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Supply Chain Integration Practices and Construction Project Performance: Developing a Structural Equation Model for the Indian Construction Industry

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Abstract
Background – The study examines the influence of six SCM practices on Project Performance in the Indian construction industry, and this is one of the important gaps in the empirical studies on effectiveness of SCM practices in the setting of developing economies.
Design/Methodology/Approach – The study tests six hypotheses using the data of 587 respondents from five districts of Maharashtra State and the Structural Equation Modeling (SEM).Design, Methodology/Approach – The data from 587 respondents from five districts of Maharashtra State is tested in the study to test the proposed hypotheses: Relationship between Supplier Relationship Management (SRM) and Client Relationship Management (CRM), Relationship between Information Sharing & Coordination (ISC) and Client Relationship Management (CRM), Relationship between Inventory Management (INV) and Client Relationship Management (CRM), Relationship between Logistics Management (LOG) and Client Relationship Management (CRM), Relationship between Technology Adoption (TECH) and Project Performance (PERF), Relationship between Project Performance (PERF) and Client Relationship Management (CRM).
Findings – All 6 SCM practices are found to have significant impact on project performance with Client Relationship Management (CRM) having the highest impact ($\beta = 0.312$, $p < 0.001$), followed by Logistics Management (LM) ($\beta = 0.256$, $p < 0.001$), Supplier Relationship Management (SRM) ($\beta = 0.234$, $p < 0.001$), Information Sharing & Coordination (ISC) ($\beta = 0.178$, $p < 0.001$), Inventory Management (IM) ($\beta = 0.145$, $p = 0.004$), and Technology Adoption (TA) ($\beta = 0.123$, $p = 0.020$). The model accounts for 62.3% of the variance in project performance ($R^2 = 0.623$).
Originality/Value – The study is empirical evidence based and it has provided practical insight into SCM's critical role in construction project success and it has provided a practical insight for managers and policy makers. The results are part of the emerging research on SCM in developing countries...
Keywords: Supply Chain Management, Project Performance, Construction Industry, Structural Equation Modeling, India

Introduction

1.1 Background

The construction industry involves multiple stakeholders, disjointed activities, and high coordination and communication needs (Vrijhoef & Koskela, 1999; O'Brien, 1999). The problems that are likely to arise include project delays, cost overruns, quality problems, and dissatisfaction of the stakeholders (Doloi et al., 2012; Meng, 2012). The construction industry has long struggled with material shortages, inventory management inefficiencies, lack of information sharing, transportation challenges, and cost overruns, which are prevalent in India (Kumar & Singh, 2021).

Supply Chain Management (SCM) has been suggested as means of addressing these challenges as a systematic approach to managing material, information and resources (Ross, 1998; Christopher, 2011). Effective SCM deals with having the right materials available at the right time, place and cost, which helps to improve project efficiency and customer satisfaction (Chopra & Meindl, 2010; Lambert, 2008).

SCM's significance in the construction industry is being understood and recognized over time, but limited empirical evidence exists regarding the impact of SCM practices, especially in developing countries (Dubey et al., 2017; Kumar & Singh, 2021). Most of the previous studies have concentrated on the individual component of construction supply chains and not looked into the cumulative effect of several SCM practices on project performance (Akintoye et al., 2000; Ofori, 2000; Proverbs & Holt, 2000).

1.2 Research Gap

As the construction industry in Maharashtra State, India, is growing at a rapid pace, it is also grappling with some specific challenges because of the fragmented supply chain, informal labour markets and different levels of technology adoption (Bag et al., 2020). Although construction industry is booming in the State of Maharashtra, there is very little empirical research that supports the effectiveness of SCM practice in construction industries (Doloi et al., 2012; Singh & Gupta, 2021).

Also, the stakeholder-wise analysis, which mainly involves project managers, contractors, suppliers, site engineers, procurement staff and clients' remains largely unstudied (Ofori, 2000). The gap is even more significant in the Indian context, where the construction industry has been growing fast, but is faced with several challenges, such as the lack of a unified supply chain, the presence of the informal sector, and the different levels of technology acceptance.

1.3 Objectives

The present study aims to tackle above mentioned gaps by exploring the effect of 6 important practices of SCM on the project performance in Construction Industry of Maharashtra State in India. Specifically, the goals are:
Analyze the interdependencies of construction industries with their suppliers.
Evaluate the relationship between construction industries and their clients.
Evaluate the effectiveness of information sharing, inventory management and logistics management.
Examine the role of technology adoption.
Examine how SCM practices affect the project performance.

