Journal of Engineering Issues and Solutions

Enhancing SME Participation through Inventory Optimization and Barrier Assessment in Construction Supply Chains: Evidence from Surkhet Valley, Nepal

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Received: May 5, 2025; Revised: July 5, 2025; Accepted: July 12, 2025

https://doi.org/10.3126/joeis.v4i1.81565

Abstract

This study aims to strengthen the participation of Small and Medium Enterprises (SMEs) in government-led construction supply chains by examining three key dimensions: material inventory optimization, identification of participation barriers, and actionable strategies for inclusion. The research was conducted in Surkhet Valley, Nepal, a region actively engaged in public infrastructure development.

For the first objective, a three-year dataset of publicly procured construction materials was analyzed using ABC analysis based on usage value and frequency. Results revealed that five materials, including reinforcement and cement, accounted for 75% of total expenditure, highlighting the need for focused inventory control on high-value items.

To address the second objective, perceptions from 58 SMEs were analyzed using Principal Component Analysis (PCA), identifying three major factors that explain 68.47% of the variance in SME challenges: (1) structural and operational barriers, such as bureaucratic delays; (2) financial and logistical constraints, like payment delays and demand volatility; and (3) capacity-related issues, including limited training and weak quality systems.

For the third objective, the Relative Importance Index (RII) and Key Informant Interviews (KIIs) were used to prioritize remedial measures. Top-ranked strategies included cost minimization, simplified procurement paperwork, and improved logistics. KIIs further emphasized the importance of transparent payment systems and SME-friendly tender policies.

The study concludes that a focused approach grounded in material classification, systemic barrier reduction, and SME-centric policy design can strengthen SME participation in public construction supply chains. Recommendations include ABC-based procurement planning, simplifying documentation requirements, SME training, and establishing preferential procurement policies.

Keywords: *Construction Supply Chain, SME Participation, ABC Analysis, Principal Component Analysis.*

1 Introduction

The construction sector is a critical pillar of national development in Nepal, contributing approximately 7.52% to the country's Gross Domestic Product (GDP) and supporting employment, infrastructure growth, and regional integration (MoF Nepal Economic Survey, 2021). As per FCAN, 2015 and cited in (Bista, Neupane, & Bhattarai, 2024), construction industry uses around 35% of Government Budget. Among the various stakeholders involved in this industry, Small and Medium Enterprises (SMEs) are key players, acting as suppliers, transporters, and subcontractors within the construction supply chain. SMEs not only enhance supply chain responsiveness but also drive regional economic activity by supporting employment and local sourcing.

Globally, SMEs have a remarkable impact on economic development, innovation, and employment generation. For instance, in China, Brazil, and OECD nations, SMEs represent 99% of all businesses and provide jobs for up to 80% of the workforce (Word Trade Organization (WTO), 2020). Similarly, in Nepal, SMEs contribute 22% to GDP and employ approximately 1.8 million people (Verma, 2024). Despite their significance, SMEs in Nepal struggle with modern inventory control and supply chain coordination. The International Labour Organization (ILO) highlights that small businesses often face difficulties in accessing financing, limited market access, low negotiation ability, deficiencies in cash flow management, and low productivity. A survey by ILO Nepal reported that 47% of SMEs cite financial constraints as a major challenge, affecting their ability to invest in efficient inventory management systems (ILO Nepal, 2005).

Efficient inventory management is especially critical in the construction sector, where delays and material shortages can stall project timelines and inflate costs. Material shortages and supply chain inefficiencies have led to delays in 60% of government projects (MoF Nepal Economic Survey, 2021). Also, studies found that poor inventory management negatively affected profitability due to supply chain disruptions (Pandey, Risal, & Mishra, 2023).

Small and Medium Enterprises (SMEs) in the construction sector face numerous challenges that hinder their effective participation in public procurement and efficient supply chain integration. Financial constraints are among the most pressing issues, with a (World Bank, 2020) report indicating that 45% of construction SMEs struggle to access finance, limiting their capacity to invest in modern inventory systems and scale operations. Technological adoption remains another significant barrier; techniques such as ABC analysis, Just-in-Time (JIT), and Economic Order Quantity (EOQ) are globally recognized for improving stock planning and optimizing material flow, yet their adoption among Nepali SMEs remains low. A study by (Nepal Rastra Bank, 2024) found that only 30% of SMEs in Nepal use structured inventory management techniques, with the majority still relying on manual stock tracking. Moreover, SMEs often find themselves disadvantaged in a competitive procurement environment dominated by large firms. The (MoF Nepal Economic Survey, 2021) reveals that over 60% of government construction contracts are awarded to larger enterprises, significantly reducing opportunities for smaller players. Existing studies e.g., (Sharma & Gupta, 2019) have identified additional obstacles such as limited technical expertise and regulatory complexity as key barriers to SME growth. Studies indicate that construction supply chains are often fragmented, leading to delays and cost (Vrijhoef & Koskela, 2000). Inefficiencies in supply chains arise from poor coordination among suppliers, contractors, and manufacturers (Christopher, 2016). In developing economies like Nepal, logistical difficulties, lack of standardization, and inadequate inventory control further intensify these issues (Doloi, 2013).

Addressing this knowledge gap and recognizing the vital role of SMEs in the construction supply chain and the ongoing inefficiencies in procurement processes, this study aims to (i) analyze and categorize government-procured construction materials in Surkhet Valley based on usage value and frequency, (ii) identify and

evaluate the key barriers experienced by SMEs in participating in public construction supply chains , and (iii) propose effective and actionable strategies for enhancing SME participation in construction supply chains.

While this study offers useful findings about construction material supply chains and SME participation in public projects, some limitations should be noted. The results are specific to government building projects in Surkhet Valley, its mid-hill topography, fragmented road networks, and dominance of small local SMEs may limit direct applicability to urbanized regions or areas with larger firms. The three-year data set (2078/79 – 2080/81) shows common patterns but may not reflect very recent changes in the market or government policies. Also, outside factors like inflation or supply disruptions were beyond the study's focus. Methodologically, the study used a combination of methods (ABC analysis, PCA, RII, and KIIs), which helped produce strong results. However, the number of participants (58 SMEs and 30 key interviews) and focus on public projects do limit the scope. Still, the study's main contributions, like identifying key materials, major barriers, and SME-supported solutions can offer useful lessons for other developing areas. Future studies could test these findings in other regions, systems, or time periods to make them more widely applicable.

