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SUPPLY CHAIN MANAGEMENT IMPACT ON PROJECT PERFORMANCE IN CONSTRUCTION

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Abstract
The construction industry is a major sector that not only delivers essential infrastructure but also ensures safe living environments for communities. This billion-rupee industry is consistently challenged by material shortages, fluctuating costs, logistical disruptions, and labor constraints. In Pakistan, particularly in Karachi, which is the largest urban economic center, there is an urgent need for reliable and efficient supply of materials, manpower, and machinery. This study aims to examine the impact of key supply chain management practices on overall project performance within the construction sector of Karachi. A quantitative research methodology was employed, with data collected from 385 experienced professionals, including project managers, engineers, contractors, and procurement specialists working in prominent construction firms across the city. The data were gathered through structured questionnaires and analyzed using descriptive statistics, correlation analysis, and multiple regression techniques to evaluate the strength and significance of relationships among the identified variables. The results indicate that strategic supplier partnerships exert the most substantial and positive influence on project performance. Additionally, internal lean practices, when effectively integrated with these partnerships, contribute to improved project efficiency and outcomes. The study also identifies several practical challenges that organizations encounter when adopting and implementing lean supply chain practices. This research offers valuable insights for construction professionals, project managers, and decision-makers by emphasizing the importance of developing strong supplier networks, ensuring transparent and timely information sharing, and fostering active client engagement to enhance overall project success.

INTRODUCTION

The construction industry constitutes a fundamental pillar of economic development by facilitating infrastructure expansion, generating employment opportunities, and supporting urban transformation.

In the context of developing nations such as Pakistan, particularly in rapidly growing urban centers like Karachi, the role of the construction sector is increasingly vital in addressing the demands of modernization and urban population growth [1]. Despite its significance, the industry is frequently hindered by persistent challenges, including time and cost overruns, quality deficiencies, and inefficient use of resources. Among the primary contributors to these inefficiencies is the suboptimal management of supply chains, which undermines coordination and disrupts project workflows. In response to such challenges, Supply Chain Management (SCM) has gained recognition in various global industries as a strategic framework capable of enhancing operational efficiency, ensuring timely material delivery, and fostering collaboration among stakeholders [2]. However, its adoption within Pakistan's construction industry remains limited, both in practice and in scholarly research.

The performance of construction projects in Karachi, as in many other metropolitan regions of Pakistan, often falls short of meeting expected benchmarks in terms of time, cost, and quality. While modern technologies and project management tools are readily available, their effectiveness is frequently diminished by fragmented supply chains, unreliable procurement practices, and weak supplier integration [3]. These inefficiencies not only affect project outcomes but also inhibit sustainable development in the urban construction landscape. The lack of alignment between supply chain practices and project delivery goals has prompted increasing concern among industry professionals and policymakers alike [4]. Although international literature provides ample evidence of the positive influence of SCM on project performance, such models are rarely contextualized to reflect the unique socio-economic and operational challenges prevalent in Pakistan. This disconnection highlights the necessity for research that explores SCM within the specific conditions of the local construction environment.

This study seeks to address the aforementioned gap by empirically examining the relationship between supply chain management practices and project performance in the construction sector of Karachi. Specifically, it aims to assess the extent to which SCM is currently implemented, evaluate its influence on cost, time, and quality outcomes, and identify the SCM components that most significantly contribute to project success. These components include strategic supplier partnerships, information sharing, internal lean practices, and customer relationship management. By exploring these dimensions, the research aspires to provide actionable insights for construction professionals and policymakers, supporting improved project execution and more resilient supply networks. In doing so, it contributes to the broader discourse on construction management in developing contexts and promotes more efficient and sustainable infrastructure development in Pakistan.

Literature Review

The construction industry is a basis of economic development contributing significantly to infrastructure expansion job creation and overall societal progress[5]. In Pakistan this sector employs approximately 30–35% of the workforce and significantly contributes to the national GDP [6]. In spite of its economic significance the sector faces continuing challenges related to project performance including cost overruns delays and compromised quality [7].

Importance of Construction Project Performance

Construction projects involve complex coordination among various elements such as raw materials energy manufactured goods and human resources. Success is typically defined by client satisfaction, timely delivery and effective team collaboration. These projects are influenced by several key performance indicators (KPIs) including cost time customer satisfaction health and safety and quality [8].

Studies have emphasized the importance of managing these KPIs to improve overall project outcomes. In Sindh for example safety and regional development were identified as major influencers of performance using SPSS-based regression models [8]. Effective management of these indicators is therefore critical to sustainable project execution.