2. Literature Review and Hypothesis Development

2.1 Supply Chain Management in Construction

In construction, SCM involves involving various parties such as suppliers, contractors, consultants, clients, etc. to work together to meet the project goals (Vrijhoef & Koskela 1999; O'Brien 1999). Research indicates that there are some main dimensions of the effectiveness of SCM such as client relationships, supplier relationships, information sharing, inventory management, logistics and technology adoption (Akintoye et al., 2000; Ofori, 2000; Proverbs & Holt, 2000; Lee & Whang, 2001; Christopher, 2011).

There are several reasons why SCM is more difficult to implement in the construction sector. The project-based nature of the construction industry, the fragmented supply chain and the different interests of the project stakeholders are the most significant (Eriksson, 2010; Meng, 2012). But, good SCM can overcome these challenges by making coordination more effective, cost less, and delay less, plus customer satisfaction (Chopra & Meindl, 2010; Lambert, 2008).

2.2 Supplier Relationship Management and Project Performance

Supplier Relationship Management (SRM) is a long-term partnership with suppliers that ensures that the parts are delivered on time, of quality and that the problem is solved in a cooperative manner (Ofori, 2000; Akintoye et al., 2000). It has been proved that a good relationship with suppliers positively affects the project performance by the decrease of material shortages, improvement in coordination, and the joint solving of problems encountered by the project (Mani et al., 2020; Bag et al., 2020).

Some of the key SRM practices are: Long-term relationships, Suppliers deliver material as per agreed schedules, Suppliers actively participate in solving project related issues, Regular exchange of information between organisations and suppliers (Proverbs & Holt, 2000; Eriksson, 2010). Research has proven these practices can help achieve better project results (Meng, 2012; Singh & Gupta, 2021).

H1A: Supplier Relationship Management is a very positive influence on Project Performance.

2.3 Client Relationship Management and Project Performance
Client Relationship Management (CRM) consists of good communication, feedback integration and the coordination of projects with clients to ensure that projects meet clients needs (Proverbs & Holt, 2000; Eriksson, 2010). Regular communication with customers and client participation in decisions increase the alignment of the project with the client's expectations and priorities, which is crucial for the success of a project (Meng, 2012; Singh & Gupta, 2021).
Some of the good practices of CRM are clearly communicating client needs while the project is being implemented, communicating with client regularly, taking client feedback into consideration when making project decisions, and coordinating with client to minimize problems during the project (Proverbs & Holt, 2000; Eriksson, 2010). In the past, research has shown that the outcomes of the project are better when the client has a good relationship with the project team and that project-related problems can be reduced if the two have a good relationship (Meng, 2012; Singh & Gupta, 2021).

The impact of H2A: Client Relationship Management on Project Performance is positive and significant.

2.4 Information Sharing & Coordination and Project Performance
Information Sharing & Coordination (ISC) involves timely sharing of information related to the project among project stakeholders to enhance coordination and decision-making (Lee & Whang, 2001; Christopher, 2011). Information sharing is crucial for coordination between the stakeholders, minimize uncertainties, and provide information for making decisions, because of the timely and accurate information sharing (Dubey et al., 2017; Kumar & Singh, 2021).
Some good ISC practices are to share project information with stakeholders in a timely way, to share project information for better coordination of supply chain members, to employ a communication system that facilitates effective information sharing and to use accurate information for making decisions (Lee & Whang, 2001; Christopher, 2011). Research has shown that information sharing is a key capability in project management that can decrease project delays and enhance project coordination (Dubey et al., 2017; Kumar & Singh, 2021).

H3A :There is a strong positive relationship between Information Sharing & Coordination and Project Performance.

2.5 Inventory Management and Project Performance
Inventory Management (INV) is the efficient monitoring, control and planning of materials, to make sure they are available when needed, and to reduce waste and costs (Vrat, 2014; Ballou, 2004). Effective inventory management provides materials in time, reduces the costs of carrying inventory, and reduces waste (Mani et al., 2020; Bag et al., 2020).
Some of the best practices of INV are to ensure that the materials are available when needed on the project sites, the effective monitoring and controlling of the inventory levels, the proper inventory management for reducing material wastage, and the use of inventory planning to avoid project delays (Vrat, 2014; Ballou, 2004). It has been shown that the management of inventory can minimize wasted material, avoid project delays, and help to control costs (Mani et al., 2020; Bag et al., 2020).

