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Educational Metaverse and SDGs: Bridging Readiness and Equity Gaps in Pakistan's Teacher Education

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Abstract

This study explores the readiness and equity dimensions of Educational Metaverse (EMV) adoption in Pakistan's teacher education sector through an extended UTAUT-SDG framework. As immersive learning technologies gain traction globally, their integration with the Sustainable Development Goals (SDGs), particularly SDG 4 (Quality Education), SDG 5 (Women Participation and Safety), SDG 9 (Innovation and Infrastructure), and SDG 10 (Reduced Inequalities), remains limited in developing contexts. Using a mixed-methods approach, data were collected from four universities in Lahore through surveys and semi-structured interviews to examine institutional readiness, equity barriers, and infrastructural enablers. Quantitative results reveal low readiness and intention to adopt despite strong perceived usefulness. Regression analysis shows that equity barriers significantly suppress adoption intention, while SDG-9 enablers positively influence readiness. Qualitative insights reinforce these patterns, highlighting gaps in XR infrastructure, affordability, accessibility, and women's participation. The study contributes theoretically by localizing UTAUT within an SDG-aligned, equity-sensitive framework and practically by proposing policy and institutional strategies for inclusive EMV adoption. Findings underscore that without systemic readiness and inclusive governance, the metaverse may amplify rather than reduce educational inequalities in Pakistan.

Keywords: educational metaverse, SDG integration, teacher education, institutional readiness, equity barriers

1. Introduction

The integration of immersive technologies into education, particularly the educational metaverse (EMV), is redefining pedagogical innovation worldwide. EMV enables simulation-based training, personalized learning, and collaborative digital experiences, making it a transformative tool in higher

education (Nguyen et al., 2024; Aideed et al., 2025). Its potential is increasingly linked with the Sustainable Development Goals (SDGs), especially SDG 4 (Quality Education), SDG 5 (Women Participation and Safety), SDG 9 (Innovation and Infrastructure), and SDG 10 (Reduced Inequalities), for advancing inclusive and future-ready education systems (Alabidi et al., 2024; Naveed & Gupta, 2023).

In Pakistan, however, EMV adoption in teacher education remains constrained by digital infrastructure gaps, institutional inertia, and socio-cultural inequities, particularly those affecting women and underserved communities (Khalil & Jumani, 2024; Alam et al., 2024). Most global EMV adoption models, such as UTAUT2 and UTAUT-TTF, originate in digitally mature contexts and neglect the systemic readiness and structural inequities prevalent in Global South nations (Maghaydah et al., 2025; Alkhwaldi, 2024). Furthermore, while the SDGs emphasize inclusive, tech-enabled education, there remains a conceptual and empirical disconnect between EMV implementation and SDG integration, particularly in low-resource, policy-fragmented systems like Pakistan's.

This disconnect creates a critical gap in contextualized, equity-sensitive research frameworks. This study addresses that gap by proposing an extended UTAUT-SDG framework, empirically analyzing how institutional readiness and equity influence EMV adoption in Pakistan's teacher education sector. By aligning metaverse integration with the national education reform agenda and SDGs, this research offers both theoretical advancement and practical direction for inclusive digital transformation. Specifically, it investigates (1) the level of institutional readiness for EMV in teacher education, (2) the equity-related barriers, including women participation and urban access, and (3) the development of a conceptual framework for inclusive, SDG-aligned EMV adoption.

EMV is reshaping digital learning ecosystems by offering environments that are immersive, interactive, and deeply personal. It represents a new frontier in pedagogical innovation and technological integration, particularly within higher education worldwide (Alkhwaldi, 2024; Nguyen et al., 2024; Yu, 2024). In Pakistan, however, institutional readiness and the long-term integration of EMV remain underexplored, even as interest in the technology grows (Khalil & Jumani, 2024; Alam et al., 2024). Given EMV's expanding role in advancing the Sustainable Development Goals, especially SDG 4 on Quality Education, it becomes essential to ask sharper questions about local preparedness, systemic capacity, and the barriers that may limit adoption. The Unified Theory of Acceptance and Use of Technology (UTAUT) has become a key framework for understanding how people adopt and engage with digital innovations (Venkatesh et al., 2003).

Researchers have increasingly applied it to contexts such as simulated virtual reality and the metaverse (Aideed et al., 2025; Maghaydah et al., 2025), making it a strong foundation for examining EMV adoption in education. Utaut2 and aspect-based models such as UTAUT-Task Technology Fit (TTF) have increased predictive validity in education contexts, particularly in instances where the behavioural intention meets the perceived utility (Nguyen et al., 2024). However, such models are often developed

in digitally mature economies and may overlook infrastructural and socio-cultural limitations in Global South contexts (Ak et al., 2025; Alkhwaldi, 2024). This study addresses this theoretical gap by integrating structural readiness and equity within an extended UTAUT framework.

Infrastructure emerges as a pivotal determinant of metaverse adoption. Studies confirm that institutional preparedness, including XR-compatible hardware, stable internet, and trained faculty, significantly influences adoption outcomes (Ateş & Polat, 2025; Jafar et al., 2025). However, Pakistani higher education institutions reveal wide disparities in digital infrastructure, budget allocations, and policy directives between public and private universities (Ahmad, Batool & Bhatti, 2024; Alam et al., 2024). These discrepancies are particularly pronounced in teacher education departments, where immersive technology is rarely embedded into curriculum design. National policy, while aligned to SDG 9 (Industry, Innovation and Infrastructure), often lacks clarity in translating digital aspirations into sectoral investments (NEC, 2018; Gautam et al., 2025). This study empirically confirms that without basic technological enablers, positive attitudes toward EMV do not translate into meaningful adoption, a trend echoed in other developing nations (Maghaydah et al., 2025).

Equity is another underrepresented dimension in EMV adoption research. Although metaverse technologies have the potential to democratize learning, they risk amplifying existing inequalities if issues of gender, accessibility, and socio-economic stratification are ignored (Alabidi et al., 2024; Raman et al., 2024). In Pakistan, systemic disparities in bandwidth availability, digital literacy, and device affordability disproportionately affect women and rural learners (Khalil & Jumani, 2024; Naveed & Gupta, 2023). Studies suggest that unless institutional and national policies actively counter these barriers, digital transformation initiatives may remain exclusionary (Joseph, 2023; SDG4 Midterm Review Pakistan, 2023). Our findings, showing equity as a significant barrier, support this argument, suggesting that immersive innovation must be accompanied by targeted access strategies linked to SDG 5 (Women Participation and Safety) and SDG 10 (Reduced Inequalities).