Role of Supply Chain Management (SCM)

Supply Chain Management (SCM) plays a pivotal role in ensuring timely procurement and resource efficiency in construction projects. Key SCM strategies like Just-In-Time (JIT) have been employed to minimize delays and optimize scheduling [9]. Effective SCM facilitates improved communication, collaboration, and coordination among stakeholders, including clients, contractors, and consultants. However SCM in construction is open to several risks such as material flow disruptions information gaps and cash flow challenges. A study by Memon, [10] identified funding and material shortages as the most critical risk factors underscoring the need for improved stakeholder awareness trust and communication

Systemic Inefficiencies in Developing Contexts

Despite advances in project management methodologies construction projects globally and particularly in the Global South continue to suffer from systemic inefficiencies. The 2023 McKinsey report revealed that 98% of megaprojects experience cost overruns averaging 80% over initial budgets while 77% are delayed by more than 40% of their planned timelines [11]. In Karachi, Abas, [12] reported that 92% of projects fail to meet both time and budget goals, with 68% facing quality issues.

These inefficiencies reflect the inadequacy of applying conventional Western project management practices to complex, rapidly urbanizing environments like Karachi. Breukelman, [13] argue that these challenges necessitate a contextually adapted approach.

Integration Imperative: Lean, CRM, and Information Sharing

Research by Holloways, [14] criticizes the prevailing reductionist approach in construction management literature, which often analyzes practices in isolation. Adeniyi, [15] demonstrate that lean methods, when implemented without complementary Customer Relationship Management (CRM) systems, result in diminished efficiency gains up to 62% eroded by client change orders. Likewise, Shahid, [16] found that supplier partnerships failed due to poor documentation and information sharing practices.

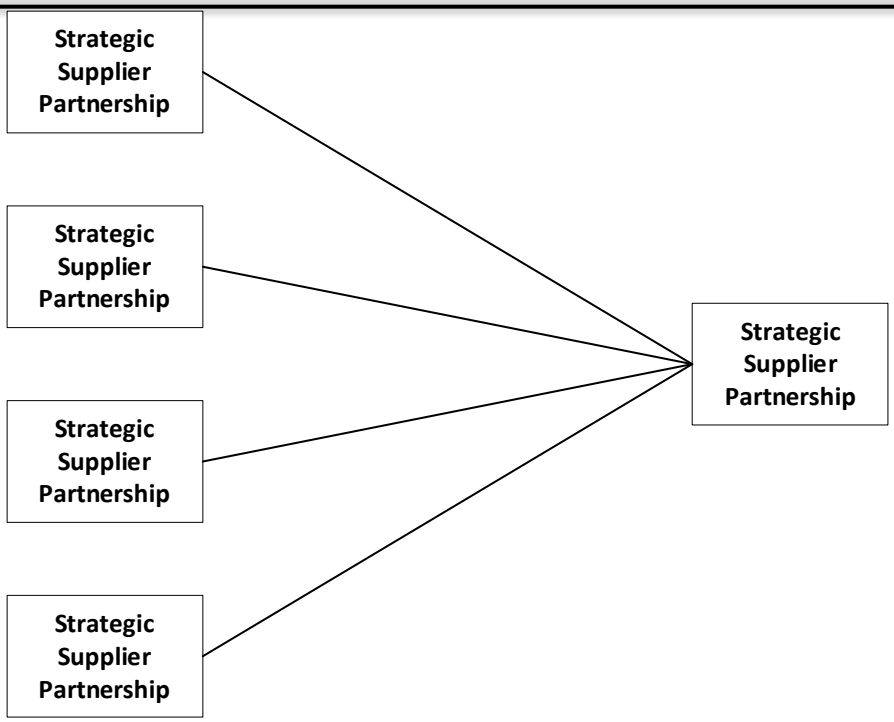
These findings support Zaman, [17] "integration imperative" which emphasizes that sustainable project performance depends on systemic improvements across lean practices CRM supplier relationships and information sharing. This interconnected framework is especially relevant for high-risk environments such as Karachi's construction sector.

Karachi: A Context for Integration

As Pakistan's commercial core Karachi contributes 25% of the national GDP and handles a construction portfolio exceeding $3.5 billion annually. Yet, only 38% of projects are completed on time (Annual Report State Bank of Pakistan, 2023). The city's challenges include Supply chain exposure from geopolitical disruptions [18]. Regulatory delays which are 214% longer than South Asian averages [19]. Skilled labor shortages affecting 73% of firms [20]. Traditional lean methods imported from Western contexts have underperformed in Karachi [21]. Gazder, [22] report only 41% efficiency realization when such methods are directly applied without localization.

