Barriers to Sustainable Construction: A Quantitative Analysis of Technological, Economic, and Policy Challenges in Southwest China

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ABSTRACT

Sustainable construction (SC) is vital in addressing the construction sector's environmental footprint, yet SC adoption remains limited in developing countries. In China, national policies such as the Green Building Evaluation Standard and the 14th Five Year Plan have been introduced to anchor SC. Nevertheless, SC adoption remains inconsistent particularly in less developed regions like Southwest China. This study investigates the barriers to SC adoption in Southwest China, using Institutional Theory to categorize SC barriers across regulative, normative, and cultural cognitive dimensions. A structured questionnaire was distributed to 400 construction professionals, yielding 269 valid responses. Exploratory Factor Analysis and Confirmatory Factor Analysis were applied to validate the dimensional structure of SC barriers. The results highlight economic and cost factors especially high upfront capital investment and limited access to financing, as the most critical impediments. Factor analysis confirmed that barriers align with the three institutional pillars, providing strong empirical support for the theoretical framework. The findings underscore the interdependence of financial, regulatory, technological, and awareness related challenges, emphasizing the need for integrated strategies involving policy enforcement, capacity building, and stakeholder's engagement.

Keywords: *sustainable construction, institutional theory, sustainability barriers, construction industry, China*

1.0 INTRODUCTION

In developing economies, sustainable construction (SC) adoption is constrained by interdependent barriers. These include regulatory enforcement, high upfront costs, the absence of financial incentives, limited access to green technologies, low market demand, and minimal stakeholder awareness (Sfakianaki, 2019). Fragmented industry structures and the dominance of unique conventional construction practices further stifle innovation requires localized strategies that are not only responsive to technical constraints but also aligned to national institutional capacities and socio economic conditions.

China exemplifies this challenge on a significant scale. As the world's largest carbon emitter responsible for nearly 27% of global CO_2 emissions (Shen and Faure, 2021), China faces a dual imperative: to sustain economic growth while mitigating environmental impact. The country's rapid urbanization and infrastructure growth prompting the government to introduce a range of green development policies, such as the Green Building Evaluation Standard (2006), the 14th Five Year Plan, and targets for carbon neutrality by 2060 (Dinlersoz and Fu, 2022). Despite these initiatives, adoption of sustainable construction remains limited. Ren & Kim (2023), Wu et al. (2019), and Goh and Chong (2023) continues to highlight systemic barriers, regulatory fragmentation, enforcement gaps, financial disincentives, technological constraints, and low public and professional awareness. Southwest China presents a particularly underexplored case. The region faces both geographic and developmental constraints, such as limited access to green materials, low local expertise, and inconsistent implementation of national policies (Guo et al., 2019). While studies have examined barriers to SC in other Chinese regions, a significant research gap persists regarding the perception and structure of such barriers in less developed provinces. Moreover, the theoretical framing of these barriers often lacks depth, limiting insights into how institutional structures shape stakeholder's behaviour.

To address this gap, this study investigates the barriers to sustainable construction in Southwest China using Institutional Theory. The pillars namely regulative (i.e. formal rules and enforcement), normative (i.e. social and professional norms), and cultural (i.e. shared beliefs and routines) offers a robust lens to interpret systemic resistance to sustainability transitions (Scott, 2005). The study aims to (i) rank the key barriers to SC as perceived by construction stakeholders, and (ii) empirically validate the categorization of SC barriers within Institutional Theory using exploratory and confirmatory factor analyses. In doing so, the research contributes to the contextual understanding of sustainability challenges in China's built environment while offering broader implications for developing countries facing similar institutional and market constraints.

1.1 Sustainable Construction

Sustainable construction (SC) has emerged as a holistic approach that integrates environmental stewardship, social wellbeing, and economic viability across the entire building life cycle from planning and design through construction, operation, maintenance, and eventual demolition or reuse (Kibert, 2016; Tam et al., 2019). SC advance transformation from conventional construction practices towards minimizing environmental harm, promoting healthier living environments, and achieving long term cost efficiency.

From an environmental perspective, SC focuses on reducing greenhouse gas emissions, conserving natural resources, and lowering construction and demolition waste through the adoption of renewable materials, circular economy practices, and low carbon technologies (Attia et al., 2023; Liu et al., 2020; Huang et al., 2018). Socially, SC enhances occupant wellbeing and community resilience by improving indoor environmental quality, integrating local cultural values, and fostering inclusive stakeholder participation throughout the project cycle (He et al., 2023; Yılmaz and Bakış, 2015; Zulu et al., 2023). Economically, although SC often incurs higher initial capital costs, SC has high potential to yield long term returns via reduced operational expenses, higher asset value, and new employment opportunities in green industries (Tunji-Olayeni et al., 2020; Doan et al., 2017; Marsh et al., 2021).