Globally, EMV is shown to enhance simulation-based training, collaborative learning, and interactive pedagogy, all critical for teacher preparation (Aideed et al., 2025; Nguyen et al., 2024). In Pakistan, recent research shows rising enthusiasm among faculty and students for using EMV in microteaching, classroom simulations, and multilingual instructional content (Ahmad, Batool, & Bhatti, 2024; Khalil & Jumani, 2024). However, Joseph (2023) warns that in contexts where pedagogical strategies are outdated and infrastructure weak, such enthusiasm may lead to superficial integration. The study reinforces this point by showing a clear gap between teachers' willingness to use EMV and the level of institutional support they actually receive. It underlines the need for real capacity building and thoughtful pedagogical redesign, not just distributing hardware, if EMV is to meaningfully advance SDG 4.

Policy inertia makes things harder. Pakistan has publicly committed to the SDGs and outlined education priorities under Vision 2025, but the move from broad goals to real progress in immersive digital

learning remains patchy (NEC, 2018; SDG 4 Midterm Review Pakistan, 2023). As Naveed and Gupta (2023) point out, even with the official rhetoric around "digital transformation," technologies like EMV are still missing from teacher education reforms. The findings here reflect that same gap: institutional policies are out of sync with what faculty actually need. This mismatch shows that EMV adoption isn't just a matter of technology or pedagogy it's a governance issue. Real progress will require coordination among ministries, accreditation bodies, and university leadership to align goals, resources, and accountability.

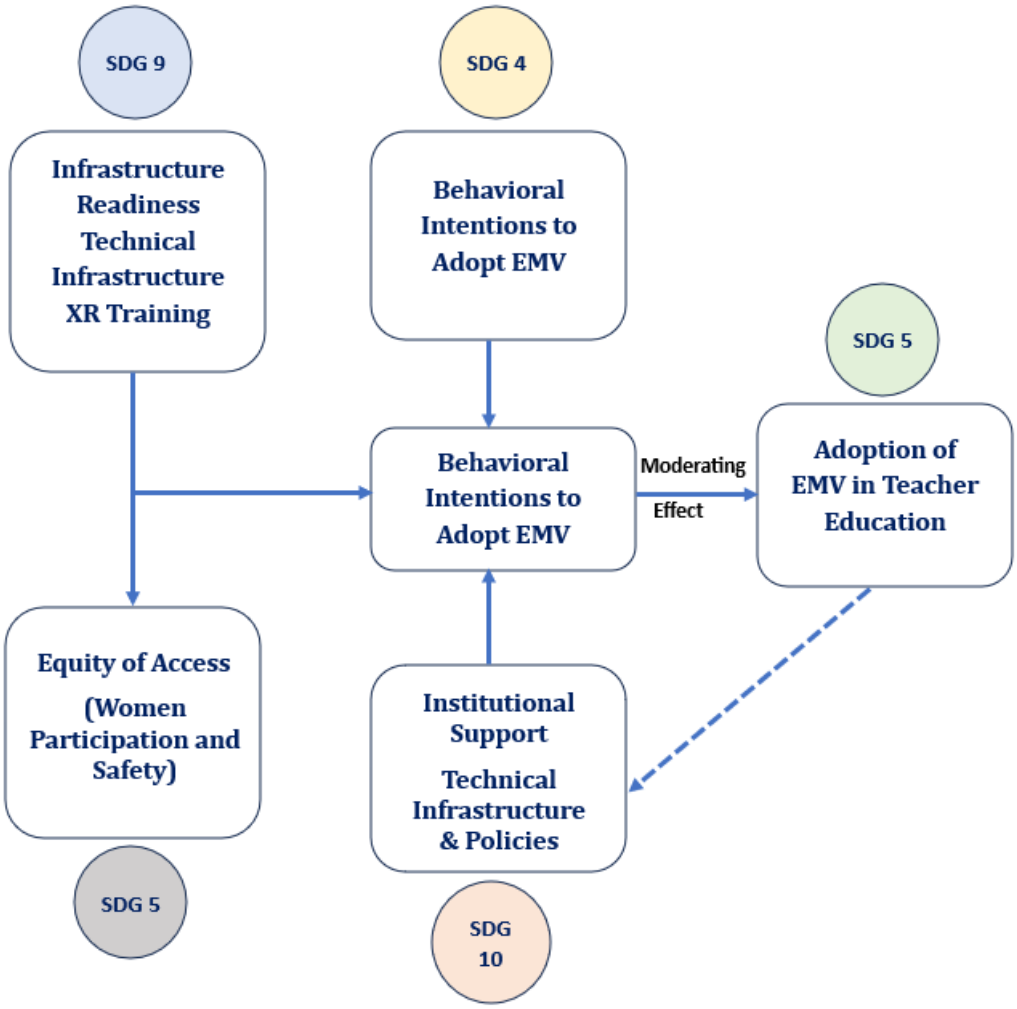
2. Conceptual Framework

This study adopts an extended Unified Theory of Acceptance and Use of Technology (UTAUT) framework, integrating Sustainable Development Goals (SDGs) and contextual variables relevant to teacher education in Pakistan. While UTAUT traditionally focuses on user acceptance factors such as performance expectancy, effort expectancy, and social influence, this study incorporates two additional constructs: infrastructure readiness and equity of access. These are essential in contexts where disparities in technological access and inclusion are prominent.

Aligned with SDG 4 (Quality Education), SDG 5 (Gender Equality), SDG 9 (Industry, Innovation, and Infrastructure), and SDG 10 (Reduced Inequalities), the proposed framework posits that institutional readiness (technical infrastructure, XR training, and digital policy) and equity (gender, economic background, geographic location) significantly influence the behavioral intention to adopt EMV in teacher education. Institutional support mediates readiness and adoption, while equity acts as a moderator from intention to sustained use.

This expanded conceptual model enables deeper analysis of adoption pathways of EMV, incorporating both user-level and systemic variables to ensure SDG-aligned, inclusive digital transformation in developing contexts.