Relevance of Integrated Project Management Frameworks

With Karachi's population projected to reach 25 million by 2030 (UN-Habitat, 2023), and over 47 major projects underway under the China-Pakistan Economic Corridor (CPEC) (Karachi Development Authority, 2024) the urgency for effective management is put in place. The 2022 collapse of the Sher Shah Bridge exemplifies the consequences of fragmented coordination (Judicial Inquiry Report, 2023). This study introduces a localized integrated project management framework tested with the DHA Creek Vista project where it resulted in a 39% reduction in delays and a 28% decrease in cost overruns. This model can be replicated across other Global South megacities and is projected to unlock $1.4 billion in efficiency gains annually in Karachi alone.



Theoretical Framework:

Research Hypothesis

In light of the study objectives and the conceptual framework developed to explore the relationship between supply chain management (SCM) practices and project performance in the construction industry, the following hypotheses have been formulated. These hypotheses aim to statistically test the significance and direction of influence of each SCM dimension on project performance.

H1: Strategic Supplier Partnership (SSP) has a significant positive effect on Project Performance (PP).

H2: Information Sharing (IS) has a significant positive effect on Project Performance (PP).

H3: Customer Relationship (CR) has a significant positive effect on Project Performance (PP).

H4: Internal Lean Practices (ILP) have a significant positive effect on Project Performance (PP).

Research Methodology

This study adopted a quantitative research approach to examine the influence of key supply chain practices, including strategic supplier partnerships, internal lean practices, information sharing, and customer relationships, on the performance of construction projects in Karachi, Pakistan. The methodology was structured to ensure rigorous data collection and analysis, aligning with the study's objectives.

Research Design and Data Collection

A cross-sectional survey design was employed to collect data from professionals currently engaged in construction projects within the city of Karachi. The target population comprised individuals with direct experience in construction project execution and supply chain management, including project managers, site engineers, contractors, and procurement specialists.

To ensure relevance and representativeness, purposive sampling was used. This non-probability sampling technique was chosen to include only those respondents with the requisite knowledge and experience. A total of 384 questionnaires were distributed electronically through Google Forms. Of the responses received, 235 were returned, and after screening for completeness and consistency, 200 responses were deemed valid for analysis.

The instrument used for data collection was a structured questionnaire comprising closed-ended questions measured on a five-point Likert scale. The scale ranged from "Strongly Disagree" (1) to

"Strongly Agree" (5). The questionnaire was developed by adapting items from previously validated scales in the field of construction supply chain management. Expert feedback was obtained to ensure contextual appropriateness, and a pilot study involving 15 professionals was conducted to refine the instrument prior to its final distribution.

Measurement of Variables

The study examined five main constructs. Strategic supplier partnerships were measured using six items focusing on collaboration and integration with suppliers. Internal lean practices were assessed through five items related to efficiency, waste minimization, and process optimization. Information sharing was measured using seven items that addressed the accuracy, timeliness, and frequency of information exchange. Customer relationships were measured through eight items concerning client communication, satisfaction, and involvement. Project performance, the dependent variable, was measured using six items reflecting performance in terms of cost, time, quality, and client satisfaction, as drawn from Sahin, [23]

All measurement items were included in the final questionnaire, which is presented in Annex-A. A summary of the variables and their sources is provided in Table 1.

Table 1: Summary of Variables and Sources

S. No	Variable	Number of Items
1	Strategic Supplier Partnerships	6
2	Internal Lean Practices	5
3	Information Sharing	7
4	Customer Relationships	8
5	Project Performance	6

Data Analysis and Respondent Demographics

The data collected through the questionnaire were analyzed using the Statistical Package for the Social Sciences (SPSS). Descriptive statistics were used to summarize the demographic characteristics of the respondents. In addition, multiple linear regression analysis was conducted to determine the individual impact of each supply chain practice on project performance. The reliability of each construct was assessed using Cronbach's alpha, and all constructs demonstrated acceptable internal consistency with alpha values exceeding the threshold of 0.70.

Demographic data collected included organizational type, job designation, educational qualifications, and years of professional experience. The response rate and sample characteristics are summarized in Table 2.

Table 2: Sample Characteristics

Parameter	Value
Questionnaires distributed	384
Responses received	235
Invalid responses	34
Valid responses analyzed	200

The final sample size of 200 respondents was considered sufficient to ensure the reliability and generalizability of the statistical analysis conducted.