2 Materials and Methods

2.1 Selection of Study Area

This study centers on Surkhet Valley, located in Karnali Province, Nepal, a region that has emerged as a strategic administrative and commercial hub in mid-western Nepal. Geographically positioned at 28°36′N 81°38′E, Surkhet lies approximately 600 kilometers west of Kathmandu and spans 2,489 square kilometers. As per the 2021 census, it is home to 415,126 people and comprises five municipalities and four rural municipalities, with Birendranagar serving as both the district and provincial capital.

Surkhet was chosen for this study due to its growing role in government infrastructure development, especially after federal decentralization. Public Procurement Monitoring Office (PPMO) data shows that over 550+ construction contracts have been implemented in the Valley across three fiscal years. These projects demand a timely and coordinated supply of materials such as cement, steel, aggregates, bricks, and sand. However, SMEs in Surkhet Valley, which are central to material supply, face unique barriers, ranging from inadequate access to capital and transportation, to weak inventory practices and limited inclusion in procurement systems. Although public construction projects are growing, there is still little research on the demand for construction materials and the role of SMEs in local areas like Surkhet Valley. As a rapidly urbanizing provincial capital with good connectivity, Surkhet provides a relevant setting to explore local challenges in procurement, inventory management, and SME inclusion. This localized focus helps generate practical understanding for improving construction supply chains in similar provincial regions.

Figure 1: Study area showing Surkhet in Map of Nepal (Source: Wikidata)

2.2 Study Population

The study population includes SME owners and contractor's representatives involved in publicly procured government building construction projects in Surkhet Valley. Additionally, building procurement documents from three fiscal years were analyzed to assess material demand and inventory management practices.

2.3 Sample Size

The sample size was determined according to the nature and objectives of the research. For first objective, 67 government procurement documents from three fiscal years (FY 2078/79 to 2080/81) were analyzed. Similarly for the second objective, 58 SME owners involved in the construction material supply chain were taken as sample. The sample size was calculated using (Cochran, 1963), assuming a 95% confidence level, 5% margin of error, and a population proportion of 0.5. The required sample size was determined to be 51, but 58 responses were collected, ensuring adequacy. For the third objective, same 58 SMEs, 15 other SME owners and 15 contractor representatives were taken. This diverse sampling approach ensured both reliability and contextual relevance.

2.4 Data Collection

The study utilized both primary and secondary data to examine construction material supply chains and SME participation in Surkhet Valley.

2.4.1 Primary Data

Primary data were gathered through structured questionnaires and Key Informant Interviews (KIIs). Surveys were conducted with 58 SME owners and contractor representatives, focusing on inventory practices, supply chain challenges, and SME involvement. The questionnaire, designed using Kobo Toolbox, included general respondent information and a Likert-scale section to assess perceptions on key challenges and potential strategies. In addition, KIIs, with 15 SME owners and 15 contractor representatives, provided deeper perspectives into barriers and potential strategies for enhancing SME participation in the supply chain.

2.4.2 Secondary Data

Secondary data were sourced from the Public Procurement Monitoring Office (PPMO), where a total of 557 contract documents across three fiscal years (2080/81, 2079/80, and 2078/79) were reviewed, of which 67 contracts related specifically to government building construction were analyzed to assess material demand. Supplementary literature, policy documents, and expert consultations supported the data analysis and contextual understanding.

2.5 Data Analysis

The study employed both quantitative and qualitative methods to analyze the collected data. Initially, data were cleaned, categorized, and processed to ensure accuracy and consistency. To ensure full methodological transparency, we explicitly link each analytical approach to its unique contribution:

2.5.1 Material Demand Analysis (Objective 1)

- Descriptive statistics quantified baseline procurement patterns from government records.
- ABC classification then revealed the Pareto distribution: while only 21.74% of materials (Category A) accounted for 75% of total procurement value, enabling targeted inventory management strategies for high-impact items like reinforcement steel and cement.

2.5.2 Barrier Identification (Objective 2)

- The *5-point Likert scale survey* (n=58 SMEs) captured perceptual data on 13 predefined parameters.
- Exploratory Factor Analysis (PCA) transformed these into three latent barrier dimensions:
  - Structural-operational (KMO=0.82, 28.6% variance)
  - Financial-logistical (22.1% variance)
  - Capacity-quality (18.4% variance)

This statistically validated the need for multidimensional interventions beyond anecdotal challenges.

2.5.3 Strategy Development (Objective 3)

- RII analysis of Likert-scale responses objectively ranked 10 policy measures by SME-perceived effectiveness (e.g., simplified registration ranked highest with RII=0.87).
- Key Informant Interviews (n=30) provided grounded context through:
  - Thematic analysis of operational pain points (e.g., 80% cited payment delays)
  - Word cloud visualization highlighting "bureaucracy" and "logistics" as dominant concerns

This mixed-method approach ensured quantitative priorities were cross-validated with qualitative realities.

The summary of methodological contribution is presented in table 1

Table 1: Methodological Contribution

Method	Applied to Objective	Key Contribution
ABC Analysis	1 (Demand Trends)	Identified high-value materials (21.74% = 75% of cost)
PCA	2 (Barriers)	Extracted 3 latent barrier dimensions
RII + KII	3 (Strategies)	Ranked solutions + contextual validation

3 Results and Discussion

3.1 Demand Analysis and Classification of Construction Materials Based on Their Value and Usage

The first objective of this study was to analyze the demand for construction materials in Surkhet Valley and classify them based on their usage value for efficient inventory management. This was achieved through a systematic review of government building procurement documents from three fiscal years (2078/79 to 2080/81), focusing on the quantities and costs of materials listed in the Bills of Quantities (BOQs).

Step 1: Identification, Quantification and Usage Value Calculation

All major materials used in government building projects were listed (Table 2), and their quantities across three fiscal years were compiled. The usage value for each material was calculated by multiplying its quantity by its unit rate (Table 3).