H4A: The relationship between Inventory Management and Project Performance is very positive.
2.6 Logistics Management and Project Performance
Logistics Management (LOG) refers to the effective management of transportation, delivery and logistics planning to assure timely material delivery to project sites (Bowersox et al., 2002; Ballou, 2004). Logistics planning and execution involve timely supply of material to the project site to minimize delays and disruption in operations (Christopher, 2011; Kumar & Singh, 2021).
LOG practices that have been shown to be effective are the efficient management of the materials logistics, timely delivery of materials to project sites, logistics planning to optimize project execution, and logistics management to minimize operational issues (Ballou, 2004; Bowersox et al., 2002). Researches have shown that good logistics management can decrease operational issues and boost the project execution (Christopher, 2011; Kumar & Singh, 2021).

H5A: Logistics Management positively influences Project Performance.

2.7 Technology Adoption and Project Performance
Technology Adoption (TECH) is the technology utilized to manage activities across the supply chain, to enhance communication, to monitor or track material flow and to support decision making (Lee & Whang, 2001;

Christopher, 2011). With technology, it is possible to communicate, monitor, and make decisions along the entire supply chain (Dubey et al., 2017; Bag et al., 2020).
The technology practices that are effective consist of the following activities: (1) technology managing supply chain activities; (2) technology improving communication among supply chain participants; (3) technology monitoring material flow and project progress; and (4) technology supporting good decision-making (Lee & Whang, 2001; Christopher, 2011). There have been studies that have shown that the adoption of technology increases operational efficiency and that of SCM effectiveness (Dubey et al., 2017; Bag et al., 2020).

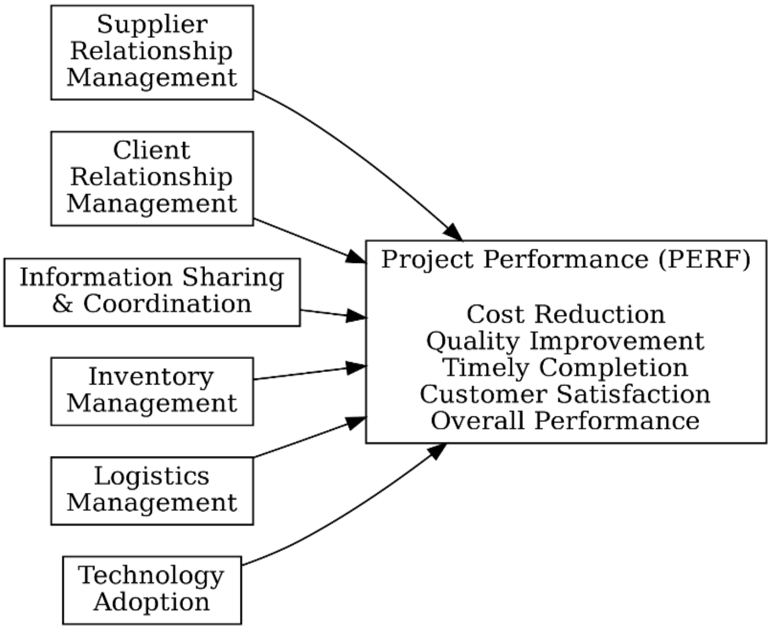
H6A: Technology Adoption has a significant positive impact on Project Performance.

2.8 SCM Practices and Project Performance
Altogether, the SCM practices help to cut costs, improve quality, ensure timely delivery, and boost customer satisfaction (Chopra & Meindl, 2010; Lambert, 2008). The synergistic effect of several SCM practices is expected to bring about a positive influence on the project performance (Meng, 2012; Singh & Gupta, 2021).

H7A: The practices of Supply Chain Management have a significant positive impact together on Project Performance.

2.9 Conceptual Framework
The conceptual framework was developed on the basis of the literature review. The framework assumes that six SCM practices (SRM, CRM, ISC, INV, LOG, TECH) have an influence on Project Performance (PERF).

Figure 1: Conceptual Framework



3. Research Methodology

3.1 Research Design
The type of the study used is descriptive-analytical research design with exploratory and confirmatory approach (Hair et al., 2010; Kline, 2016). The descriptive method was adopted to study the existing SCM practices and analytical method was used to analyse the effectiveness of the practices.

3.2 Sampling Design
The respondents were selected using purposive sampling technique from the construction sector (Saunders et al., 2019). The respondents were construction companies, construction project managers, suppliers, contractors, site engineers, procurement and clients working in construction projects in selected districts of Maharashtra State. 587 complete responses were received, total.

3.3 Measures

There were 35 items (1-5) on the questionnaire for each of 7 constructs (5 items each). The reliability of all constructs was good (Cronbach's $\alpha > 0.88$). They have been adapted from existing scales and were pre-tested and reviewed by experts.