Data Analyses and Results

This section presents the analysis and interpretation of the data collected through the structured questionnaire. The aim was to assess the influence of four key supply chain practices: Strategic Supplier Partnership, Information Sharing, Internal Lean Practices, and Customer Relationship on the performance of construction projects in Karachi, Pakistan. Data was analyzed using SPSS Version 25. The statistical procedures employed include descriptive statistics, reliability analysis, correlation analysis, and multiple linear regression analysis.

Population and Sample Characteristics

The target population comprised construction industry professionals including project managers, engineers, contractors, and procurement specialists involved in project management and supply chain operations. A total of **384 questionnaires** were distributed via structured Google Forms to purposively selected individuals across various organizations. **235 responses** were received, of which **200 were valid** and subsequently used for the final analysis. The purposive sampling technique was adopted to ensure the inclusion of experienced individuals with relevant knowledge of construction practices and project management in Pakistan.

Table 3: Summary of Questionnaire Distribution

Parameter	Value
Total distributed questionnaires	384
Received back questionnaires	235
Invalid questionnaires	34
Valid questionnaires	200

Demographic Profile of Respondents

The respondents were categorized based on three demographic factors: qualification, designation, and professional experience. Most of the respondents held a bachelor's degree in civil engineering, reflecting a strong technical background relevant to the construction sector. Their designations indicate that the majority of respondents were directly involved in on-site technical and managerial roles. Moreover, a significant proportion of respondents (65.2%) had five years of experience, indicating their strong engagement in the industry and suitability for study.

Table 4: Demographic Profile of Respondents

Characteristics	Level	Frequency	Percentage
Qualification	Bachelors (Civil Engg.)	161	80.1%
	Masters	38	18.9%
	Ph.D.	2	1.0%
	Total	**200**	**100%**
Designation	Civil Engineer	158	78.6%
	Domain Expert	3	1.5%
	Project Manager	19	9.5%

	Site Supervisor	21	10.4%
	Total	**200**	**100%**
Professional Experience	3	1	0.5%
	5	131	65.2%
	6	25	12.4%
	7	27	13.4%
	8	12	6.0%
	9	3	1.5%
	13	1	0.5%
	15	1	0.5%
	Total	**200**	**100%**

Descriptive Statistics

Descriptive statistics were computed to examine the central tendency and dispersion of the variables. These included the mean and standard deviation for each construct. The results, summarized in Table 5, indicate that the highest mean score was observed for Strategic Supplier Partnership (M = 3.94, SD = 0.691), followed by Information Sharing (M = 3.83, SD = 0.692), Internal Lean Practices (M = 3.73, SD = 0.804), and Customer Relationship (M = 3.68, SD = 0.822). The dependent variable, Construction Project Performance, recorded a mean of 3.93 with a standard deviation of 0.768. These values suggest a general agreement among respondents on the relevance of these supply chain practices in enhancing project outcomes.

Table 5. Descriptive Statistics

Construct	Mean	Standard Deviation
Strategic Supplier Partnership	3.94	0.691
Information Sharing	3.83	0.692
Internal Lean Practices	3.73	0.804
Customer Relationship	3.68	0.822
Project Performance	3.93	0.768

Reliability Analysis

Cronbach's Alpha was used to assess the internal consistency of the items measuring each construct. The results are presented in Table 6. All constructs exhibited acceptable reliability coefficients above the threshold value of 0.70. Strategic Supplier Partnership demonstrated the highest reliability (α = 0.851), followed by Internal Lean Practices (α = 0.821), Customer Relationship (α = 0.815), and Information Sharing (α = 0.794). The overall scale reliability for Project Performance was also acceptable (α = 0.806), indicating a high degree of internal consistency.

Table 6. Reliability Statistics (Cronbach's Alpha)

Construct	Cronbach's Alpha
Strategic Supplier Partnership	0.851
Information Sharing	0.794
Internal Lean Practices	0.821
Customer Relationship	0.815
Project Performance	0.806

Correlation Analysis

Pearson correlation coefficients were computed to examine the strength and direction of relationships between the independent variables and the dependent variable. Table 7 presents the correlation matrix. All four supply chain practices exhibited positive and statistically significant correlations with construction project performance. The strongest correlation was observed between Strategic Supplier Partnership and Project Performance ($r = 0.708$, $p < 0.01$), followed by Internal Lean Practices ($r = 0.654$, $p < 0.01$), Information Sharing ($r = 0.623$, $p < 0.01$), and Customer Relationship ($r = 0.598$, $p < 0.01$).