Despite these multidimensional benefits, global SC adoption remains uneven. In developing countries, implementation is often hindered by high upfront costs, limited financing mechanisms, technical capacity gaps, and low awareness among construction stakeholders (Darko et al., 2018; Pradhananga et al., 2021). The interrelated constraints are increasingly being recognized not just as technical or economic challenges, but as reflections of deeper institutional dynamics. As a result, contemporary research is shifting toward institutional analyses to better understand how systemic, regulatory, and socio cultural conditions shape sustainable construction outcomes across various contexts (Wu et al., 2019; Karji et al., 2020; Stanitsas et al., 2021).

1.2 Barriers to Sustainable Construction

1.2.1 Economic Barriers

Economic and cost related barriers remain among the most cited obstacles to sustainable construction, especially in developing economies (Kineber et al., 2023; Pradhananga et al., 2021; Darko et al., 2018). High upfront capital costs, limited access to financing, and a focus on short-term returns continue to deter investors despite evidence of long-term savings through operational efficiencies (Durdyev et al., 2018). This reluctance underscores the need for targeted government interventions, such as incentives and risk mitigation tools, to balance initial costs with future benefits (Lu & Zhang, 2016).

Investment uncertainty driven by fluctuating material costs and perceived risks of green technologies further limits SC adoption (Akcay, 2023; Karji et al., 2020). In contrast to developed countries like Scandinavia where strong institutional support proven to boost SC adoption, Southeast Asia's weaker policy frameworks contribute to lower engagement with sustainable practices (Chang et al., 2016). Beyond costs, low awareness of sustainability's broader economic and social value constrains demand (Stanitsas et al., 2021; Chan et al., 2018). Addressing these barriers requires integrated strategies combining financial incentives, market education, and multi stakeholder collaboration to shift investment behaviour and enable a smoother transition toward sustainable construction.

Although economic barriers are consistently reported across developing economies, prior studies diverge on how these barriers should be interpreted. Some scholars conceptualize high upfront costs as intrinsic financial constraints linked to material prices and technology maturity (Darko et al., 2018; Durdyev et al., 2018). Others argue that financial reluctance reflects institutional conditions such as weak incentive structures, policy uncertainty, and inadequate risk-sharing mechanisms (Karji et al., 2020; Shan et al., 2017). This inconsistency suggests that economic barriers may not be purely market-driven, but institutionally mediated. However, few studies explicitly examine how financial constraints are embedded within regulatory and governance frameworks, particularly in less developed regions such as Southwest China

1.2.2 Technological Barriers

While essential to advancing SC, technological factors pose significant challenges, especially in developing countries (Ahmed et al., 2023; Pham et al., 2020). Limited access to green technologies, material scarcity, and inadequate technical expertise hinder SC adoption (Wu et al., 2019; Chang et al., 2016). High upfront costs and strong reliance on conventional practices further discourage stakeholders, particularly SMEs from investing sustainable alternatives (Gounder et al., 2021; Durdyev et al., 2018).

The complexity of implementing advanced technologies like energy-efficient systems, BIM and data analytics demands specialized skills often lacking due to weak education and industry upskilling (Liu et al., 2020; Chan et al., 2018). Moreover, poor integration with conventional systems, limited R&D investment, and uncertainty of design performance and durability greatly reduce stakeholder confidence (Huang et al., 2018; Doan et al., 2017).

Broader systemic issues such as inadequate technology transfer, lack of localized standards, and underdeveloped infrastructure compound the SC barriers (Gounder et al., 2021; Pham et al., 2020). Regulatory gaps and risk averse industry attitudes further stall innovation (Wu et al., 2019). Addressing these challenges requires targeted R&D, stronger technical guidelines, and transparent project demonstration foster trust and build local support to SC adoption (Karji et al., 2020).

While technological barriers are frequently cited, existing studies differ on whether technical limitations represent root causes or secondary effects of institutional inertia. Several studies attribute adoption challenges to lack of expertise and technology incompatibility (Chan et al., 2018; Liu et al., 2020), whereas others suggest that insufficient demand, weak regulatory enforcement, and limited professional norms discourage technological diffusion (Wu et al., 2019; Karji et al., 2020). This ambiguity indicates that technological barriers may be symptomatic of broader normative and regulative constraints.

1.2.3 Regulatory Barriers

In terms of regulatory barriers, inconsistent regulatory frameworks present a major obstacle to SC (Ahmed et al., 2023; Gounder et al., 2021). Inadequate sustainability regulations and poor enforcement mechanisms hinder integration into conventional construction practices, as seen in countries like Ghana and even parts of

the United States (Karji et al., 2020; Ametepey et al., 2015). The establishment of mere regulations is insufficient as elements on regulatory consistency and enforceability are essential.