Table 2: List of Construction materials and their quantity for three fiscal years

Item No.	Construction Materials	Unit	Quantity		
			FY 2080/2081	FY 2079/2080	FY 2078/2079
1	Stone	cum.	6788.60	2551.44	1660.70
2	Reinforcement	KG	1115372.84	2090800.45	721171.10
3	Binding Wire	KG	16730.59	31362.01	10817.57
4	Bricks	Nos	2243855.70	1931484.52	1664621.99
5	Aggregate	cum.	11490.79	14437.60	10458.27
6	Cement	Bags	129483.17	174189.46	102233.40
7	Sand	cum.	9697.21	9328.12	7268.94
8	MS Metals	KG	118777.00	130885.64	144590.61
9	Nut Bolts Different Sizes	KG	1425.32	1570.63	1735.09
10	Plywood	sqm	36433.96	27596.29	27017.92
11	Nails Different sizes	KG	11752.89	8902.03	8715.46
12	Emulsion Paint	Litre	7848.26	7967.75	12826.94
13	Weather Coat paint	Litre	4582.08	3976.56	1738.17
14	Enamel paint	Litre	570.39	479.91	1543.81
15	Wall Putty	KG	44582.49	71676.01	59892.66
16	Water proofing	Litre	4809.62	5447.39	4446.90
17	Tile	sqm	7281.34	4764.63	3706.46
18	Granite	sqm	2741.38	3156.81	3295.70
19	Aluminium Panels	sqm	2353.18	1835.62	1339.93
20	Wooden Door/Windows Shutter	sqm	679.80	502.48	659.15
21	Salwood Chaukhat	cum.	22.18	16.40	22.85
22	Electrical works	LS			
23	Sanitary works	LS			

Table 3: Usage Value of the construction materials

Item No.	Construction Materials	Unit	Quantity			Usage Value
			FY 2080/2081	FY 2079/2080	FY 2078/2079	
1	Stone	cum.	13237774.88	4975316.33	2989255.50	21202346.70
2	Reinforcement	KG	111537284.00	209080045.00	68907898.61	389525227.61
3	Binding Wire	KG	2091324.08	3920250.84	1298107.98	7309682.90
4	Bricks	Nos	38145546.90	31386623.52	26217796.28	95749966.70
5	Aggregate	cum.	36770531.14	46200309.38	31374795.12	114345635.63
6	Cement	Bags	108765865.77	146319143.18	85876054.81	340961063.76
7	Sand	cum.	31031084.35	29849994.79	21806819.43	82687898.57
8	MS Metals	KG	14405274.56	15873810.96	16772510.76	47051596.28
9	Nut Bolts Different Sizes	KG	212145.22	233772.23	246382.40	692299.86
10	Plywood	sqm	16030942.40	12142367.58	11347526.40	39520836.38
11	Nails Different sizes	KG	1234053.48	932398.52	871545.81	3037997.81
12	Emulsion Paint	Litre	3814255.79	3872324.36	6233891.87	13920472.02
13	Weather Coat paint	Litre	4769949.50	4139599.50	1724267.62	10633816.61
14	Enamel paint	Litre	329683.25	277385.22	850638.21	1457706.68
15	Wall Putty	KG	3299104.26	5304025.06	4252378.86	12855508.18
16	Water proofing	Litre	1389978.74	1574294.27	1285154.10	4249427.10
17	Tile	sqm	993902.91	650371.33	505931.79	2150206.03
18	Granite	sqm	8224140.00	9470437.21	9689358.00	27383935.21
19	Aluminium Panels	sqm	1684876.88	1264857.94	878994.08	3828728.90
20	Wooden Door/ Windows Shutter	sqm	2427565.80	1794347.12	2353824.65	6575737.57
21	Salwood Chaukhat	cum.	4657800.00	3443873.15	4582841.70	12684514.85
22	Electrical works	LS	32404246.71	42616443.80	24005277.92	99025968.43
23	Sanitary works	LS	16202123.36	21308221.90	12002638.96	49512984.21

Step 2: Ranking by Usage Value, Percentage and Cumulative Analysis

Materials were sorted in descending order of their usage value to identify high-priority items (Table 4). Then after, the percentage cumulative usage value and percentage cumulative share of items were determined (Table 5).

Table 4: Rearranged Usage Value and Items

Item No.	Construction Materials	Unit	Usage value in descending order
2	Reinforcement	KG	389525227.6
6	Cement	Bags	340961063.8
5	Aggregate	cum.	114345635.6
22	Electrical works	LS	99025968.43
4	Bricks	Nos	95749966.7
7	Sand	cum.	82687898.57
23	Sanitary works	LS	49512984.21
8	MS Metals	KG	47051596.28
10	Plywood	sqm	39520836.38
18	Granite	sqm	27383935.21
1	Stone	cum.	21202346.7
12	Emulsion Paint	Litre	13920472.02
15	Wall Putty	KG	12855508.18
21	Salwood Chaukhat	cum.	12684514.85
13	Weather Coat paint	Litre	10633816.61
3	Binding Wire	KG	7309682.899
20	Wooden Door/Windows Shutter	sqm	6575737.574
16	Water proofing	Litre	4249427.1
19	Aluminum Panels	sqm	3828728.903
11	Nails Different sizes	KG	3037997.81
17	Tile	sqm	2150206.026
14	Enamel paint	Litre	1457706.676
9	Nut Bolts Different Sizes	KG	692299.8555

Table 5: Percentage cumulative usage value and Percentage cumulative share of items