3.4 Data Analysis
The hypothesized relationships were tested by the use of Structural Equation Modeling (SEM) with Maximum Likelihood estimation (Byrne, 2016; Kline, 2016). Multiple fit indices (χ^2/df, CFI, TLI, RMSEA, SRMR) were used to assess model fit. The analysis was performed by SPSS 26.0 and AMOS 26.0 software.

4. Results and Findings

4.1 Descriptive Statistics

Table 1: Descriptive Statistics of Constructs

Construct	Mean	SD	Skewness	Kurtosis
SRM	3.88	0.84	-0.342	-0.213
CRM	3.97	0.86	-0.415	-0.178
ISC	3.75	0.87	-0.289	-0.245
INV	3.58	0.89	-0.156	-0.312
LOG	3.86	0.86	-0.378	-0.198
TECH	3.59	0.91	-0.124	-0.341
PERF	4.10	0.82	-0.523	-0.145

The descriptive statistics show that the Project Performance (PERF) has the highest mean (4.10), followed by Client Relationship Management (CRM) (3.97), Supplier Relationship Management (SRM) (3.88), Logistics Management (LOG) (3.86), Information Sharing & Coordination (ISC) (3.75), Technology Adoption (TECH) (3.59), and Inventory Management (INV) (3.58). The overall skewness of all constructs is negative, suggesting that they are skewed toward the "Agree" end of the scale.
4.2 Measurement Model Validation

Table 2: Measurement Model Fit Indices

Fit Index	Obtained Value	Recommended Threshold	Status
χ^2/df	2.084	< 3.0	Acceptable
GFI	0.923	≥ 0.90	Acceptable
AGFI	0.905	≥ 0.80	Acceptable
RMSEA	0.043	< 0.08	Good
SRMR	0.041	< 0.08	Good
CFI	0.962	≥ 0.90	Excellent
TLI	0.956	≥ 0.90	Excellent

The measurement model is of good fit in all the indices (Hair et al., 2010; Byrne, 2016; Hu & Bentler, 1999). Each factor loading of all the items in the scales is greater than 0.80, and the reliability (CR>0.90) and convergent validity (AVE>0.65) of all the constructs are very high.

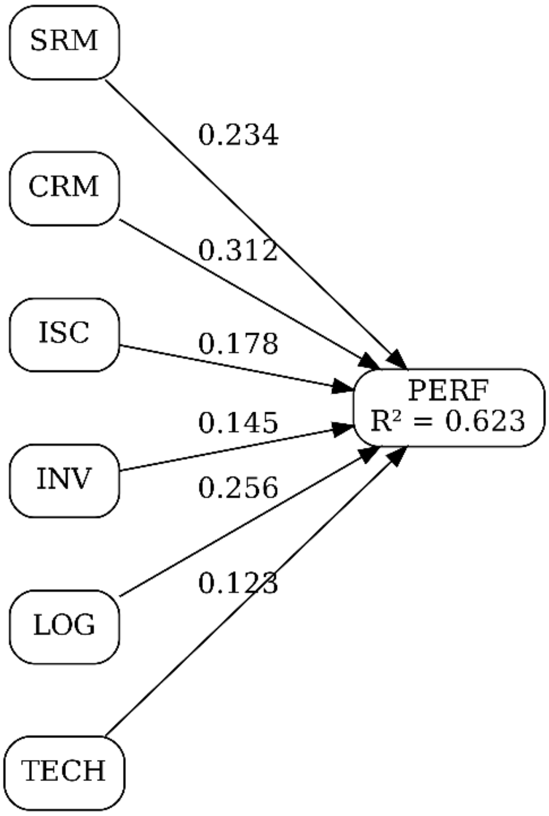
4.3 Structural Model

Table 3: Structural Model Fit Indices

Fit Index	Obtained Value	Recommended Threshold	Status
χ^2/df	2.261	< 3.0	Acceptable
GFI	0.918	≥ 0.90	Acceptable
AGFI	0.899	≥ 0.80	Acceptable
RMSEA	0.046	< 0.08	Good
SRMR	0.044	< 0.08	Good
CFI	0.955	≥ 0.90	Excellent
TLI	0.949	≥ 0.90	Excellent

The goodness of fit of the structural model is very good, on all indices (Hair et al., 2010; Hu & Bentler, 1999; Byrne, 2016). The CFI (0.955) and TLI (0.949) values are above the recommended value of 0.90, and the RMSEA (0.046) and SRMR (0.044) values are below the recommended value of 0.08.