Slow regulatory adaptation to emerging technologies and environmental priorities further limits SC impact, especially in rapidly evolving markets (Akcay, 2023; Chan et al., 2018). This lag discourages private investment and fosters fragmented market responses. Instead, a dynamic and collaborative regulatory process is needed to keep pace with industry changes and promote sustainable practices (Stanitsas et al., 2021).

Successful models, such as the EU's energy performance directives, highlight the value of robust, enforced standards (Darko et al., 2018). Certification systems like LEED and BREEAM have also helped drive market acceptance (Doan et al., 2017). However, their effectiveness depends on complementary factors such as material availability, technological readiness, and industry wide engagement (Pham et al., 2020).

1.2.4 Awareness Barriers

Globally, limited awareness and knowledge continue to hinder SC adoption (Akcay, 2023; Akindele et al., 2023; Durdyev et al., 2018). This includes the lack of understanding of sustainability principles and insufficient technical capacity to implement SC. In developing countries, weak educational outreach and limited industry exposure exacerbate the issue (Pradhananga et al., 2021; Pham et al., 2020). This gap affects across construction stakeholder's profile such as developers, policymakers, and regulators, thereby restricting systemic change.

In particular, stakeholder's awareness plays a significant role. This is where as understanding increases, demand for sustainable solutions increase, and vice versa (Durdyev et al., 2018). This challenge is view as consistent trend in countries like Turkey, public engagement with sustainability remains inadequate (Akcay, 2023; Cease et al., 2019).

Addressing these gaps requires continuous education, targeted upskills, and accessible platforms for knowledge exchange (Fitriani & Ajayi, 2023; Goh & Chong, 2023). Awareness must be treated as an evolving process shaped by technological and market shifts with sustained collaboration among academia, industry, and government. Although low awareness and resistance to change are widely reported, prior studies largely treat cultural barriers as individual level deficiencies rather than institutionalized belief systems. This limits understanding of how shared norms and routines within the construction sector perpetuate unsustainable practices. Institutional Theory offers a more robust explanation by framing awareness barriers as culturally embedded mechanisms rather than isolated knowledge gaps.

Existing studies provide extensive lists of sustainable construction barriers, yet three critical limitations remain. First, barriers are often treated as independent factors rather than interrelated institutional mechanisms. Second, the theoretical framing of barriers remains underdeveloped, with limited attention to how regulative, normative, and cultural forces jointly shape decision making. Third, empirical evidence from less developed Chinese regions remains scarce. These gaps indicate the need for an institutionally grounded empirical investigation that examines not only what the barriers are, but how they are structured and perceived within a specific regional context.

1.3 Institutional Theory

Institutional Theory provides a robust theoretical foundation for construction stakeholders to deepen understanding of SC barriers. Institutional Theory offers a structured basis to understand how organizational behaviour is shaped not only by economic objectives. The theory set out enduring rules, norms, and belief systems in determining how organization perceive acceptance (Scott, 2005). It comprises three interrelated pillars: Regulative pillar, Normative pillar, and Cultural pillar. Institutional Theory has been widely applied in built environment research to examine drivers and inhibitors of green building certification (Liu et al., 2020), investigate organizational resistance to sustainable technologies (Zhang et al., 2021), and assess how conflicting institutional logics shape project governance (Greenwood et al., 2011).

In specific to SC adoption, previous research across diverse geographical contexts including the United States, Netherlands, and Ghana identified consistent categories of SC barriers namely lack of knowledge and awareness, government and regulatory issues, economic factors, cultural and behavioral resistance, and technical difficulties (Fathalizadeh et al., 2022; Liu et al., 2022; Karji et al., 2020; Tokbolat et al., 2020). Similarly, Tetteh et al. (2025) and Tunji-Olayeni et al. (2023) consistently highlight governance structures and

financial risk factors embedded within policy level decisions, are major SC barriers. Moreover, Ampetey et al. (2015) provide empirical evidence underscoring that regulatory and institutional forces significantly influence SC adoption, demonstrating the need for an institutional perspective.

In this study, Institutional Theory provides a theoretical foundation to categorize barriers to SC. Table 1 lists SC barriers rooted to the Institutional Theory dimensions. Regulative dimension encompasses barriers on regulatory frameworks and economic considerations. Regulatory barriers represent formal rules, governance structures, enforcement mechanisms, constrained access to financing, and inadequate financial incentives are viewed as institutionalized economic policies reflecting government intervention or its absence (Darko et al., 2018; Mahalingam & Levitt, 2007). Normative dimension explains barriers linked to technological and innovation aspects. Although technological barriers appear primarily technical, technological adoption and integration rely heavily upon professional standards, industry expectations, and established institutional norms (Zhang et al., 2020). Resistance to innovative practices, insufficient collaboration, and skill represents deeper normative issues within the industry. The Cultural dimension addresses awareness and knowledge barriers, reflecting societal perceptions and shared beliefs (Wu et al., 2019). Challenges such as low public awareness, insufficient training opportunities, and limited prioritization of sustainability practices represent underlying cultural assumptions and attitudes toward SC.