Figure 1: Conceptual Framework for EMV Adoption Aligned with SDGs



3. Methodology

3.1 Research Design

This study employed a mixed-methods, convergent design to examine readiness for educational-metaverse (EMV) adoption in teacher education and its alignment with the Sustainable Development Goals (SDGs) (Creswell & Plano Clark, 2018). A structured survey quantified awareness, readiness, equity barriers, and enabling innovation/infrastructure conditions; semi-structured interviews provided depth on policy, governance, accessibility, and implementation. The design is appropriate for Pakistan's low-adoption, low-evidence context, allowing breadth (quantitative baselines) and depth (stakeholder perspectives) to be integrated RQ-wise and SDG-wise (SDG 4, SDG 5, SDG 10, SDG 9).

3.2 Research Context and Sampling

To bring about diversity in governance and resourcing in urban teacher-education environments, the study was carried out in four universities in Lahore (two public and two privates). Teacher-education departments were contacted since they prepare future teachers and instill institutional standards of technology-enhanced pedagogy. In the case of the survey pre-service teachers were approached through lists of departments and in-class announcement; 125 respondent target provided adequate consistent power to be considered a scale and regression whilst still feasible. In the case of interviews, purposive sampling identified policy and operations informants across roles: deans/directors, teacher educators (faculty) and IT experts at universities. This combination balanced day-to-day realities in the classroom with institutional and technical decision making.

3.3 Instruments and Measures

Two complementary instruments were developed and refined through expert review and a small pilot to ensure clarity, relevance, and explicit alignment with the research questions (RQs), the UTAUT lens (PE, EE, SI, FC, BI), and the SDG framework.

Quantitative Tool (Survey Questionnaire)

The survey measured awareness/readiness, equity barriers, SDG-9 enablers, and perceived SDG contributions using a 5-point Likert scale (*1 = strongly disagree; 5 = strongly agree*).

- Awareness & Readiness (RQ1 → SDG 4): familiarity with VR/AR/XR/AI/avatars; perceived ease of use; institutional support (devices, labs, digital resources); and self-efficacy to integrate immersive pedagogy. Mapped to SDG 4.4 (teacher digital skills) and SDG 4.7 (education for sustainable development).
- Equity Barriers (RQ2 → SDG 5 & SDG 10): five within-urban dimensions, women participation, affordability, accessibility/disability, safety/privacy, and bandwidth/reliability, capturing constraints on participation (e.g., access to shared devices/licenses, availability of accessibility features, privacy-by-design safeguards). Aligned to SDG 5.5/5.b and SDG 10.2/10.3.
- SDG-9 Enablers: Innovation & Infrastructure (RQ1/RQ3 → SDG 9): items on network QoS, XR-ready labs and shared device/license pools, accessibility-by-default procurement, industry/ed-tech partnerships, faculty PD with protected time, and cloud/edge plus security policies. Aligned to SDG 9.1/9.c/9.5; primarily operationalize Facilitating Conditions in UTAUT.
- Perceived Contribution to SDGs (RQ3 → SDG 4/5/10; enabling link to SDG 9): perceived potential of EMV to improve teacher-education quality (SDG 4), support women participation and safety (SDG 5), and reduce inclusion gaps among urban learners (SDG 10), contingent on enabling infrastructure (SDG 9).

Multi-item scales formed composites (higher = more of the construct; for equity, higher = greater barrier, with reverse coding as needed). Internal consistency was assessed via Cronbach's α (target ≥ .70). Construct validity was examined using EFA/CFA; model adequacy followed conventional thresholds (e.g., CFI/TLI ≥ .90, RMSEA/SRMR ≤ .08). Content validity was established through item-level mapping to UTAUT constructs and SDG targets.

Qualitative Tools (Interview Guides)

Four semi-structured guides; Deans/Directors, Teacher Educators, IT Experts, and Metaverse/XR Experts; were designed to complement the survey and avoid duplication across actors (≤14 prompts each). Questions were organized under three themes mirroring the RQs and SDGs: (i) Readiness & Enablers (RQ1; SDG 4/9) covering strategic relevance, faculty capability, XR labs/devices, bandwidth/QoS, procurement, partnerships, and PD; (ii) Equity & Inclusion (RQ2; SDG 5/10) addressing women participation and safety, affordability/subsidy and access to shared resources, accessibility features, and privacy-by-design; and (iii) Policy & Implementation (RQ3; SDG 4/5/9/10) focusing on governance, curriculum alignment, pilot-to-scale pathways, monitoring with equity KPIs, and operational sustainability. This structure ensured that qualitative evidence deepened and explained quantitative patterns while remaining directly traceable to the study's objectives and SDG commitments.

3.4 Data Collection Procedures

Surveys were administered on-site and online. Participants received an information sheet and provided informed consent before participation. Interviews (30-45 minutes) were conducted face-to-face where possible and online as needed; all were audio-recorded with permission and professionally transcribed or carefully note-verified.

3.5 Data Analysis

Quantitative

Descriptive statistics (means, SDs) established baselines for awareness and readiness (RQ1). To explain Behavioral Intention (BI), we estimated a hierarchical regression: Step-1 with UTAUT predictors (PE, EE, FC, SI), Step-2 adding the Equity Barriers composite, and Step-3 adding the SDG-9 Enablers composite. This isolates the incremental effect of equity frictions and enabling infrastructure on intention. Where assumptions were violated, robust SEs were used. Results were reported RQ-wise with focus on SDG implications (where sample size permitted, a confirmatory PLS-SEM/AMOS cross-check of the UTAUT measurement and structural paths was conducted and reported succinctly).

Qualitative

Interview data were analyzed thematically (Braun & Clarke, 2006). An initial codebook was derived from the RQs/SDGs and refined inductively. Two researchers double-coded a subset to stabilize the scheme, reconciled differences through discussion, and applied the final codebook to the corpus. Themes were synthesized by actor group (deans/directors, teacher educators, IT, XR experts) and then integrated RQ-wise to align with the quantitative strand.

3.6 Ethical Considerations

Institutional permission was obtained from researchers' universities. Participation was voluntary, with the right to withdraw at any time. Data were anonymized, stored securely, and used solely for research. Interview quotes are reported without personally identifying details.

3.7 Rigor and Trustworthiness

Credibility was supported through method triangulation, pilot testing of instruments, and member checks with a subset of interviewees to verify interpretations. Dependability and confirmability were strengthened by an audit trail (item mapping, codebook revisions, analytic memos). Transferability is enhanced by thick description of context (urban Lahore teacher-education) and transparent reporting of instruments and analyses.