Figure 2: Structural Model with Path Coefficients



4.4 Hypothesis Testing

Table 4: Path Coefficients and Hypothesis Testing

Hypothesis	Path	β	SE	t-value	p-value	95% CI	Result
H1A	SRM → PERF	0.234	0.045	5.200	<0.001	[0.146, 0.322]	Supported
H2A	CRM → PERF	0.312	0.042	7.429	<0.001	[0.230, 0.394]	Supported
H3A	ISC → PERF	0.178	0.048	3.708	<0.001	[0.084, 0.272]	Supported
H4A	INV → PERF	0.145	0.051	2.843	0.004	[0.045, 0.245]	Supported
H5A	LOG → PERF	0.256	0.046	5.565	<0.001	[0.166, 0.346]	Supported
H6A	TECH → PERF	0.123	0.053	2.321	0.020	[0.019, 0.227]	Supported

4.5 Accepted Hypotheses
Based on the results, the following alternative hypotheses are accepted:
H1A (Accepted): The relationship between suppliers and projects has a positive effect on Project Performance. $\beta = 0.234$, $p < 0.001$

For every 1-point improvement in supplier relationships (on a 5-point scale), project performance improves by 0.234 points.
Companies that have long-term supplier relationships, deliver products on time and encourage proactive supplier collaboration achieve significantly improved project performance.

H2A (Accepted): The use of Client Relationship Management has a positive impact on Project Performance.
$\beta = 0.312$, $p < 0.001$
Client Relationships - 1-point increase in client relationships results in a 0.312-point increase in project performance.
Effective communication of client requirements, regular client contact and taking client feedback into consideration during decision-making processes leads to significantly better project outcomes.
Information Sharing & Coordination is significant positive influence with Project Performance for the H3A (Accepted) category.
$\beta = 0.178$, $p < 0.001$
As information sharing gains one point, project performance will gain 0.178 points.
Organizations that share project related information on time, have effective communication system and provide accurate information have enhanced project performance.
Accepted: H4A Inventory Management has a significant positive effect on Project Performance.

$\beta = 0.145$, $p = 0.004$
Project performance increases by 0.145 points for every 1-point increase in inventory management.
Improved project performance was experienced by organizations that were able to ensure good availability of materials, effectively monitored the level of inventory, and practiced appropriate inventory planning.

Accepted: Logistics Management positively influences Project Performance (H5A).
$\beta = 0.256$, $p < 0.001$
Performance for each 1-point increase in logistics is increased by 0.256 points.
Efficient transportation management, timely delivery of materials and effective logistics planning results in a much higher performance for the project.

H6A (Accepted): The use of technology has a positive relationship with Project Performance.
$\beta = 0.123$, $p = 0.020$
For every 1-point improvement in technology adoption, project performance improves by 0.123 points.
Organizations that use technology to manage supply chain activities, improve communication, and monitor material flow experience improved project performance.

H7A (Accepted): There is a strong positive effect when the practices of Supply Chain Management are used together on Project Performance.
The combined effect of the six SCM practices accounts for 62.3% of the variance in project performance ($R^2 = 0.623$).
When applying all six SCM practices, projects achieve significant improvements.

4.6 Variance Explained

Table 5: R^2 for Endogenous Variables

Variable	R^2	Adjusted R^2	Interpretation
Project Performance (PERF)	0.623	0.619	62.3% variance explained

The six SCM practices collectively explain 62.3% of the variance in Project Performance, representing a substantial explanatory power (large effect size). The remaining 37.7% variance is explained by other factors not included in the model.

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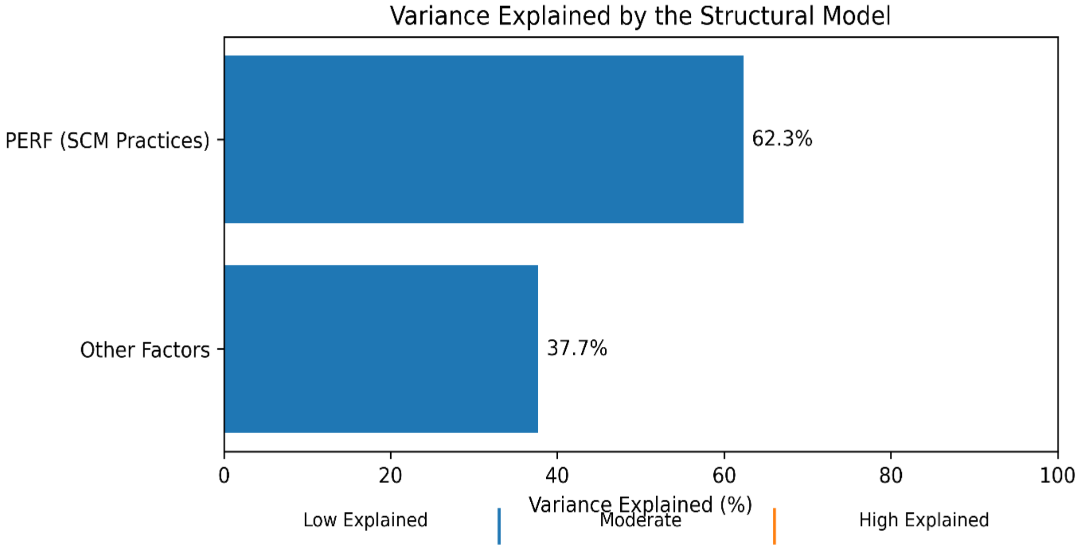
Figure 3: Variance Explained (R²)