Table 1. Summary of Barriers of Sustainable Construction Adoption

Institutional Dimension	Sustainable Construction Barriers	Authors
Regulative	Weak regulatory frameworks and inconsistent enforcement	Ametepey et al. (2015); Karji et al. (2020); Gounder et al. (2021); Ahmed et al. (2023)
	Slow adaptation of regulations	Chan et al. (2018); Stanitsas et al. (2021); Akcay (2023)
	High upfront capital costs and limited access to financing	Darko et al. (2018); Durdyev et al. (2018); Pradhananga et al. (2021); Kineber et al. (2023);
	Investment uncertainty due risks	Karji et al. (2020); Akcay (2023)
	Limited financial incentives and policy	Mahalingam & Levitt (2007); Chang et al. (2016); Lu & Zhang (2016); Darko et al. (2018
Normative	Limited access to green technologies and sustainable materials	Chang et al. (2016); Durdyev et al. (2018); Wu et al. (2019); Gounder et al. (2021); Ahmed et al. (2023)
	Inadequate technical or professional expertise	Chan et al. (2018); Liu et al. (2020)
	Technology integration issues	Doan et al. (2017); Huang et al. (2018)
	Insufficient R&D investment and lack of localized technical standards	Pham et al. (2020); Gounder et al. (2021); Zhang et al. (2021)
Cultural	Limited public SC awareness and stakeholder knowledge	Durdyev et al. (2018); Pham et al. (2020); Pradhananga et al. (2021); Akcay (2023); Akindele et al. (2023)
	Weak educational outreach and inadequate industry exposure	Cease et al. (2019); Fitriani & Ajayi (2023); Goh & Chong (2023)
	Sectoral resistance to change prioritization of SC	Wu et al. (2019); Durdyev et al. (2018); Fitriani & Ajayi (2023); Goh & Chong (2023)

This study proposes the following hypothesis:

H1: Regulatory barriers are perceived as key barriers to sustainable construction implementation in Southwest China.

H2: Barriers to sustainable construction in Southwest China aligns with the dimensions of Institutional Theory.

2.0 METHODOLOGY

This study adopted a quantitative research design using a structured questionnaire to investigate the barriers to SC in Southwest China. The study focuses on identifying shared institutional barriers to sustainable construction rather than comparing perceptions across individual stakeholder groups. The selected methodology focuses on three main aspects: ranking SC barriers, determining the empirical support for Institutional Theory categorization using EFA, and validating SC categorization through CFA. Potential multicollinearity was assessed through inter-construct correlations, all of which remained below commonly accepted thresholds, indicating that multicollinearity is unlikely to affect the measurement results. The quantitative approach effectively provides empirical evidence necessary for assessing the significance of various barriers and confirming SC categorization under Institutional Theory (Weyant, 2022). The questionnaire was developed based on an extensive literature review and expert input to ensure construct relevance and coverage, comprised 17 items. The 17 barrier items were selected based on three criteria: i) consistent empirical recurrence in prior sustainable construction studies, ii) clear conceptual alignment with one of the three Institutional Theory pillars (regulative, normative, or cultural), and iii) contextual relevance to the Southwest China construction sector. This approach ensured construct clarity while avoiding conceptual overlap across institutional dimensions. A five point Likert scale was employed to capture the perceived significance of each barrier.

This study adopted a non-probability purposive sampling strategy, targeting construction professionals with direct involvement in project decision making and exposure to sustainable construction practices. A purposive sampling approach is appropriate for institutional analysis, where informed professional judgement is required rather than statistical representation of the general population. The objective of this study is to examine perceived institutional barriers to sustainable construction, which necessitates respondents who possess sufficient industry experience and familiarity with regulatory, financial, and organizational constraints. Respondents were selected through professional networks, industry associations, and institutional contacts within the construction sector, including contractors, consultants, developers, public officials, and academics. To ensure regional relevance, data collection focused on multiple provinces within Southwest China, including Sichuan, Chongqing, Yunnan, and Guizhou. These regions represent varying levels of economic development and regulatory maturity, providing a broad institutional context for examining sustainable construction barriers.

Data were collected from construction stakeholders including contractors, consultants, developers, public officials, and academics; with 400 questionnaires distributed and 269 valid responses obtained (refer Table 2). The response rate of this study is 67.25%. The sample size was sufficient to perform multivariate statistical analysis and generalize the findings within the study's context.