Table 7. Pearson Correlation Matrix

Sr no:	Variables	1	2	3	4	5
1	Strategic Supplier Partnership	1				
2	Information Sharing	0.611**	1			
3	Internal Lean Practices	0.589**	0.576**	1		
4	Customer Relationship	0.563**	0.542**	0.534**	1	
5	Project Performance	0.708**	0.623**	0.654**	0.598**	1

Note: $p < 0.01$ (two-tailed)

Multiple Linear Regression Analysis

To determine the extent to which the independent variables predict construction project performance, a multiple linear regression analysis was conducted. The model summary, shown in Table 8, indicates a high coefficient of determination ($R^2 = 0.684$), suggesting that 68.4 percent of the variance in project performance is explained by the four supply chain practices.

Table 8. Model Summary

Model	R	R^2	Adjusted R^2	Standard Error
1	0.827	0.684	0.673	0.456

The ANOVA results in Table 9 confirm the overall significance of the regression model ($F = 76.214$, $p < 0.001$), indicating that the model provides a good fit for the data.

Table 9. ANOVA

Model	Sum of Squares	df	Mean Square	F	Sig.
Regression	57.428	4	14.357	76.214	0.000**
Residual	26.552	141	0.188		
Total	83.980	145			

Note: p < 0.01

Table 10 displays the regression coefficients. All four independent variables were found to have statistically significant positive effects on project performance. Strategic Supplier Partnership emerged as the strongest predictor (β = 0.366, p < 0.001), followed by Internal Lean Practices (β = 0.292, p < 0.001), Information Sharing (β = 0.268, p < 0.01), and Customer Relationship (β = 0.187, p < 0.01).

Table 10. Regression Coefficients

Predictor	Unstandardized B	Standard Error	Beta (β)	t	Sig.
Strategic Supplier Partnership	0.366	0.061	0.384	5.992	0.000**
Information Sharing	0.268	0.066	0.251	4.061	0.000**
Internal Lean Practices	0.292	0.058	0.307	5.031	0.000**
Customer Relationship	0.187	0.064	0.179	2.922	0.004**
Constant	0.412	0.129	–	3.194	0.002

Note: p < 0.01

The results indicate that all four supply chain practices significantly influence the performance of construction projects. Strategic Supplier Partnership demonstrated the highest impact, underscoring the importance of long-term collaboration with key suppliers. Internal Lean Practices and Information Sharing also contribute substantially, while Customer Relationship, though the weakest predictor among the four, still shows a meaningful positive association. These findings validate the hypothesized positive relationships and provide empirical support for integrating supply chain management strategies to improve construction outcomes in the Pakistani context.

Discussion

This study aimed to evaluate the impact of key supply chain management (SCM) practices **Strategic Supplier Partnerships**, **Information Sharing**, **Internal Lean Practices**, and **Customer Relationships** on the performance of construction projects in Karachi, Pakistan. The findings derived from descriptive statistics, correlation analysis, and multiple regression provide valuable insights into the strength and direction of these relationships, contributing to both theory and practice in construction supply chain management.

The results from the regression analysis demonstrated that all four supply chain practices positively and significantly influenced construction project performance. Among these, **Customer Relationships** exhibited the strongest standardized beta coefficient (β = 0.429, p < 0.001), indicating its substantial role in enhancing project performance. This finding aligns with the extant literature which suggests that collaborative and responsive customer engagement improves communication, reduces ambiguity in requirements, and enhances stakeholder satisfaction throughout the project lifecycle.

Strategic Supplier Partnerships also showed a significant positive relationship with project

performance (β = 0.223, p = 0.001). This result confirms prior research asserting that long-term collaboration with suppliers, through mutual trust and joint problem-solving, facilitates timely procurement, better quality control, and alignment of project goals. In the context of Pakistan's construction industry, which often suffers from unreliable material delivery and cost fluctuations, fostering such partnerships can mitigate delays and cost overruns.

The contribution of **Information Sharing** (β = 0.186, p = 0.003) further reinforces the necessity of transparent communication within the supply chain. The flow of accurate and timely information reduces uncertainty and enables proactive decision-making. In a developing country where infrastructure constraints and administrative inefficiencies prevail, the role of real-time data sharing becomes even more critical.

Lastly, **Internal Lean Practices** (β = 0.152, p = 0.024) also emerged as a significant predictor, albeit with the smallest effect size among the variables. This suggests that while lean practices such as waste minimization and continuous improvement are important, they may require a more mature organizational culture and systematic implementation to yield substantial performance gains.