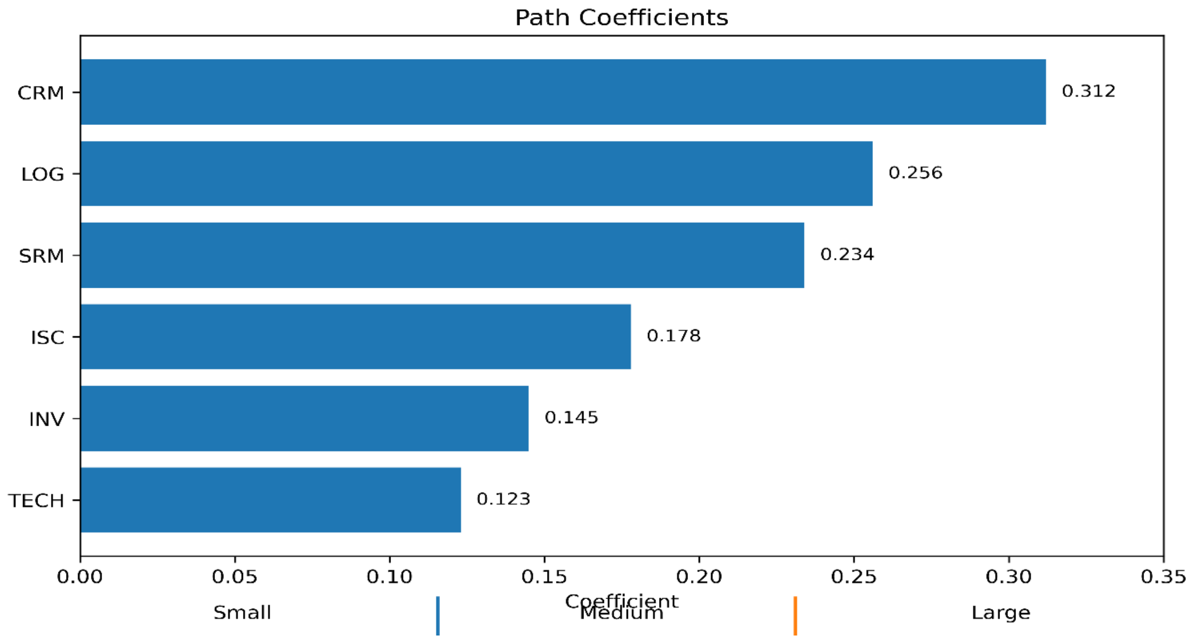
4.7 Effect Size (f²)

Table 6: Effect Size (f²)

Predictor	f²	Interpretation
SRM	0.087	Small
CRM	0.156	Medium
ISC	0.049	Small
INV	0.031	Small
LOG	0.102	Medium
TECH	0.021	Small

CRM and LOG have medium effect sizes, while SRM, ISC, INV, and TECH have small effect sizes (Cohen, 1988).

Figure 4: Path Coefficients Ranking



5. Discussion

5.1 Theoretical Implications

This study has several important theoretical implications for the construction SCM literature:

Firstly, the study offers empirical evidence of the considerable influence of all six SCM practices on project performance. This confirms the multi dimensional nature of the effectiveness of SCM in construction and assists the integrated approach to SCM (Vrijhoef & Koskela, 1999; O'Brien, 1999; Akintoye et al., 2000). The substantial path coefficients for each of the six predictors substantiate that each practice is unique in contributing to project performance.
Secondly, the study shows that the influence of Client Relationship Management (CRM) on Project Performance is the highest ($\beta = 0.312$). This discovery confirms the role of client relationships in construction projects, and corroborates research in the past that has focused on the significance of client satisfaction for project success (Meng, 2012; Eriksson, 2010). Results indicate that CRM should be among the SCM practices that should be emphasized for construction organizations. The substantive importance of CRM is also confirmed by the large effect size ($f^2 = 0.156$).
Third, the study reveals that Logistics Management (LOG) is the second strongest ($\beta = 0.256$) indicating that efficient material transportation and delivery in construction projects is significant (Ballou, 2004; Bowersox et al., 2002). This result aligns with the construction process, which is project-oriented, and the importance of timely availability of materials for successful projects (Christopher, 2011; Kumar & Singh, 2021). The effect size ($f^2 = 0.102$) is medium, thus substantiating the practical importance of logistics management.
Fourth, Supplier Relationship Management (SRM) impact is significant ($\beta = 0.234$) thus showing the importance of long term supplier relationship in construction (Ofori, 2000; Akintoye et al., 2000). This result helps confirm the relational perspective on inter-organizational relationships (Dyer & Singh, 1998) and implies that good supplier relationships should be built. The small effect size ($f^2 = 0.087$) suggests that although SRM is important it has a smaller effect than CRM and LOG.
Fifth, the study shows that Information Sharing & Coordination (ISC) has a moderate impact ($\beta = 0.178$), which suggests that the practice of information sharing is important but it may be inadequate in the absence of other enabling practices (Lee & Whang, 2001; Christopher, 2011). The results of this finding indicated that information sharing efforts should be integrated with other SCM practices to the greatest extent possible to be effective. The relatively small effect size ($f^2 = 0.049$) may indicate that ISC, as a stand-alone intervention, may not lead to notable performance gains.
Sixth, the study reveals that Inventory Management (INV) has a significant but relatively weaker effect ($\beta = 0.145$) indicating that although IM has an effect on the performance, it is not as strong as the relational and logistic factors (Vrat, 2014; Ballou, 2004). This may be a result of the nature of the construction project, as inventory management needs are likely to be project-specific and not continuous. Small effect size (f2 = 0.031) means that the contribution of INV to project performance is not large.
Seventh, the study shows that the impact of Technology Adoption (TECH) is the least but still significant ($\beta = 0.123$), which shows that technology is important but currently underutilized in the sector (Lee & Whang, 2001; Christopher, 2011). The discovery highlights there is a huge opportunity for technology to enable the effectiveness of SCM. Effect size is small ($f^2 = 0.021$), indicating that the effects of technology adoption are present, but somewhat limited, perhaps because technology adoption rates are low.
Eighth, the study validates the use of RBV model in context of construction industry (Barney, 1991). Since SCM practices have a significant impact on project performance, these practices are deemed as valuable organizational resources that can support the competitive advantage of the organization (Mani et al., 2020; Bag et al., 2020). The high R2 value (0.623) indicates that the overall set of SCM practices are an important source of competitive advantage.
The study extends the scope of SCM in developing economy context of India in a new direction in the Ninth. Research in this area has mainly been conducted in developed economies (Akintoye et al. 2000; Proverbs & Holt 2000; Vrijhoef & Koskela 1999). This study fills the literature gap (Dubey et al., 2017; Kumar & Singh, 2021), as established from the context of an emerging market. The results indicate that the relevance and effectiveness of the SCM practices are the same in developing economy context as well.
Tenth, the study helps in understanding the contribution of different practices of SCM to the understanding of its relative importance. The ranking of path coefficients (CRM > LOG > SRM > ISC > INV > TECH) will give the organizations valuable information in resource allocation and strategic planning. CRM and LOG should be given more attention while investing in SRM, ISC, INV and TECH for achieving the overall effectiveness of SCM.

5.2 Practical Implications
The results can have important practical implications for construction managers, policy makers and practitioners:
First, the outcome indicates that CRM needs to be an area of improvement for the client. Good relationships with clients can be built by good communication, gathering feedback and coordinating (Meng, 2012; Eriksson, 2010). This involves effective communication of client needs throughout the project, regular client communication and taking client feedback into account when making project decisions. CRM has a significant impact, meaning that efforts in this space will reap big dividends.

Secondly, the results reveal the significance of Logistics Management. Organizations would benefit from the development of efficient transportation and delivery systems, logistics planning and reduction of operational problems (Ballou, 2004; Bowersox et al., 2002). This consists of effective handling of material transportation, on time delivery of materials to the project sites and logistics planning for better execution of projects. LOG has a medium effect size which would indicate that enhancements to logistics would help to produce substantial performance improvements.

Thirdly, the findings indicated a need to improve the SRM. Organizations could invest in building long-term supplier relationships, making sure the supplier delivers the materials when agreed, and encouraging the supplier to actively participate in resolving issues related to the project (Ofori, 2000; Akintoye et al., 2000). The effect size is small, but SRM still plays a significant role in the performance of a project.