4. Results

4.1 Research Question 1

Quantitative Analysis

To address Research Question 1, a quantitative analysis was conducted to examine the level of institutional readiness for Educational Metaverse (EMV) adoption in teacher education institutions. The analysis explored four key constructs derived from the extended UTAUT-SDG framework; Performance Expectancy, Effort Expectancy, Institutional Readiness, and Equity Awareness; measured through a five-point Likert scale ranging from 1 to 5.

Table 1: Construct Descriptives and Measurement Quality

Construct (composite)	Mean	SD	A	CR	AVE
Awareness (VR/AR/XR/AI/avatars)	2.20	0.70	0.82	0.84	0.52
Readiness (confidence/institutional support)	2.40	0.80	0.80	0.83	0.50
Performance Expectancy (PE)	3.70	0.80	0.86	0.88	0.59
Effort Expectancy (EE)	2.30	0.70	0.79	0.82	0.51
Facilitating Conditions (FC)	2.10	0.80	0.81	0.85	0.53
Social Influence (SI)	2.40	0.90	0.77	0.80	0.50
Behavioral Intention (BI)	2.50	0.80	0.88	0.90	0.61
Equity Barriers (women-participation, affordability, accessibility/disability, safety/privacy, bandwidth/reliability)	3.25	0.85	0.84	0.86	0.55
SDG-9 Enablers (QoS, XR labs/device pools, accessibility-by-default, partnerships, PD, cloud/security)	2.60	0.80	0.85	0.87	0.57

The measurement model demonstrated robust internal consistency (α, CR ≥ .70) and satisfactory convergent validity (AVE ≥ .50), confirming reliability for inferential analysis.

Descriptive results reveal a clear belief-practice gap in Lahore's teacher education context. Awareness (M = 2.20) and Readiness (M = 2.40) are both below the midpoint, reflecting a pre-adoption stage. Only Performance Expectancy is positive (M = 3.70), indicating recognition of EMV's potential for simulation-based and interactive learning. However, Effort Expectancy (M = 2.30) and Facilitating Conditions (M = 2.10) are low, highlighting concerns about usability, infrastructure, and institutional support, such as device access, connectivity, and technical assistance. Similarly, Social Influence (M = 2.40) is weak, suggesting limited peer or administrative motivation.

Consequently, Behavioral Intention remains below average (M = 2.50): educators value EMV conceptually but lack confidence and institutional support for adoption. Broader systemic variables further explain this hesitation. Equity Barriers are moderate (M = 3.25), encompassing challenges in women's participation, affordability, accessibility, and data safety. Meanwhile, SDG-9 Enablers (M = 2.60), reflecting innovation and infrastructure readiness, remain insufficient, constrained by inconsistent network quality, inadequate XR labs, and fragmented professional development.

These findings reinforce that SDG 4's educational ambitions are undermined by weak support from SDG 9 (infrastructure) and SDG 5 and 10 (equity). Low facilitating conditions and effort expectancy suppress behavioral intention, keeping EMV adoption in an early developmental phase. Variability across institutions (SD ≈ 0.7- 0.9) suggests shared constraints across the sample, underscoring the need for stronger infrastructure, inclusive access, and coordinated policy to move from awareness to active adoption.

Qualitative Analysis

Leaders from teacher education departments in universities perceive educational metaverse as a way to strengthen practice-based teacher education (SDG 4), but they point to missing enablers (SDG 9), i.e. XR-ready labs, reliable bandwidth, device/license pools, and protected PD time. They frame financing and partnerships as first steps, "*Establishing public-private partnerships and securing international grants are essential*." This mix explains high PE but low EE/FC and cautious intention.

Teacher educators (faculty) describe clear pedagogy gains (SDG 4) but express day-to-day use is hard without steady QoS, bookable kits, turnkey accessibility, and coached professional development (SDG 9). One faculty member said "*the immersive technologies let us simulate the real-life teaching contexts, enhancing the curriculum.*" So, value is visible (PE high), but effort and support remain weak (EE/FC low), so intention stays low.

IT teams prioritize network concurrency/QoS, device readiness, and secure, interoperable platforms, which are core SDG 9 levers that make teaching sessions actually run and thus serve SDG 4. As one summary notes, "*enhancing technological infrastructure… involves upgrading the network capabilities and getting suitable hardware*." They add privacy-by-design and monitoring to keep sessions reliable and safe, which lifts FC and makes 'use' feel easier (EE).

4.2 Research Question 2

Quantitative Analysis

To address Research Question 2, quantitative analysis was conducted to evaluate the intensity and distribution of equity-related barriers influencing Educational Metaverse (EMV) adoption. While the first research question established institutional readiness gaps, this stage examines how structural inequities, particularly those affecting women's participation, affordability, accessibility, and digital safety, shape adoption potential in teacher education.

Table 2: Equity Barrier Subscales: Descriptives and Reliability

Equity barrier (subscale)	Mean	SD	A
Women (participation, safety, encouragement)	2.78	0.88	0.76
Affordability (devices, licenses, subsidy)	2.92	0.84	0.82
Accessibility/Disability (captions, alt-I/O, low-spec/WebXR, multilingual)	2.86	0.82	0.80
Safety/Privacy (data protection, avatar/identity, assessment integrity)	2.74	0.91	0.78
Bandwidth/Reliability (latency, uptime, lab congestion/QoS)	2.90	0.89	0.81

The five equity subscales demonstrate strong internal consistency (α = .76 -.82), validating their composite use. Although all means fall below the midpoint (≤ 2.92), indicating that respondents do not perceive severe barriers, variation across dimensions (SD ≈ 0.82-0.91) highlights specific constraints. Affordability (M = 2.92) and Bandwidth/Reliability (M = 2.90) emerge as key challenges, reflecting recurring device and license costs and unstable connectivity that disrupt immersive sessions. Accessibility/Disability (M = 2.86) follows, emphasizing limited captioning, alternative inputs, and multilingual options. These dimensions correspond to SDG 10.2/10.3 (inclusive access) and SDG 9.1/9.c (ICT infrastructure) and align with UTAUT's Facilitating Conditions and Effort Expectancy, explaining modest adoption intentions despite high perceived usefulness.