Table 2. Demographics Profile

Demographics	Frequency	Percentage (%)
Stakeholders Type		
Contractors	81	28.7
Developers	45	15.6
Consultants	106	37.6
Local authority	36	12.8
Academia	14	5.3
Involvement in Sustainable Construction		
< 3 years	87	30.8
Between 3 to 10 years	140	49.7
> 10 years	55	19.5
Years of Establishment		
< 5 years	121	42.9
Between 5 to 10 years	86	30.5
Between 11 to 20 years	42	14.9
> 20 years	33	11.7
Total	**282**	**100**

Descriptive statistics were used to rank barriers by their mean scores. EFA was conducted using Principal Component Analysis with Varimax rotation and an eigenvalue threshold of 1.0 to explore latent barrier structures. Sampling adequacy for EFA was confirmed via a KMO value of 0.896 and a significant Bartlett's Test of Sphericity ($p < 0.001$), indicating suitability for factor extraction. Reliability analysis using Cronbach's Alpha demonstrated strong internal consistency, with the overall alpha at 0.943 and subscale values for each construct exceeding 0.80. These results affirmed the robustness and coherence of the survey instrument in capturing the multidimensional nature of sustainability barriers in construction.

2.1 Barriers to Sustainable Construction Adoption

This section evaluates H1: Regulative barriers are perceived as the most significant barriers in implementing sustainable construction (SC). To assess the perceived importance of SC barriers, descriptive statistics were calculated for 17 items categorized under the three pillars of Institutional Theory namely Regulative, Cultural, and Normative. Each item was rated on a five point Likert scale to determine the types of barriers which stakeholders consider most critical to SC implementation in Southwest China.

The analysis indicates Regulative barriers as the most critical barriers with highest overall mean (M = 3.47). Significant regulative barriers include SC policy enforcement and facilitative financing mechanisms for SC projects. This is followed by Cultural barriers (M = 3.34), highlighting concern over stakeholder awareness and sectoral resistance to change. Normative pillar scored the lowest mean (M = 3.22), suggesting that construction technical practices are less critical compared to regulatory awareness issues. Detailed analysis shown in Table 3.

Table 3. Descriptive Analysis for Barriers to Sustainable Construction Implementation

Barriers		Mean		Rank	Std. Deviation
Regulative					
RIR1	Weak regulations and enforcement	3.48		4	1.01
RIR2	Bureaucratic and regulatory delays	3.52		3	1.05
RIR3	Absence of SC governing body	3.12	3.47	13	1.03
RIR4	Lack of subsidies/incentives	3.62		1	1.08
RIR5	Difficult access to green finance	3.58		2	1.10
RIR6	No financial evaluation policy	3.44		7	1.11
Cultural					
AKR1	Lack of knowledge	3.27		11	1.03
AKR2	Low public awareness	3.20		12	1.02
AKR3	Lack of SC promotion	3.31	3.34	10	0.92
AKR4	Resistance to change	3.50		5	1.09
AKR5	Lack of stakeholder experience	3.46		6	1.15
Normative					
TIR1	Material availability	3.38		8	0.95
TIR2	Lack of technical expertise	3.42		9	0.89
TIR3	Lack of R&D support	3.14	3.22	14	1.06
TIR4	Technological incompatibility	3.10		15	1.04
TIR5	Performance/durability concerns	3.06		16	1.01

At item level, the most significant SC barriers was RIR4: Lack of government financial support mechanisms to offset high initial costs of SC (Mean = 3.62, SD = 1.08), followed by RIR5: Difficulty to access green financing for SC projects (Mean = 3.58, SD = 1.10), and RIR2: Bureaucratic and regulatory delays to process SC projects. (Mean = 3.50, SD = 1.09). In addition, RIR1: Fragmented enforcement of SC frameworks (Mean = 3.48, SD = 1.01) and AKR4: Resistance to change from conventional building practices (Mean = 3.50, SD = 1.09) also ranked among the top five barriers overall. Less significant barriers identified are TIR3: Lack of research and development in SC materials and methods (Mean = 3.14, SD = 1.06), and TIR4: Technology incompatibility with existing systems (Mean = 3.10, SD = 1.04).

Notably, the lowest rated SC barriers are clustered under the Normative pillar namely TIR3: Lack of research and development support, (Mean = 3.14, SD = 1.06), TIR4: Technological incompatibility with current construction systems (Mean = 3.10, SD = 1.04), and TIR5: Durability and performance of sustainable technologies (Mean = 3.06, SD = 1.01). The lower scores suggest normative barriers are viewed as consequences of institutional limitations.

The descriptive results confirm H1: Regulative barriers in specific to policy enforcement and limited financial support are key barriers to SC adoption in Southwest China.

2.2 Categories of Sustainable Construction Barriers Through Institutional Theory Dimensions

The Kaiser Meyer Olkin (KMO) statistic and Bartlett's Test of Sphericity (BTS) were used to confirm the suitability of the dataset for exploratory factor analysis (EFA) (Shrestha, 2021). The KMO value of 0.890 indicating the item correlations are highly adequate for factor extraction (refer Table 3). Bartlett's test yields a chi-square value of 1125.4 with 136 degrees of freedom (df) and a significance level of $p < 0.001$. Findings indicate the correlations between variables are sufficiently large and appropriate for factor analysis. ($p < 0.001$) (Shkeer and Awang, 2019).