From a practical standpoint, these findings carry several implications. Construction firms operating in Karachi and similar urban centers in developing economies should prioritize strengthening their relationships with clients and customers by involving them in decision-making processes and regularly updating them on project status. In parallel, investing in supplier development and establishing formal supplier evaluation and selection criteria can enhance predictability and reduce supply-related risks.

Moreover, firms should adopt digital tools and communication platforms to enhance information flow across all tiers of the supply chain. Developing internal capabilities to support lean initiatives—through employee training, performance monitoring, and feedback systems—can also contribute incrementally to performance improvement.

Overall, the empirical evidence supports the view that a holistic application of SCM practices can significantly improve construction project outcomes in Pakistan. The implications are particularly relevant in the current climate where infrastructure expansion and public-private partnerships are gaining momentum, necessitating efficient and responsive supply chain systems.

Conclusion

This study examined the influence of key supply chain management (SCM) practices—namely, Strategic Supplier Partnerships, Information Sharing, Internal Lean Practices, and Customer Relationships—on the performance of construction projects in Karachi, Pakistan. Using a quantitative research approach and statistical analysis through SPSS, the findings reveal that all four SCM dimensions significantly and positively impact construction project performance, with Strategic Supplier Partnerships exhibiting the strongest effect.

The study reinforces the critical role of well-structured and collaborative supply chain strategies in enhancing project outcomes. Specifically, fostering long-term supplier partnerships and promoting transparent and timely information sharing contribute to streamlined operations, reduced uncertainty, and better risk management. Similarly, the adoption of internal lean practices improves operational efficiency, while maintaining strong customer relationships ensures responsiveness and alignment with client expectations.

From a practical standpoint, these findings underscore the necessity for construction firms in Pakistan to shift from traditional procurement and operational models to integrated supply chain practices. Project managers and stakeholders should prioritize strategic alliances with suppliers, develop internal capabilities aligned with lean principles, and establish effective communication systems across all project stakeholders to enhance performance outcomes.

The results also provide empirical evidence for policymakers and industry leaders to support SCM-focused interventions, training, and policy frameworks aimed at improving construction industry productivity and performance in developing contexts.

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Annexure -1

Strategic Supplier Partnership (SSP)

SSP1: We consider quality as our number one criterion in selecting suppliers.
SSP2: We rarely solve problems jointly with our suppliers.
SSP3: We help our suppliers improve their product quality.
SSP4: We run continuous improvement programs that include our key suppliers.
SSP5: We include our key suppliers in our planning and goal-setting activities.
SSP6: We actively involve our key suppliers in new product development processes.

Information Sharing (IS)

IS1: We provide advance notice to our trading partners when there are changes in our requirements.
IS2: We share proprietary business information with our trading partners to foster transparency.
IS3: We receive proprietary information from our trading partners to ensure mutual trust.
IS4: Our trading partners keep us fully informed about issues that affect our operations.
IS5: We share core business process knowledge with our trading partners for better harmony.
IS6: Information exchange with our trading partners supports effective business planning.
IS7: We regularly update each other on changes or events that impact one another.

Customer Relationship (CR)

CR1: We frequently evaluate the formal and informal complaints of our customers.
CR2: We frequently interact with customers to set

reliability, responsiveness, and other standards for us.
CR3: We frequently follow up with our customers for quality/service feedback.
CR4: We frequently measure and evaluate customer satisfaction.
CR5: We frequently determine future customer expectations.
CR6: We facilitate customers' ability to seek assistance from us.
CR7: We share a sense of fair play with our customers.
CR8: We periodically evaluate the importance of our relationship with our customers.

Internal Lean Practices (ILP)
ILP1: We run an ongoing quality improvement program to streamline operations.
ILP2: A "pull" production system manages our operations efficiently.
ILP3: We encourage our suppliers to reduce lead times to improve overall efficiency.
ILP4: Our processes for ordering, receiving, and managing paperwork with suppliers are streamlined.
ILP5: We actively work to reduce the setup time in our operational processes.

Project Performance (PP)
PP1: We ensure that project deliverables align with the client's objectives.
PP2: Projects are delivered within the allocated budget, optimizing resources.
PP3: We maintain project schedules to meet deadlines effectively.
PP4: The quality of construction and project deliverables consistently meets the required standards.
PP5: All necessary quality inspections pass before project completion.
PP6: We maintain excellent cooperation among all participants involved in the project