Safety/Privacy (M = 2.74) and Women's Participation (M = 2.78) register lower but more dispersed scores, indicating concerns about data protection, identity exposure, and unequal confidence in virtual environments. Such issues relate to SDG 5.5/5.6 and SDG 10.3, showing how moderate averages can conceal concentrated inequities. Overall, barriers cluster around cost, connectivity, and accessibility, hallmarks of an early-adoption context. Regression results (Table 3) confirm these factors significantly reduce behavioral intention, reinforcing the need for affordability programs, reliable bandwidth, accessibility-first design, and women-safe participation policies to ensure equitable EMV integration.

Table 3: Hierarchical Regression Predicting Behavioral Intention (BI)

Predictor (standardized)	Step 1 β (95% CI)	P	Step 2 β (95% CI)	P	Step 3 β (95% CI)	P
Performance Expectancy (PE)	+0.41 [0.28, 0.54]	<.001	+0.29 [0.16, 0.42]	<.001	+0.25 [0.12, 0.38]	.000
Effort Expectancy (EE)	+0.06 [-0.05, 0.18]	.27	+0.08 [-0.04, 0.20]	.19	+0.07 [-0.05, 0.19]	.261
Facilitating Conditions (FC)	+0.18 [0.04, 0.32]	.012	+0.11 [-0.02, 0.24]	.083	+0.06 [-0.07, 0.19]	.037
Social Influence (SI)	+0.09 [-0.03, 0.21]	.13	+0.06 [-0.06, 0.18]	.31	+0.04 [-0.08, 0.16]	.051
Equity Barriers (composite)	-	-	−0.34 [-0.47, -0.21]	<.001	−0.28 [-0.41, -0.15]	.000
SDG-9 Enablers (composite)	-	-	-	-	+0.22 [0.07, 0.37]	.004

Model fit:
Step 1 (UTAUT only): R^2 = .38, F(4, ~85) p < .001
Step 2 (+ Equity): R^2 = .47, ΔR^2 = +.09, FΔ p < .001
Step 3 (+ SDG-9): R^2 = .52, ΔR^2 = +.05, FΔ p = .004

The hierarchical model explains a substantial share of variance in Behavioral Intention (BI). With only UTAUT predictors (Step 1), the model accounts for 38% of BI. Adding Equity Barriers increases the variance explained to 47% (ΔR^2 = +.09, p < .001), and incorporating SDG-9 Enablers raises it further

to 52% ($\Delta R^2 = +.05$, $p = .004$). This progression demonstrates that both structural constraints and structural supports make independent, meaningful contributions beyond individual beliefs, exactly as predicted by the SDG-aligned framework.

At the predictor level, Performance Expectancy (PE) remains the strongest positive driver across all steps ($\beta = +.41 \rightarrow +.25$, $p < .001$), showing consistent belief in EMV's teaching potential. However, the decline in its strength suggests that PE's impact materializes fully only when enabling infrastructure exists. Facilitating Conditions (FC) are initially significant ($\beta = +.18$, $p = .012$) but become non-significant once SDG-9 Enablers are introduced, indicating that concrete institutional provisions, such as network quality, device pools, accessibility-by-default procurement, and structured professional development, outweigh generic support perceptions.

Effort Expectancy (EE) and Social Influence (SI) remain insignificant, confirming that in early-adoption contexts, perceived complexity and peer influence are secondary once infrastructure and governance factors are considered. In contrast, Equity Barriers exert a consistent negative effect ($\beta = -.34 \rightarrow -.28$, both $p < .001$), meaning that affordability, accessibility, safety/privacy, and women's participation issues significantly reduce intention even after accounting for other predictors. SDG-9 Enablers show a positive relationship ($\beta = +.22$, $p = .004$), highlighting that innovation and infrastructure capacity actively promote EMV adoption rather than merely supporting it.

Overall, results affirm that belief in EMV's usefulness is necessary but insufficient. Sustainable adoption depends on parallel progress in enabling infrastructure (SDG-9) and inclusive equity practices (SDG-5 and SDG-10), the foundation for achieving SDG-4's quality and equitable digital education goals.

Qualitative Analysis

Leaders framed equity as both a governance and financial challenge, emphasizing that EMV adoption will stall without "supportive policies and a strong ethical framework." They called for explicit safeguards for identity, data use, and assessment integrity to ensure women's and vulnerable groups' participation, reinforcing SDG 5 and 10. Affordability pressures on devices, licenses, and lab upgrades were identified as major barriers, with warnings that access would remain confined to select programs without dedicated funding.

Teacher educators tied equity to everyday feasibility, citing limited device pools, selective scheduling, and unstable Wi-Fi as deterrents. Current pilots were described as "boutique rather than beneficial," reflecting fears of reputational risk from failed sessions (SDG 5/10 → SDG 4). Privacy during avatar-based learning also emerged as a concern, underscoring the need for institutional data-protection policies before scaling.

Technologists interpreted equity through infrastructure and operations, noting that accessibility features are "rarely funded," disadvantaging disabled and multilingual learners (SDG 10). They linked inclusion

to reliable bandwidth, equitable scheduling of shared XR resources, and infrastructure fairness (SDG 9 enabling SDG 4/5/10).

These themes parallel survey findings where affordability and bandwidth were the highest barriers (M≈2.9). Qualitative insights clarify why strong perceived usefulness has not translated into adoption, equity constraints persist until SDG-9 enablers strengthen institutional readiness.