S.N.	Re-arranged Items	Cum % usage value	Cum % items	Class
1	Reinforcement	28.10%	4.35%	
2	Cement	52.69%	8.70%	
3	Electrical works	60.94%	13.04%	A
4	Aggregate	68.08%	17.39%	
5	Bricks	74.99%	21.74%	
6	Sand	80.95%	26.09%	
7	Sanitary works	84.52%	30.43%	
8	MS Metals	87.92%	34.78%	B
9	Plywood	90.77%	39.13%	
10	Granite	92.74%	43.48%	
11	Stone	94.27%	47.83%	
12	Emulsion Paint	95.28%	52.17%	
13	Wall Putty	96.20%	56.52%	
14	Salwood Chaukhat	97.12%	60.87%	
15	Weather Coat paint	97.89%	65.22%	
16	Binding Wire	98.41%	69.57%	
17	Wooden Door/Windows Shutter	98.89%	73.91%	C
18	Water proofing	99.19%	78.26%	
19	Aluminum Panels	99.47%	82.61%	
20	Nails Different sizes	99.69%	86.96%	
21	Tile	99.84%	91.30%	
22	Enamel paint	99.95%	95.65%	
23	Nut Bolts Different Sizes	100.00%	100.00%	

Step 3: ABC Classification

Using standard ABC analysis principles:

Category A items (~70–80% of value; ~20% of items) include Reinforcement, Cement, Electrical works, Aggregate, and Bricks. Category B items (~15–25% of value; ~30–40% of items) include Sand, Sanitary works, MS Metals, Plywood, Granite, and Stone. Category C items (~5–10% of value; ~50–60% of items) include various low-cost materials like Paints, Tiles, Nails, Aluminum Panels, and others. A visual summary of ABC distribution is provided in Figure 2 and Figure 3.

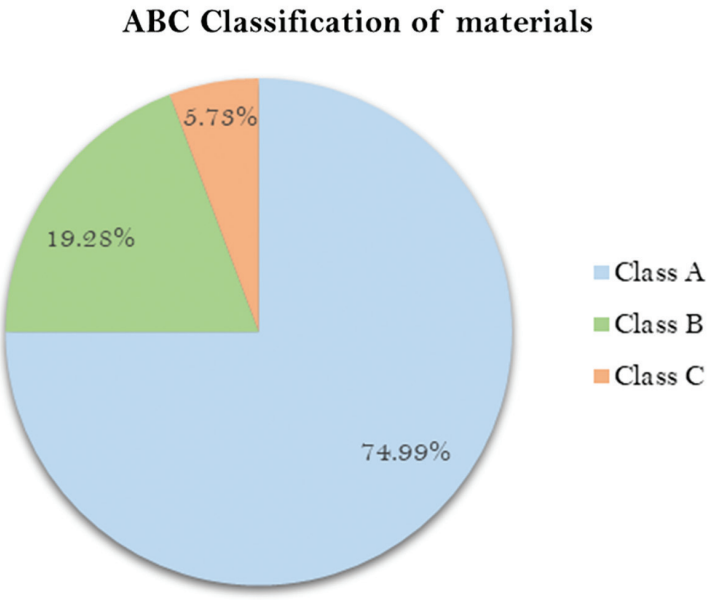

Figure 2: Pie chart Representation of the ABC Classification of Construction materials

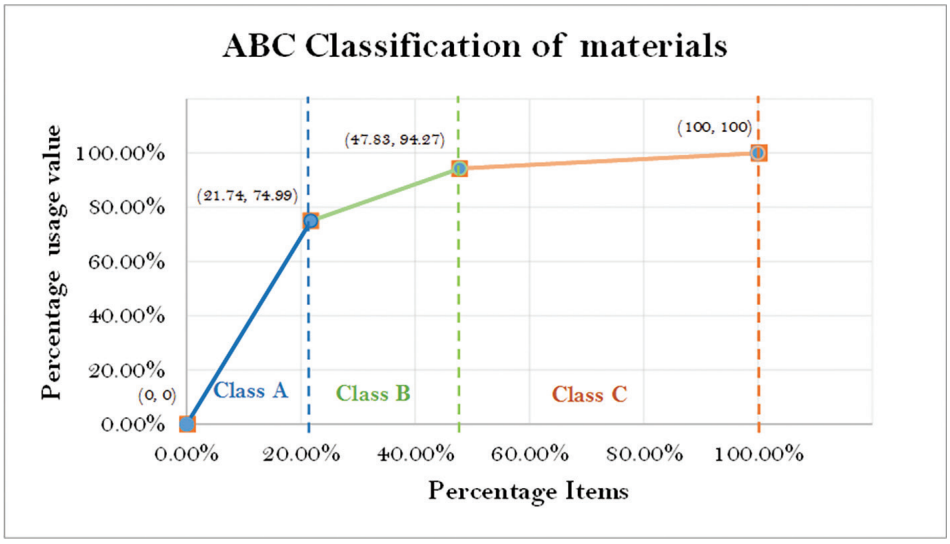

Figure 3: Line Diagram Representation of the ABC Classification of Construction materials

3.2 SME Perceptions on Challenges and Opportunities in Supply Chain Participation

The second objective aimed to assess SME perceptions on challenges and opportunities in the construction material supply chain in Surkhet Valley in publicly procured projects. This was achieved through structured questionnaires based on 13 key parameters identified from literature and industry experts. Responses were rated on a 5-point Likert scale, ranging from 1 (negligible) to 5 (very high).

3.2.1 General information

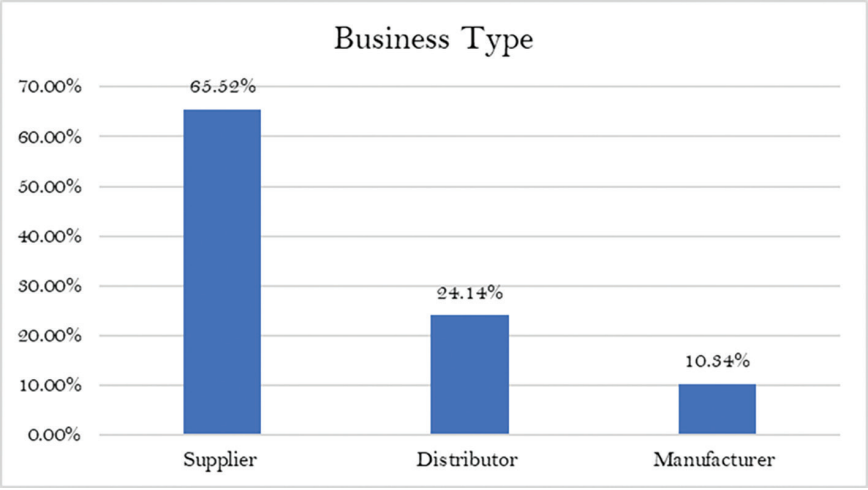

Figure 4: Business Type Distribution of SMEs in the Construction Supply Chain

In the general survey, 58 SME owners were asked about their business type. The majority (65.52%) were suppliers, followed by distributors (24.14%) and manufacturers (10.34%).

