitors.	S8	0.64	9
If a company/supplier fails to demonstrate environmental and social responsibility, consumers will report it.	S9	0.65	8

The RII score and ranking of each parameter in the technology category are shown in table 7.

Table 7 Barriers RII scores and Ranks – Technology

Questions	Code	RII	Rank
Lack of trained and skilled resources	T1	0.76	4
Lack of tailored support and training regarding implementation strategies with respect to construction industry	T2	0.79	1
Lack of knowledge about their (ie manufacturers, suppliers, and end users) impact on environment	T3	0.77	3
No proper long-term strategies in place towards a sustainable development	T4	0.79	1
Not willing to learn from past experiences which caused disruptions in supply chains.	T5	0.75	5

Discussion

This study included 279 participants to determine the barriers to applying sustainable practises in the construction industry. While the criteria were limited to the economy, social, and

technological elements, table 8 shows the top 10 hurdles to the adoption of sustainable practises.

Table 8 Top ten barriers in implementation of Sustainable Strategies

Rank	**Question**	**Category**	**RII**
1	High impact of environmentally friendly and sustainable practices on the final cost of product in the market	Economic	0.82
2	Lack of proper information sharing between different competitors in the industry	Social	0.82
3	Initially high operational costs to comply with sustainability standards	Economic	0.81
4	High demand for cheaper products rather than sustainable products	Economic	0.81
5	High costs for purchasing environmentally friendly materials	Economic	0.80
6	High costs in adapting sustainable and environmentally friendly norms	Economic	0.80
7	Lack of strict regulatory enforcement	Social	0.79
8	Lack of tailored support and training regarding implementation strategies with respect to construction industry	Technology	0.79
9	No proper long-term strategies in place towards a sustainable development	Technology	0.79
10	Lack of proper customer feedback regarding the need for sustainability in the supply chains	Social	0.77

- According to the participants, the most significant barrier to applying sustainable methods in the building supply chain is the increased cost of final products as a result of environmentally friendly procedures, as well as the impact of that high price on market presence.
- It has also been revealed that the industrial partners do not understand the concept of information sharing.
- While the initial costs of making environmentally friendly items are high, the market has a strong preference for low-cost environmentally friendly products over expensive ecologically friendly products.
- There is also a scarcity of targeted support and training for various categories of construction supply chain players.

- Because there is no long-term strategy in place to seek sustainable development, there is also no effective consumer feedback and remedial steps based on such feedback.

Conclusions

The purpose of this research was to identify major hurdles to sustainable supply chain management in the Indian construction business. The current market trend is moving away from rivalry between firms and toward competition across supply chains. In order to survive in the market for a longer length of time, it is necessary for players to focus on value analysis across the supply chain rather than on their own growth.

The higher ultimate cost of a product produced using environmentally friendly and sustainable techniques has been identified as the most significant barrier to the implementation of sustainable strategies. Industry competitors lack communication and data exchange, resulting in incoherent and unsustainable strategies.

References

1. Darko, O. -Manu, and E. And Edwards. 2016. "Identifying Potential Critical Risks in the Construction Supply Chain-An Empirical Study in Ghana." Mindanao Journal of Science and Technology Vol.14 (2016) 79-100
2. Papadonikolaki, E., R. Vrijhoef, and H. Wamelink. 2015. "BIM adoption in integrated supply chains: A multiple case study." Proc. 31st Annu. Assoc. Res. Constr. Manag. Conf. ARCOM 2015, (September): 631–640.
3. William J. O'Brien, Kerry London and Ruben Vrijhoef 2002 "Construction Supply Chain Modeling: a research review and interdisciplinary research agenda" Proceedings IGLC-10, August 2002, Gramado, Brazil
4. Bankvall, L., L. E. Bygballe, A. Dubois, and M. Jahre. 2010. "Interdependence in supply chains and projects in construction." Supply Chain Manag., 15 (5): 385–393. https://doi.org/10.1108/13598541011068314.
5. Al-Werikat, G. 2017. "Supply Chain Management In Construction; Revealed." International Journal Of Scientific & Technology Research Volume 6, Issue 3
6. Pham, T., and H. Pham. 2021. "Improving green performance of construction projects through supply chain integration: The role of environmental knowledge." Sustain. Prod. Consum., 26: 933–942. Elsevier B.V. https://doi.org/10.1016/j.spc.2021.01.004.
7. Studer, W. P., and L. C. B. D. B. Mello. 2021. "Core elements underlying supply chain management in the construction industry: A systematic literature review." Buildings. MDPI.
8. Croom, S., S. Barani, D. Belanger, T. Lyons, and J. Murakami. n.d. "Sustainable supply chain management-an exploration of current practice."
9. United Nations Global Compact "Guide to Corporate Sustainability"
10. Mokhtar, M. F., B. Omar, N. H. M. Nor, N. F. M. Pauzi, S. Hassan, and W. A. W. Mohamed. 2016. "Social and Economic Concern of Supply Chain Sustainability (SCS)." IOP Conf. Ser. Mater. Sci. Eng. Institute of Physics Publishing.
11. Sarkar, A., and P. K. J. Mohapatra. 2006. "Evaluation of supplier capability and performance: A method for supply base reduction." J. Purch. Supply Manag., 12 (3): 148–163. https://doi.org/10.1016/j.pursup.2006.08.003.