4.3 Research Question 3

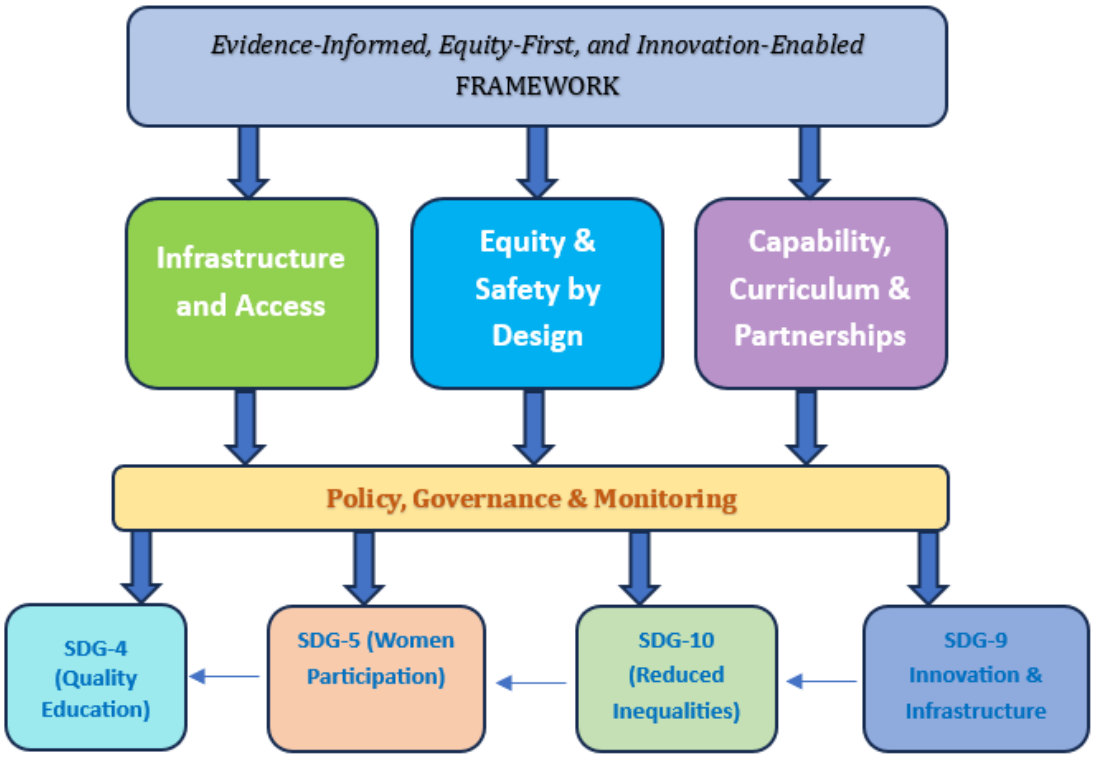
Evidence-Informed, Equity-First, and Innovation-Enabled Framework

Findings from the earlier questions point to a consistent story. Survey results show strong beliefs about usefulness while ease of use and institutional support remain low. Equity constraints are present and the regression indicates that they reduce intention to adopt, whereas innovation and infrastructure conditions increase it and largely account for the generic sense of support. Leaders, faculty, and IT staff say the same in tangible terms in interviews. Expatriates desire device pools with budgets, ownership identity, and validated contracts. Faculty desire a stable access to the lab, a set up with few instructions and brief tutorials. Concurrency on the network, security and interoperability with current learning systems are the stress areas of IT staff. This knowledge base will encourage a framework not only to promote SDG 4 Quality Education and SDG 9 Industry Innovation and Infrastructure, but also to respond to SDG 5 women participation and SDG 10 Reduced Inequalities.

The framework will start with establishment of reliable conditions at the time of live teaching. Schools are supposed to have good connections at all times, fully operational laboratories, shared headsets and licenses that can be booked by all, and integrate freely with the learning platform so that the teacher can implement activities without additional procedures. This establishes a direct connection between these actions and SDG 9 Industry Innovation and Infrastructure and facilitates the changes in perceived usefulness that lead to routine practice in teacher education, regarded as essential in SDG 4 Quality Education.

Every decision should contain equity and be safe. Accessibility features that Procurement needs to require include captions, alternate inputs, low specification options and multilingual interfaces. The cost burden to staff and students can be reduced by shared resources and small subsidies. The principles of privacy by design should address consent, avatar space identity, data protection, and assessment integrity. With a basic participation tracker, it could be understood whether women and students with disabilities are participating and whether a group is being left behind. Such actions promote SDG 5 women participation (meaning gender equality) and SDG 10 Reduced Inequalities and they contribute to ease and support, in turn benefiting SDG 4 Quality Education.

Figure 2: Framework Linking EMV Readiness, Equity, and SDG Alignment



Infrastructure alone isn't enough; it needs to be paired with capability and good governance. Teachers should have access to guided practice: short, focused professional development cycles that include protected time for experimentation. This kind of "coached running" lets them try out immersive lessons that directly connect to program outcomes and assessments. When it comes to implementation, local context matters. Bilingual and locally adapted content often works better than one-size-fits-all global materials. Partnerships with external providers should be formalized, with clear service levels for uptime, updates, helpdesk support, and training. The rollout should start with targeted pilot programs that use equitable scheduling and are evaluated on clear criteria, i.e. cost, engagement, learning impact, and equity. A simple dashboard tracking network performance, usage, gender participation, accessibility compliance, and key learning indicators can help decision-makers make quick, evidence-based adjustments. Taken together, these steps align SDG 9 (Industry, Innovation, and Infrastructure) with SDG 4 (Quality Education), while reinforcing SDG 5 (women participation referring Gender Equality) and SDG 10 (Reduced Inequalities).

5. Conclusion

This study examined the adoption of educational metaverse (EMV) in Pakistan's teacher education sector through an extended UTAUT-SDG framework, revealing critical readiness and equity gaps. While faculty and leadership perceive EMV as valuable for immersive, practice-based learning (high Performance Expectancy), adoption remains low due to deficient infrastructure and equity barriers.

Specifically, enabling conditions under SDG 9; such as network reliability, XR labs, and supported faculty development; weak, preventing the transition from perceived usefulness to actual use. Concurrently, equity frictions, particularly around women's participation, affordability, accessibility, and privacy, undermine inclusion and alignment with SDG 5 and SDG 10.

The research contributes theoretically by adapting the UTAUT framework to a Global South, low-adoption setting and integrating structural and equity considerations. Practically, it proposes a contextualized, SDG-aligned roadmap for EMV implementation that moves beyond attitude-based models toward institutional transformation. This study demonstrates that immersive technologies cannot thrive on enthusiasm alone; systemic preparedness and inclusive design are vital. Without investment in enabling infrastructure and policy safeguards, EMV may reinforce educational divides rather than bridge them. Future research should expand into rural contexts and monitor longitudinal outcomes to build a more holistic, inclusive digital education ecosystem in line with SDG 4.

6. Discussion and Implications

The findings reaffirm that institutional readiness is a prerequisite for effective educational metaverse (EMV) adoption in Pakistan's teacher education sector. Despite enthusiasm for immersive learning, the absence of XR-compatible infrastructure, faculty training, and coherent digital policy continues to hinder sustainable implementation, consistent with evidence from other emerging contexts (Abdulmuhsin et al., 2025; Bhat et al., 2025; Khalil & Jumani, 2024). While global frameworks such as UTAUT and UTAUT2 emphasize behavioral intention and perceived usefulness (Mukred et al., 2025; Al-Sharafi et al., 2024), this study shows that in resource-limited systems, institutional and governance readiness outweigh individual willingness to adopt innovation.