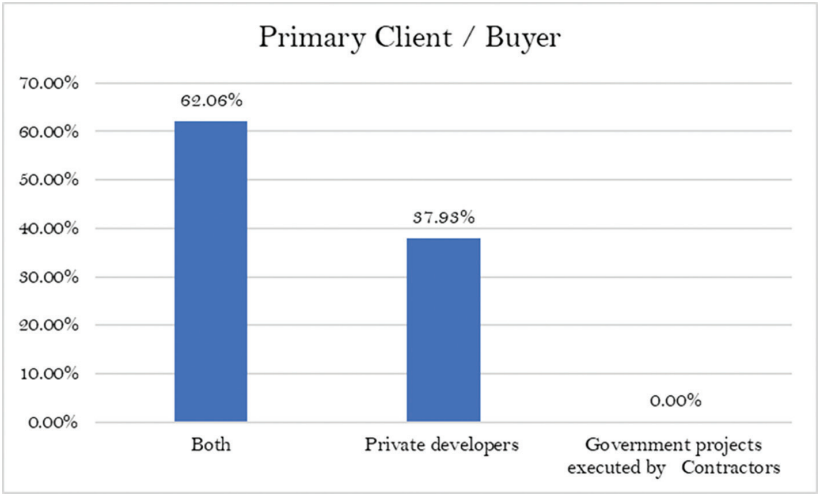

Figure 5: Primary Clients or Buyers

Most SMEs (62.06%) said they supply materials to both private and government projects, while 37.93% work only with private clients. This means the private sector plays a big role in keeping SME businesses running. Interestingly, none of the SMEs said they supply only to government projects. This suggests that depending only on government contracts may not be practical for SMEs. It could be because of problems like late payments, complicated procedures, or tough competition from bigger suppliers.

In short, this finding shows that SMEs depend a lot on private construction projects and that the government needs to make it easier and fairer for small businesses to take part in public construction work.

3.2.2 Principal Component Analysis of the Data Based on the Responses for Existing Barriers

To identify the underlying barriers faced by SMEs in participating in the construction materials supply chain for public projects, Exploratory Factor Analysis (EFA) using Principal Component Analysis (PCA) with Varimax rotation was conducted on thirteen variables. Factor analysis is a data reduction method used to group correlated variables into fewer hidden factors, helping to understand patterns that aren't directly visible life (Fabrigar, 1999). The study followed three major steps for factor analysis:

Step (a) assessing the suitability of the data

To assess the suitability of data, KMO and Bartlett's test was carried out and presented in table 6.

Table 6: KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy		**0.820**
Bartlett's Test of Sphericity	Approx. Chi-Square	437.097
	Df	78
	Sig.	.000

The Kaiser-Meyer-Olkin (KMO) test yielded a value of 0.820, indicating excellent sampling adequacy. An average value > 0.6 is acceptable for sample a size < 100 *(Tabachnick & Fidell, 2013)*. Bartlett's Test of Sphericity was also significant ($\chi^2 = 437.097$, $p < 0.001$), confirming sufficient correlations among the variables to proceed with factor analysis. The significant value < 0.05 indicates that factor analysis may be worthwhile for the data set *(Kaiser, 1974)*.

Step (b) extracting factors

PCA was employed to reduce the 13 observed variables into a smaller number of hidden factors. According to Kaiser's Criterion (eigenvalues > 1), three factors were retained. The Scree Plot also supported this decision, as the curve clearly leveled off after the third component. The total variance explained is presented in table 7.

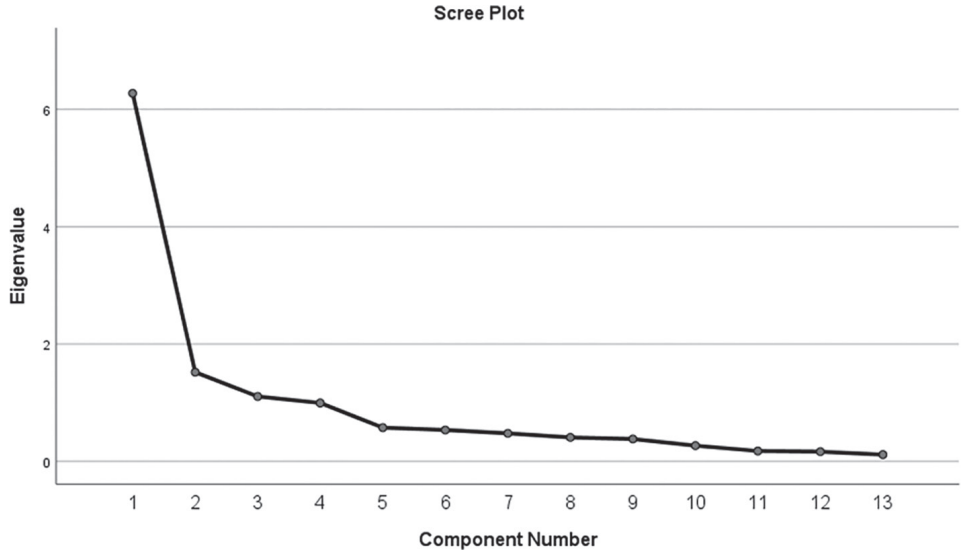

Figure 6: Scree Plot for Evaluation of Current Barrier

Table 7: Eigenvalues (EV) and Total Variance Explained Extraction Method: Principal Component Analysis