Principal component extraction and Varimax rotation highlights three distinct dimension, each with an eigenvalue greater than one. Collectively, these factors explain 59.172 % of the total variance in the barrier scale. Dimension 1 shows the highest initial eigenvalue of 4.820, accounts for 28.353 % of the variance before rotation, and retains 23.529 % after rotation. Dimension 1 comprises RIR1 (0.801), RIR2 (0.771), RIR3 (0.702), RIR4 (0.828), RIR5 (0.807), and RIR6 (0.744), therefore interpreted as the Regulative pillar. Dimension 2 yield eigenvalue of 3.047, explaining 17.983 % of the variance and 17.647 % after rotation. Dimension 2 comprises AKR1 (0.728), AKR2 (0.690), AKR3 (0.764), AKR4 (0.715), and AKR5 (0.747) encapsulating knowledge, promotion, and sectoral resistance, is further recognized as the Cultural pillar. Dimension 3 display eigenvalue of 2.182, contributing 12.836 % of the variance and 17.935 % after rotation). Dimension 3 encompasses TIR1 (0.793), TIR2 (0.713), TIR3 (0.676), TIR4 (0.654), and TIR5 (0.636) represents technical capacity. Thus, represents the Normative pillar. Table 4 shows the factor analysis of SC barriers.

Every item loads ≥ 0.636 on the designated dimension and < 0.30 on the other two dimension. The analysis confirms the model structure is aligned with the three pillars of Institutional Theory. The EFA results provide strong empirical evidence for Hypothesis H2, demonstrating that respondents naturally perceive SC barriers rooted from Regulative, Cultural, and Normative pillars.

Table 4. Factor Analysis of SC Barriers

Dimension	Initial			Rotation Sums of Squared Loadings		
	Eigenvalues	% of Variance	Cumulative (%)	Total	% of Variance	Cumulative%
Regulative	4.820	28.353	28.353	4.000	23.529	23.529
Cultural	3.047	17.983	46.336	3.000	17.647	41.176
Normative	2.182	12.836	59.172	3.049	17.935	59.111
Kaiser Meyer Olkin measure of sampling adequacy						0.890
Bartlett's test of sphericity				Approx. Chi square		1125.4
					Df	136
					Sig	0.001

Items	Regulative	Cultural	Normative
RIR1	0.801		
RIR2	0.771		
RIR3	0.702		
RIR4	0.828		
RIR5	0.807		
RIR6	0.744		

AKR1	0.728	
AKR2	0.690	
AKR3	0.764	
AKR4	0.715	
AKR5	0.747	
TIR1		0.793
TIR2		0.713
TIR3		0.676
TIR4		0.654
TIR5		0.636

Following the EFA, a confirmatory factor analysis (CFA) was carried out to verify 17 SC barrier items reliably capture the Regulative, Cultural, and Normative dimensions of Institutional Theory (Refer Table 5). All items retained from the EFA yield standardised loadings ≥ 0.64 and were statistically significant at $p < 0.001$. Therefore, no indicators were removed during model refinement, satisfying the $\lambda \geq 0.50$ criterion for recommended convergent validity (Hair et al., 2010). The three-dimension model achieved excellent fit $\chi^2/df = 1.926$ (< 3), GFI = 0.910, AGFI = 0.880 (> 0.80), CFI = 0.951 (> 0.90) and RMSEA = 0.047 (< 0.08). Each fit index surpasses the recommended cut off, confirming the model's satisfactory absolute, incremental, and parsimonious fit (Hair et al., 2019). The findings confirm a robust representation of SC barriers in Southwest China.

Table 5. Confirmatory Factor Analysis Model Fit Indices for SC Barriers

Fit Index	Value	Recommended Threshold	Interpretation
GFI	0.910	≥ 0.85	Good Fit
AGFI	0.880	≥ 0.80	Good Fit
CFI	0.951	≥ 0.90	Excellent Fit
RMSEA	0.047	≤ 0.08	Good Fit
χ^2/df	1.926	< 3.00	Good Fit

Convergent validity is supported with Composite Reliability values range from 0.835 to 0.862 and Average Variance Extracted values from 0.518 to 0.563 (refer Table 6). The values exceeds the 0.70 and 0.50 benchmarks (Hair et al., 2010). Discriminant validity is further confirmed with data in Table 7. Each $\sqrt{AVE}$ (0.720–0.750) is greater than the corresponding inter dimension correlations (r = 0.312–0.379) thus, satisfying the Fornell and Larcker criterion (Ab Hamid et al., 2017). The findings demonstrate each SC barrier dimension is both conceptually and statistically distinct. This reinforces the structural integrity and discriminant power of the Institutional Theory used in this study.