Another general theme that arose was equity issues linked to women's participation and access to digital access. Although this study conducted research in urban universities, the research indicates that there are ongoing gender and geographic disparities in internet transformation in developing countries (Diao and Su, 2025; Rashid, 2025). To incorporate SDG 5 (Women's Participation and Safety) and SDG 10 (Reduced Inequalities) in EMV policy frameworks is thus of utmost importance. Unless implemented inclusively, metaverse projects can contribute to concentrating the differences instead of eliminating them (Al-Adwan et al., 2024; Rehman et al., 2025).

Perversity introduces coherence impediments on EMV development as well. The disconnect between the digital goals of Vision 2025 and the capabilities of higher education institutions to deliver their goals reflects the lack of governance in the rest of the Global South (Abdulmuhsin et al., 2025; Rao, 2024). This paper places adoption of EMV not just as a technological reformation but as a systemic change that would require integration of aligned approaches, financial funding and intersectoral coordination. It makes a theoretical contribution by suggesting a hybrid UTAUT-SDG framework that melds

sustainability and equity in institutional preparedness paradigms, providing an evidence-based standard to guide policymakers on the future of inclusive EMV integration in teacher education.

Conflicts of Interest

Authors declare that they have no conflict of interest.

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Ethics Approval and Informed Consent

The study was conducted in accordance with institutional research guidelines. Participation was voluntary, and informed consent was obtained from all participants.

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Empirical Evidence on the Construct Validity and Reliability of an Instrument Assessing Antecedents to Willingness to Pay a Premium: A Pilot Study

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Abstract

Research on sustainable and green consumption behaviour has been widely studied, including within the Malaysian context. However, there has been limited research on sustainable labelling on packaged food among Malaysian consumers. Therefore, there is a limited questionnaire specifically tailored to this sustainable labelling on packaged food products. A pilot test was carried out to support an investigation into the antecedents of consumers' WTPP for sustainably labelled packaged food. Based on Signaling Theory and Diffusion of Innovation Theory, a conceptual framework comprising six constructs was formulated. In total, 34 questionnaire items were adopted or adapted from prior studies. Responses from 30 working adults were evaluated to assess the measurement instrument. All six constructs used to examine the antecedents of WTPP, Altruistic Concerns (AC), Biospheric Concerns (BC), Egoistic Concerns (EC), Perceived Credibility (PC), Perceived Relative Advantage (PRA), and WTPP, demonstrated strong internal consistency. At this pilot study stage, internal consistency reliability was assessed using Cronbach's alpha and corrected item-total correlations. Their alpha values are 0.899, 0.913, 0.904, 0.901, 0.860, and 0.890, respectively, exceeding the recommended minimum threshold of 0.70. In addition, the corrected item-total correlations for all items were above 0.30, confirming that each item contributes meaningfully to its respective construct and is psychometrically sound. These pilot results indicate the questionnaire items are suitable for use in future research and may offer useful evidence to inform sustainable labelling policies, certification standards, and incentives that promote greener manufacturing among Malaysian producers.

Keywords: environmental concern, perceived credibility, perceived relative advantage, sustainable labelling, willingness to pay a premium

1. Introduction

Rising concerns about climate change in recent years have contributed to the increase in consumer sensitivity towards their purchase decisions (Leggen, 2023). Aligned with "SDG 12: Responsible consumption and Production", consumers are increasingly willing to purchase products that are considered sustainably produced and processed (Lestari & Nita, 2021; Ut-tha et al., 2021; Vicente et al., 2021). Meanwhile, producers are also placing greater emphasis on conveying their sustainability initiatives in the process of development and production of the product (Shahidi Hamedani et al., 2025; Zhang & Yin, 2025). The use of sustainable labelling on product packaging helps consumers to identify the environmentally friendly options, and at the same time, signals the producers' sustainability efforts. However, the certification processes come with additional costs, which are often reflected in the final product prices (Fanasch & Frick, 2020; Singh et al., 2023).

Past research has investigated the willingness to pay a premium for green, eco-friendly, and sustainable products in general (Al Mamun et al., 2018, 2023; Bastounis et al., 2021; Lestari & Nita, 2021; Oesman, 2021; Singh et al., 2023; Wei et al., 2018). Limited research has been done to examine the role of sustainable labels on packaged food products, especially in emerging markets, particularly Malaysia. In the effort to measure the antecedents of Malaysian consumers' WTPP for sustainably labelled packaged food, it is crucial to analyze the validity and reliability of the adopted or adapted research instruments by conducting a pilot study (Khanal & Chhetri, 2024). The validation process includes face validity, content validity, and construct validity, through expert review, pre-testing, and a pilot study to confirm the clarity and contextual relevance of the instruments, thus reducing the measurement errors (Masuwai et al., 2024). Accordingly, the objective of this pilot study is to evaluate the validity and reliability of the adopted and adapted instruments developed to study the antecedents of WTPP for packaged food products with sustainable labels.

Table 1 below provides a summary of the variables adopted and adapted, their reference sources, the corresponding reliability value of the construct, and the Likert-scale format used in the source literature.

Table 1: Summary of variables, their Sources, Reliability Value, Number of adopted and adapted questions, and Likert-scale points

Variable name	Source	Reliability	Number of Adopted & Adapted Questions	Scales
WTPP	Al Mamun et al. (2023)	0.855	4	7-point
	Bhutto et al. (2021)	0.832	1	5-point
	Bushara et al. (2023)	0.715	1	5-point
	Al Mamun et al. (2018)	0.980	1	5-point
	Wei et al. (2018)	0.938	1	7-point
Environmental Concern	Wesley Schultz (2001) in Cruz & Manata (2020)	EC: 0.92	4	7-point
		AC: 0.91	4	7-point
		BC: 0.95	4	7-point
PRA	Stachewicz (2011)	0.870	8	5-point
PC	Moussa & Touzani (2008)	0.847	6	7-point

Adopted and adapted instruments should be reliable and valid for further analysis (Hair et al., 2019). Validity and reliability of the questionnaires are a vital part of quantitative research (Masuwai et al., 2024). To overcome the measurement error, validity and reliability must be established before the commencement of the research (Masuwai et al., 2024). By conducting this pilot study, the empirical result will be able to quantify the measurability of questionnaires, ensuring the questions being asked permit valid inferences to be made.