Total Variance Explained						
Component	**Initial Eigenvalues**			**Rotation Sums of Squared Loadings**		
	Total	**% of Variance**	**Cumulative %**	**Total**	**% of Variance**	**Cumulative %**
1	6.274	48.260	48.260	3.696	28.433	28.433
2	1.521	11.697	59.957	2.662	20.475	48.908
3	1.106	8.507	68.465	2.542	19.557	68.465
4	.996	7.660	76.125			
5	.575	4.425	80.550			
6	.535	4.117	84.667			
7	.477	3.673	88.340			
8	.409	3.144	91.484			
9	.381	2.934	94.417			
10	.269	2.066	96.483			
11	.176	1.358	97.841			
12	.165	1.271	99.112			
13	.115	.888	100.000			

Table 7 shows that three factors with eigenvalues greater than 1 were extracted using Principal Component Analysis. These three components collectively explained 68.47% of the total variance, which is considered a strong outcome for factor analysis in social research. Specifically, component 1 explained 48.26% of variance (Eigenvalue = 6.274), component 2 explained 11.70% (Eigenvalue = 1.521), and component 3 explained 8.51% (Eigenvalue = 1.106). This high variance and a strong KMO value of 0.820 confirm that factor analysis is appropriate and meaningful for this dataset.

Step (c) rotating and interpreting the factors

Rotated factors for the interpretation is presented in table 8.

Table 8: Rotated Component Matrix with variable loadings

Barriers	Component		
	1	2	3
Barrier 1	.745	.155	.176
Barrier 2	.172	.749	.102
Barrier 3	.517	.655	.018
Barrier 4	.629	.492	-.008
Barrier 5	.684	.055	.436
Barrier 6	.765	.092	.415
Barrier 7	.703	.260	.084
Barrier 8	.655	.468	.124
Barrier 9	.551	.545	.183
Barrier 10	.161	-.076	.834
Barrier 11	.246	.254	.788
Barrier 12	.288	.534	.588
Barrier 13	.011	.673	.648

After the PCA, the factors are rotated using the Varimax method, which maximizes the variance of squared loadings of a factor to make the interpretation clearer. The values of loading greater than 0.4 (Hair, Black , Babin, & Anderson, 2010) were retained for the clear interpretation. Table 9 below shows the loadings of each variable (B1 to B13) on each factor:

Table 9: Rotated Component Matrix showing Factor Loadings of Key Barriers

Barrier	Description	Component 1	Component 2	Component 3	Interpretation
B1	Material shortages and price volatility	.745			Strong loading on C1
B2	Financial constraints		.749		Strong loading on C2
B3	Logistical challenges		.655		Moderate loading on C2
B4	Skilled labor shortages	.629			Moderate loading on C1
B5	Regulatory and bureaucratic hurdles	.684			Moderate loading on C1
B6	Access to Information and Technology	.765			Strong loading on C1
B7	Competition and Market Demand	.703			Strong loading on C1
B8	Environmental and social challenges	.655			Moderate loading on C1
B9	Supply Chain Coordination		.545		Moderate loading on C2
B10	Lack of training and capacity-building			.834	Strong loading on C3
B11	Quality Control			.788	Strong loading on C3
B12	Delays in payment from government contractors affect financial stability			.588	Moderate loading on C3
B13	Fluctuations in demand for materials due to govt. contracts affect inventory management practices		.673		Moderate loading on C2

Component 1: Structural and Operational Challenges

This factor includes high loadings from items related to resource shortages (labor, materials), bureaucratic inefficiencies, limited access to technology and market information, and environmental regulations. These are systemic challenges that influence project execution capacity and long-term participation in government-led supply chains.

Component 2: Financial and Logistical Barriers

This factor includes constraints related to budget limitations, delivery delays, contract-based demand fluctuations, and supply coordination issues. These mid-level barriers hinder SMEs' ability to manage procurement cycles and fulfill government contracts efficiently.

Component 3: Capacity and Quality-Driven Issues

This factor reflects internal limitations such as inadequate training of contractors, weak internal quality assurance, and inconsistent cash flow due to delayed payments from government clients. These issues directly affect SMEs' operational resilience and service quality in public projects.

These findings suggest that addressing both systemic and project-level capacity barriers are essential for sustainable project execution. Like the Kathmandu Valley study by (Joshi, Bhattarai, & Bhandari, 2023), which identified divergent stakeholder perceptions on SCM challenges (public=quality/delays vs. private=cost/efficiency), this study also supports the similar findings on SME-specific barriers for the supply chain participation.

3.3 Recommended Strategies for Enhancing SME Involvement in Construction Supply Chains

The third objective of this study was to identify and recommend effective strategies for improving the participation of Small and Medium Enterprises (SMEs) in the construction material supply chain within the Surkhet Valley. To address this, a mixed-method approach was employed. Quantitative data were collected using a structured questionnaire based on a five-point Likert scale, while qualitative findings were gathered through Key Informant Interviews (KIIs).

The questionnaire survey targeted the same group of SMEs that participated in the second objective, ensuring consistency of perspective. In addition, KIIs were conducted with 15 SME representatives and 15 contractor representatives, providing a dual stakeholder perspective on supply chain dynamics, including issues related to demand, coordination, material delivery, and payment processes.

3.3.1 Quantitative Analysis: RII-Based Prioritization of Improvement Measures

The first part of this analysis involved ranking ten potential measures for improving SME participation in public procurement, using the Relative Importance Index (RII). Respondents rated each measure on a scale from 1 (strongly disagree) to 5 (strongly agree). Table 10 presents the RII values and corresponding ranks for each proposed intervention.

Table 10: RII value from questionnaire survey on possible measures

Measures to Overcome	RII	Rank
Implement strategies that help SMEs reduce procurement and operational costs	0.888	1
Simplify documentation and tendering processes	0.866	2
Improve logistics and scheduling practices	0.860	3
Promote continuous communication among stakeholders	0.854	4
Foster reliable supplier relationships	0.850	5
Encourage inventory planning and stock control	0.846	6
Streamline procurement and delivery cycles	0.842	7
Improve quality, communication, and service delivery	0.836	8
Strengthen SME capacity for customer service	0.832	9
Enable profitability through pricing, cost control, and timely payments	0.830	10

The RII analysis highlights that SMEs prioritize structural and operational reforms to improve their participation in the public construction supply chain. Reducing procurement and operational costs ranked

highest (RII: 0.888), reflecting concerns over rising material costs and limited financial capacity. Simplifying documentation (RII: 0.866) and improving logistics (RII: 0.860) were also top concerns, pointing to the administrative and coordination challenges SMEs face.