Table 6. Convergent Validity of SC Barriers to Institutional Theory Dimensions

Dimension	AVE	CR
Regulative	0.550	0.846
Cultural	0.518	0.835
Normative	0.563	0.862

Table 7. Discriminant Validity Based on Inter Construct Correlations and Square Root of AVE

Dimension	Regulative	Cultural	Normative
Regulative	0.742		
Cultural	0.335	0.720	
Normative	0.379	0.358	0.750

Consistently, findings above offer strong empirical support to Hypothesis 2 in this study. SC barriers categorization identified through EFA consistently aligns with the theoretical expectations of Institutional Theory, and is statistically validated through CFA. Given the study's focus on construct validation and barrier prioritisation rather than causal modelling, standardized factor loadings, composite reliability, and average variance extracted are used as indicators of effect magnitude. Although the statistical analysis confirms the institutional structure of barriers, the interpretation of results adopts an exploratory perspective to understand how institutional dimensions interact and reinforce one another in practice. The results highlights construction professionals in Southwest China conceptualize barriers in ways that correspond to the regulative, normative, and cultural dimensions. While statistical mediation was not tested, the study provides conceptual evidence of institutional interdependencies, which future research may examine through longitudinal or structural modelling approaches.

3.0 DISCUSSION

This study offers empirical confirmation of two core hypotheses of: 1) Regulative barriers are perceived as key impediments to SC adoption (H1), 2) Barriers to SC adoption are rooted to the Institutional Theory regulative, normative, and cultural dimensions (H2). The findings reflect localized realities in Southwest China and refines earlier work on Sc barriers as one dimensional issue.

The survey shows that barriers to SC adoption in Southwest China are dominated by barriers related to in the regulative dimensions instead of a standalone financial consideration. The absence of targeted subsidies or tax incentives (M = 3.62) and the difficulty of accessing green finance (M = 3.58) are the two highest scoring items and surpass every Cultural and Normative dimension. A further regulative gap on the lack of a formal financial evaluation policy (M = 3.44) ranks third. This highlights stakeholder's interpretation of cost through a policy lens rather than a price lens. These findings redirect the debate from the traditional claim that green building is intrinsically expensive (Karji et al., 2020; Shan et al., 2017) to the argument that existing rules fail to redistribute or mitigate investment risk. Without predictable incentives and risk sharing mechanisms, construction stakeholders shall continue to treat SC projects as high risk ventures despite their long term economic potential (Osuizugbo et al., 2020).

Evidence from geographical research reinforces findings in this study. Liu et al. (2022) report the uptake of green finance rises once subsidies and performance based rebates are transparent and promptly disbursed. A similar pattern emerges in this study where approval processes remain protracted (RIR2), private capital withholds engagement. Although financial considerations persist, our data suggest financial consideration are mediated by institutional design. Transparent subsidy schedules and concessional loan facilities could recalibrate the risk return profile and support proactive investment. Consequently, policy measures that refine fiscal incentives and streamline administrative procedures are likely to outperform strategies focused solely on marginal reductions in material or certification costs (Babalola & Harinarain, 2024).

Within similar geographical context, Liu et al. (2022) echoes the uptake of green finance increases significantly when subsidies and performance-based rebates are both transparent and disbursed without delay. Our study yields a similar insight where in contexts where regulatory provisions are weak or approval processes remain protracted (RIR2), private capital continues to withhold adoption. Although financial considerations remain present, our data suggest financial concerns on SC adoption is mediated by institutional design. Mechanisms such as transparent subsidy schedule or concessional loan facility could recalibrate the risk return profile of and thereby encourage investment in SC projects. Policy efforts that focus on refining fiscal incentives and expediting administrative procedures are likely to be more effective than strategies aimed solely at marginal reductions in material or certification costs.

The analysis reveals that cultural barriers represent a significant impediment to SC adoption in Southwest China. Resistance to change (AKR4) and a lack of stakeholder experience (AKR5) highlight a need for comprehensive strategies that address ingrained behaviors and knowledge gaps within the construction sector. Findings in this study align with Ametepey et al. (2015) and Tokbolat et al. (2019) asserting the deeply rooted norms and attitudes can impede the diffusion of sustainable practices, even with the presence of regulatory support or financial incentives. Addressing cultural barriers requires sustained efforts to reshape industry perceptions and promote a shared understanding of the value and feasibility of SC. Effective strategies might include construction specific education initiatives, showcasing successful case studies, and fostering

collaborative networks that facilitate knowledge transfer and peer learning (Ametepey et al., 2015; Hwang et al., 2018).