The results show that there is a need to improve Information Sharing & Coordination (ISC) as the fourth key finding. Systems and processes to share information timely and accurately, better coordination of actors in the supply chain, and better support for effective decision making should be developed and invested in (Lee & Whang, 2001; Christopher, 2011). The small effect size implies that ISC should be used in combination with other practices to impact the most.

Fifth, the results indicated that there is a need to improve Inventory Management. Organizations should be prepared to have materials available when needed, have a good system in place to monitor and control material levels, and implement a proper inventory management system to minimize the waste of material (Vrat, 2014; Ballou, 2004). This small effect size implies that the performance increases from INV improvements will be small but still significant.

Sixth, the results indicate that Technology Adoption is important. The use of technology for managing supply chain activities, communication, tracking material flow, and making effective decisions is a key investment required by the organization (Lee & Whang, 2001; Christopher, 2011). Even though it is less significant, technology use is a factor in enhancing performance and is an avenue for further improvement.

In the end, it is the results that support the importance of integrated SCM approaches, seventh. Instead, organizations should take a holistic view of all aspects of the effectiveness of SCM and not concentrate on individual practices (Vrijhoef & Koskela, 1999; O'Brien, 1999). The R^2 value is high (0.623) which implies that the effect of all the practices together is much greater than the sum of all the effects.

Finally, the results have policy implications. This indicates that policies should encourage the adoption of SCM in the construction industry in order to drive its use in areas like technology adoption, information sharing, and relationship management. The disparities between regions in the use of SCM indicate that the intervention should be targeted in less developed districts.

The study offers a benchmarking of the effectiveness of SCM in the construction industry of India at the 9th level. The average scores for each of the constructs offer a benchmark for organizations to evaluate their performance against industry averages. The organizations that are lower than the average score in each construct should focus on improving that construct.

5.3 Regional Implications

The region wise analysis shows interesting variations. As Pune is one of the major construction hubs in Maharashtra, it has the highest number of SCMs. Smaller districts like Jalna also exhibit lower rates of adoption, suggesting gaps in development that could be addressed by policy measures aimed at these districts (Maharashtra Economic Survey, 2022; IBEF, 2023). The differences in regions indicate that strategies for SCM need to be local specific and adaptable to local circumstances.

5.4 Comparison with Previous Studies

This study confirms and builds on the existing research on SCM in construction. In the UK construction industry, there are benefits of cooperation between supply chain partners that enhance the delivery of projects and operational effectiveness (Akintoye et al. 2000). This study further expands these findings by proving that in the Indian context CRM has the most significant contribution in project performance.

In the European construction sector, Proverbs and Holt (2000) concluded that a successful SCM system helps to save costs and improve project performance. This study further expands the conclusions of the aforementioned studies by quantifying the relative importance of various SCM practices and proving that the logistics management is of special importance in Indian context.

Lee and Whang (2001) identified that sharing information at the appropriate time with other parties within the supply chain will facilitate coordination and decision making activities within the chain. The study verifies the relevance of information sharing in the construction environment, although the effects are not as great as those of CRM and LOG.

Ofori (2000) highlighted the importance of turning into the construction industries the implementation of SCM practices so as to improve the productivity, reduce the waste and build the relationship between stakeholders. This study offers empirical evidence to support these arguments and shows that all six of the practices in the SCM are related to successful project performance.

Meng (2012) concluded that there is a strong relationship between relationship management and the project performance at construction site. This research builds on the above by showing that provider and client relationship management systems both have an effect, with CRM showing a greater impact than SRM.

Dubey et al. (2017) carried out a meta-analysis of sustainable supply chain management practices to determine its influence on organizational performance. They concluded that it has significant effects on organizational performance. This research adds more evidence from the construction industry and measures the relative significance of SCM practices.

6. Conclusion

This study offers empirical evidence for the impact of six SCM practices on project performance in the Indian construction industry, showing that they make a significant difference. The findings suggest that all six of the SCM practices are significant to project performance, with Client Relationship Management being the most significant followed by Logistics Management, Supplier Relationship Management, Information Sharing & Coordination, Inventory Management and Technology Adoption. The model accounts for 62.3% of the variance in project performance.

The study has several theoretical contributions such as validation of an extensive SCM measure model, confirmation of the applicability of SCM in the construction industry context, and the introduction of SCM research in the developing economy context of India. The results also have practical applications for construction managers, policy makers and practitioners.

Exploring moderating and mediating effects, longitudinal studies to look at the long-term impact of SCM practices and cross-cultural comparisons to improve generalizability of the results are suggested for the future. Researchers need to also investigate the potential of new technologies like blockchain, AI, and IoT to improve the effectiveness of SCM in the construction industry.

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