Mid-ranked priorities included better stakeholder communication, stronger supplier relationships, and improved stock control, emphasizing the need for predictability and integration in the supply chain. Lower-ranked measures like service quality and profitability were seen as long-term outcomes of broader system reforms.

SMEs seek practical changes, cost efficiency, simplified processes, and better logistics while viewing performance outcomes as secondary benefits. These findings support targeted policy reforms to simplify procedures, enhance coordination, and strengthen SME engagement in public procurement.

3.3.2 Thematic Analysis of Qualitative Data

To explore the strategies that can improve SME involvement, this study employed a thematic analysis of open-ended responses gathered from 15 SMEs representatives and 15 contractors' representatives. The data focused on actionable recommendations aimed at enhancing the availability, reliability, and strategic integration of SMEs within government-led projects. The thematic analysis method was selected for its adaptability and effectiveness in capturing the complexity within the data. It is particularly useful in exploring participants' viewpoints, identifying both shared and differing experiences, and uncovering meaningful findings (Nowell, Norris, White, & Moul, 2017). It helped identify common patterns and turn raw interview data into main topics, showing shared problems and suggested solutions from the stakeholders. The analysis followed Braun and Clarke's six-step framework, involving familiarization, coding, theme development, and reporting (Clarke & Braun, 2013).

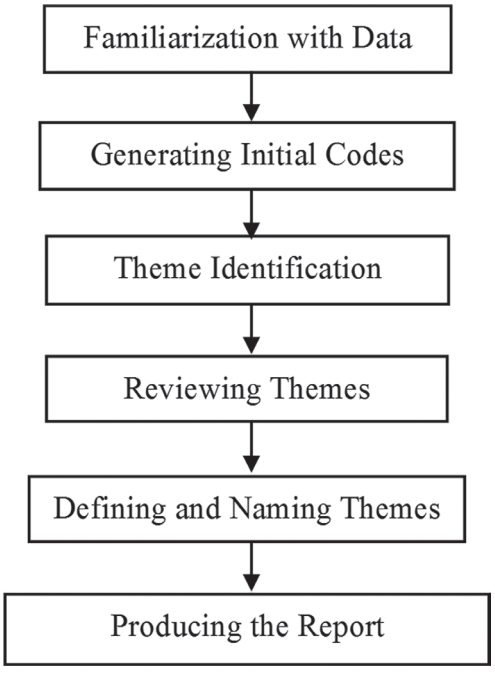

Figure 7: Thematic Analysis Process Flowchart

Key themes were further organized under three overarching objectives:

1. Making supply of Materials from SMEs More Available and Reliable

Participants highlighted the need for fixed delivery schedules, clear material standards, and better inventory control to improve material availability. SMEs suggested that logistical hubs near project sites and simplifying registration could enable more timely and cost-effective supply. These extracted are presented in table 11, table 12, and table 13.

Table 11: Themes and Responses on Enhancing Availability and Reliability of SME Materials

Theme	Interpretation	Illustrative Responses
Standardization and Scheduling	Respondents consistently emphasized the need for fixed delivery timelines and clear material specifications, which can align SME deliveries with construction site requirements.	"Fixed schedule and clear standards" (R1, R14); "Coordinated approach with forecasts" (R13)
Inventory and Stock Planning	SMEs acknowledged gaps in their inventory control and recommended steady stock maintenance, better logistics, and proximity-based supply hubs.	"Better inventory planning" (R11); "Supply points closer to sites" (R12)
Collaboration Among SMEs	Several SMEs suggested that group procurement or consortium approaches could help fulfill larger orders and meet government-scale demand.	"SMEs should collaborate and form groups" (R6)
Process Simplification and Fair Access	Respondents mentioned bureaucratic burdens and recommended simplifying registration and pricing mechanisms to allow easier participation.	"Simplify registration" (R8); "Price agreements for fixed periods" (R7)

2. Enhancing Supply Chain Efficiency for Quality and Timely Deliveries

Improving efficiency needs both better systems and supportive policies. Respondents highlighted financial help like tax relief and quicker payments to support SMEs. They also suggested special contracts, training, and simpler tender processes to reduce bureaucratic burdens and help small firms compete.

Table 12: Themes and Responses on Enhancing Supply Chain Efficiency for Timely and Quality Deliveries

Theme	Interpretation	Illustrative Responses
Policy-Based Incentives	Financial motivations like tax benefits, quick payments, and credit facilities were strongly emphasized to attract SMEs.	"Tax benefits" (R8); "Financial aid or credit" (R15)
Preferential Procurement	Suggestions to prioritize SMEs in tenders and offer reserved contracts were noted repeatedly.	"Special contracts to reliable SMEs" (R1); "Priority in tenders" (R6)
Capacity Building and Training	SMEs requested technical assistance and structured training programs to help them meet government demands.	"Training programs for SMEs" (R5)
Administrative Reform	Respondents emphasized the need to simplify tender procedures and reduce bureaucratic red tape.	"Simplified tendering" (R14); "Programs that reduce red tape" (R13)

3. Encouraging SME Participation in Public Construction Projects

To encourage sustained SME engagement, participants asked for easier rules, better access to credit, and advance payments to solve cash flow issues. Participants also urged the government to facilitate procurement-related orientation and technical workshops.

Table 13: Themes and Responses on Promoting SME Participation in Public Construction Projects

Theme	Interpretation	Illustrative Responses
Supportive Regulatory Environment	Respondents stressed the need for policies that reduce red tape and offer clearer entry pathways into public projects	"We need easier entry rules" (R5); "Simplified bidding process" (R9)
Financial Accessibility	SMEs highlighted difficulty in accessing working capital and emphasized the importance of payment guarantees and credit facilities.	"Faster payments help a lot" (R3); "Need soft loans or advance payments" (R10)
Institutional Support	Emphasis was placed on government-led support such as capacity-building workshops, orientation on procurement, and technical training.	"Orientation programs would help" (R2); "Training for compliance" (R11)
Process Simplification	Participants called for easier documentation, digital platforms, and streamlined onboarding mechanisms.	"Too many forms to fill" (R6); "Online portal would help" (R7)

These themes match the RII results and show a shared need for big improvements. Key points like clear schedules, easier processes, financial help, and government support show where action is needed to make construction supply chains fairer and more efficient.