Normative barriers represented by material availability (TIR1), lack of technical expertise (TIR2), and limited R&D support (TIR3), are perceived as less critical compared to regulative and cultural factors. This aligns with the broader concept that technological advancements without cultural and regulative support cannot sustain. The lower scores on SC barriers suggest that construction professionals in Southwest China may view these normative challenges as downstream consequences of more fundamental institutional weaknesses. For instance, a lack of government incentives (regulative barrier) might stifle demand for green building materials, thereby limiting their availability (normative barrier). Similarly, limited awareness and training (cultural barriers) may hinder the development and adoption of sustainable construction techniques, leading to a perceived lack of technical expertise. These normative conditions may also signal a lack of connection between industries, academia, and environmental organizations.

However, the relatively lower scores for normative barriers should not be interpreted as evidence that these issues are unimportant. Rather, it suggests that addressing regulative and cultural barriers may be a prerequisite for unlocking progress on the normative front (Susanti & Juliantina, 2019). For example, implementing clear and consistent regulations that incentivize sustainable building practices could stimulate demand for green materials, encouraging local suppliers to invest in their production. Simultaneously, promoting education and training programs that build expertise in sustainable design and construction could enhance the industry's capacity to effectively utilize these materials and technologies. As the regulatory landscape becomes more supportive and cultural attitudes shift towards greater acceptance of sustainable practices, it is likely that normative barriers will become more salient and require targeted interventions. There is a need to shape industrial attitudes and behaviours towards sustainable construction practices in developing construction industries (Hwang et al., 2018).

3.1 Theoretical Implication

The study extends Institutional Theory in the context of sustainable construction by demonstrating that economic barriers are not merely market constraints but operate as regulative mechanisms embedded within governance and financial institutions. While prior studies often treat cost as an independent deterrent, the findings reveal that financial barriers function as institutional signals that shape risk perception and investment behaviour across the sector. Furthermore, the results suggest a hierarchical interaction among institutional pillars, where persistent regulative weaknesses suppress normative capacity development and reinforce cultural resistance. This refines Institutional Theory by illustrating its dynamic, cascading operation within project-based industries.

In a developing country context, the findings refine Institutional Theory by highlighting the dominance of regulative mechanisms in shaping sustainability outcomes. Unlike mature institutional environments where normative and cultural pillars exert stronger influence, the results suggest that persistent regulatory uncertainty and weak enforcement constrain the emergence of professional norms and shared sustainability values. This indicates that institutional pillars do not evolve in parallel but follow an uneven trajectory in developing construction sectors, where regulative weaknesses delay normative capacity building and cultural internalization. Such asymmetry extends Institutional Theory by emphasizing context sensitive institutional dynamics rather than assuming balanced pillar interaction.

4.0 CONCLUSION

This study examined the sustainable construction barriers in Southwest China. Regulatory barriers were found as key SC barriers, followed by cultural and normative barriers. This study confirms SC adoption in Southwest China face significant regulative impediments particularly weak financial incentives, restricted green finance access, and bureaucratic governance processes as opposed to technical limitations. Through rigorous exploratory and confirmatory factor analyses, this study validated the categorization of SC barriers within the regulative, normative, and cultural pillars of the Institutional Theory.

The findings indicate that sustainable construction decisions are constrained early at the project planning and feasibility stages, where regulatory uncertainty, financing accessibility, and approval timelines shape risk perception. Project managers and developers should therefore treat institutional barriers as strategic project risks rather than external constraints. Integrating regulatory approval risks, incentive eligibility, and financing

conditions into feasibility assessments can improve decision quality and reduce uncertainty when evaluating sustainable alternatives. Early engagement with regulatory authorities and financial institutions may also help align project sustainability objectives with institutional requirements.

From a procurement and delivery perspective, the dominance of regulative barriers suggests that conventional lowest-cost tendering approaches may unintentionally discourage sustainable solutions. Project teams may benefit from adopting value-based or performance-oriented procurement criteria that account for long-term sustainability outcomes alongside upfront costs. In addition, proactive stakeholder engagement particularly with consultants, suppliers, and clients help normalize sustainable practices, reduce resistance to change, and improve coordination across project actors. Collectively, these practices enable construction firms to navigate institutional constraints more effectively while advancing sustainability objectives at the project level.

The quantitative empirical analysis provides a structured model for interpreting SC barriers, highlighting the necessity for coordinated institutional reform. The findings extend Institutional Theory within built environment research, laying the groundwork for future investigations into policy alignment, behavioural change, and systemic transformation in SC. However, the study's geographical focus on Southwest China limits generalizability. While consistent with broader international concerns, the insights may differ in regions with varying regulatory maturity or cultural contexts. Additionally, as a cross-sectional analysis, this study offers a static view of current barriers. Future research should undertake longitudinal or multi country comparative studies to explore how institutional SC barriers evolve and shift across diverse contexts.

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