3.3.3 Word cloud visualization of Responses from KII

In addition to thematic analysis, a word cloud was generated to visually represent the most frequently mentioned terms from the open-ended responses of 15 SMEs and 15 contractors. This helped to quickly identify key concerns and recommendations. (Saranya & Geetha, 2020) suggest creating word clouds based on topics identified through the LDA topic modeling algorithm. Their approach was applied to user reviews in the clothing domain. Similarly, (Seifert, Ulbrich, & Granitzer, 2011) recommend using word clouds to simplify the process of document labeling in training datasets. (*Word cloud Generated from worldcloud.com)*

Figure 8: Dominant Terms according to KII in word cloud format

Terms such as "government", "SMEs", "supply", "schedule", "quality", "contracts", and "incentives" appeared prominently, highlighting recurring themes related to policy support, timely delivery, quality standards, and better contract management.

3.3.4 Comparative Discussion: RII vs. KII Insights on Strategies to Enhance SME Involvement

The analysis of RII rankings and Key Informant Interviews (KIIs) shows strong alignment on the challenges SMEs face in public construction supply chains. Both methods emphasize cost reduction and administrative simplification, with RII ranking cost minimization (0.888) and reduced paperwork (0.866) as top priorities, which KIIs support by calling for simpler tender processes and financial help.

Scheduling and timely delivery were also highly prioritized, with RII ranking timely delivery (0.860) and reduced lead time (0.842) as key, while KIIs reinforced the importance of fixed schedules, better transportation, and closer supply points for logistical efficiency.

For inventory control and coordination, both methods agree on the need for better planning and communication. Regarding quality control and certification, RII found that satisfaction of suppliers (0.850) and clients (0.836) were essential for trust and quality, with KIIs adding depth by suggesting quality audits and technical support.

Lastly, RII indicated lower priorities for increased profitability (0.830) and customer service (0.832), while KIIs highlighted the importance of tax incentives, fast payments, and priority tendering as long-term motivators for SME involvement. These insights demonstrate a comprehensive alignment between both quantitative and qualitative methods, revealing the need for systemic changes to support SMEs in the public construction supply chain.

Table 13: Results comparison of the Questionnaire Survey and Key Informants Interview

Strategy Area	RII Rank	KII Theme Presence	Overall Insight
Cost Reduction & Admin Simplification	Very High	Strong	Strong overlap – seen as foundational
Timely Delivery & Lead Time	High	Strong	Shared logistics concern across methods
Inventory & Coordination	Mid-High	Strong	High alignment on forecasting and planning
Quality Assurance	Mid	Moderate-High	KIIs add depth on quality enforcement methods
Incentives & Financial Support	Mid-Low	Strong	More prominent in KIIs than in survey rankings

This comparison shows that RII provides a quantitative foundation, while KIIs enrich the analysis with contextual details, offering a comprehensive view of SME challenges and strategies for improved participation. Thematic analysis, word cloud, and RII comparison together give a clear view of what helps or blocks SME involvement in public construction. The results show a strong need for simpler processes, better logistics, and focused government support.

4. Conclusions

This study explored the dynamics of construction material supply chains and SME participation in public procurement within Surkhet Valley, Nepal. Through a mixed-methods approach combining ABC classification, PCA, RII analysis, and key informant interviews, the research provides a comprehensive understanding of material demand trends, participation barriers, and actionable strategies. The findings provide useful ideas for making local construction procurement more efficient, inclusive, and responsive to policy needs.

Demand Analysis and Inventory Classification

ABC analysis revealed that a small proportion of materials (21.74%) accounted for nearly 75% (74.99%) of total usage value in publicly procured building projects across Surkhet Valley, highlighting the need for tiered inventory management strategies. The precise breakdown shows:

- Category A (21.74% of items; 74.99% value): Reinforcement bars, cement, electrical components, aggregates, and bricks require strict JIT procurement, real-time stock monitoring, and prioritized budget allocation to prevent costly project delays.
- Category B (26.09% of items; 19.28% value): Semi-critical materials like sand, sanitary fixtures, and mild steel metals benefit from bi-monthly reviews and regional supplier partnerships to balance cost and availability.
- Category C (52.17% of items; 5.73% value): Non-critical items (paints, nails, tiles) can be procured through annual bulk tenders with local vendors, minimizing administrative overhead.

Barriers to SME Participation (PCA Findings)

Three main barrier components emerged: structural-operational (e.g., material shortages, bureaucracy), financial-logistical (e.g., delayed payments, procurement cycles), and capacity-quality challenges (e.g., inadequate training, weak QA). These findings point to the need for a combination of policy, financial, and institutional support measures to address the multilayered challenges faced by SMEs.

Strategies to Enhance SME Involvement

The study combined Relative Importance Index (RII) rankings with Key Informant Interviews (KII) to identify effective strategies for increasing SME engagement. Both quantitative and qualitative results pointed to the importance of simplifying administrative processes, improving logistics systems, ensuring predictable payment mechanisms, and offering targeted policy support. These interventions, if implemented in alignment with broader procurement reforms, can create a more inclusive and enabling environment that allows SMEs to participate more effectively and at scale in public construction projects.

To improve SME participation in the construction material supply chain in Surkhet Valley, the study recommends better stock management using various inventory management techniques, standardized procurement schedules, and centralized logistics hubs. Simplifying registration, ensuring timely payments, and offering SME-friendly policies like reserved tenders can lower entry barriers. Capacity-building through training and improved communication between stakeholders is also essential. Additionally, future studies should explore these issues in other regions and sectors, evaluate the long-term effects of reforms, and consider sustainable practices and alternative inventory methods for more efficient procurement.

Acknowledgements

The authors would like to thank the Civil Engineering Department, Graduate College of Engineering, Mid-West University and all the respondents for their valuable contributions.

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