The constructs on environmental concerns were adopted from Schultz (2001). One example of items on environmental concerns is "I am more concerned about the environmental problems because of the consequences for the people in my country" (Code: AC1). The PC instruments were adapted from Moussa & Touzani (2008). One example of the instrument is "I can rely on the claims made by the sustainable labels on the packaging" (Code: PC1). The PRA instruments were adapted from Stachewicz(2011), bearing questions such as "Choosing packaged food products with a sustainable label allows me to make better choices more quickly" (Code: PRA4). Lastly, the items for WTPP are adapted from a few different authors, namely Al Mamun et al.(2018, 2023), Bhutto et al. (2021), Bushara et al.(2023), and Wei et al. (2018). One example of WTPP questions is "I am willing to pay a higher price for packaged food products with sustainable labels than similar products without sustainable labels." (Code: WTPP 2). The PRA constructs were measured using a five-point Likert Scale, while the rest of the constructs, such as AC, BC, EC, PC, and WTPP, were measured using a seven-point Likert scale, in accordance with the scale format used in the original studies. The survey concluded with items to collect information on sociodemographic information of the respondents.

Content validity and face validity will indicate whether a measurement instrument is truly accurate and represents the construct of interest (Masuwai et al., 2024). It also refers to the degree to which a measure

captures all aspects of a given construct. In this pilot study, content and face validity were initially examined qualitatively through evaluations by subject-matter experts. The expert reviewers were chosen based on pre-defined criteria, including more than twenty years of experience in academia and substantial experience in social research. The selection of two academic experts was based on judgmental sampling. This judgmental sampling approach is appropriate, as the experts were chosen based on their relevant knowledge and subject expertise(Sekaran & Bougie, 2010). The two academic professors evaluated the face and content validity of the questionnaires to ensure that the items were appropriate and sufficiently reflected the intended content. Based on the feedback from the two experts, revisions were made to the questionnaires.

To further assess the face and content validity, a pre-test was conducted. Five relevant respondents, comprising industry experts and academics, were not only chosen to answer the questionnaire but also to check the grammar, spelling, language, content, and sentence construction. The instruments need to be evaluated to ensure they are effective and fit to measure the intended research objectives (Masuwai et al., 2024). Administration of the questionnaire was done by distributing Google Forms. Consents were secured from the industry experts and academics before the review process began. Based on the feedback given, the instruments were refined further to improve clarity and maintain the relevance of the study context.

Following these improvements, the instruments were then distributed to potential respondents as a pilot study. Thirty responses were collected, and the analysis was done quantitatively using Cronbach's alpha for the six constructs to assess the internal consistency of the construct. Based on Table 1, the sources for each instrument were demonstrated in the second column, next to the variable name, as well as the reliability value of adopted or adapted questionnaires, and the scale (in points) used. This pilot study employed a combination of five-point and seven-point scales for two primary reasons. First, to preserve the integrity of the adopted measurement items, the original scale formats were maintained. Second, the mixed scales employed in the questionnaire will reduce respondents' tendency to use repetitive response patterns across all sections of the survey questionnaire, which can artificially inflate covariance due to the measurement method rather than true relationships among variables. This procedural strategy is recommended by Podsakoff et al. (2003) in Cheah et al. (2018) to address common method variance (CMV) in PLS-SEM analysis.

2. Methodology

This pilot study adopted a cross-sectional methodology to examine the variable of interest. Responses from 30 working adults were sampled, which is considered adequate for assessing internal consistency using Cronbach's alpha, item-total correlations, and inter-item correlation analysis (Bujang et al., 2024; Khanal & Chhetri, 2024). Working adults in Malaysia were chosen because they frequently serve as one of the decision makers within households (Qi et al., 2024), thus making them a relevant

demographic to examine their consumption behaviour. As the chosen respondents in this pilot study are aligned with the characteristics of the target population in the main study, the responses are expected to exhibit a high degree of homogeneity with the target population, thereby enhancing the validity and accuracy of the results of this pilot study (Masuwai et al., 2024). SPSS 29.0 was used to analyze the data.

3. Results

3.1 Demographic Characteristics

The demographic analysis of the respondents is presented in Table 2.

Table 2. Demographic Characteristics of Respondents (n = 30)

Variable	Category	Frequency (n)	Percent (%)	Variable	Category	Frequency (n)	Percent (%)
Gender	Male	14	47.0	Household Income (Monthly)	Below RM5,999	12	40.0
	Female	16	53.0		RM6,000-RM11,999	8	27.0
Occupation	Full-time student	7	23.0		RM12,000-RM17,999	7	17.0
	Employee	19	63.0		RM18,000 and above	2	7.0
	Self-employed	3	10.0		Other	3	10.0
	Other	1	3.0	Age Group	18-29 years	15	50.0
Education Level	SPM	1	3.0		30-41 years	6	20.0
	Certificate/ Pre-U	1	3.0		42-53 years	8	27.0
	Diploma/STPM/STAM	8	27.0		54-65 years	1	3.0
	Bachelor's	9	30.0	Ethnicity	Malay	17	57.0
	Master's	8	27.0		Chinese	2	7.0
	Doctorate	3	10.0		Indian	7	23.0
					Other	4	13.0

Table 2 shows that the respondents had an almost equal number between men (47%) and women (53%). Sixty-three percent of the respondents worked in the private sector, while 23 percent were full-time students pursuing tertiary education. Most respondents had tertiary education, where 30% hold bachelor's degrees, 27% hold master's degrees, and 10% hold doctorate degrees. The focus of this study is younger working adult respondents (70% are below 41 years old) with higher education, following the assumption that these respondents are more environmentally conscious and would choose products with eco-labels in their consumption (Alam et al., 2023). This group of respondents is found to exhibit more awareness of sustainability-related matters too (Filho et al., 2024). The result of the household

income shows that 44% of the respondents receive between RM6,000 to RM17,999 monthly. A study by Hamilton et al. (2019) found that higher-income individuals are willing to pay more for products with a sustainable label. Another finding also reinforces the result that consumers prefer products with sustainable labels (Ma et al., 2022). Malays made up 57% of the respondents, followed by 23% Indians, 7% Chinese, and 10% other. The composition reflects Malaysia's diversity and representation of different cultural perspectives in consumption behaviour. As a conclusion, the respondents' demographic categories align with the typical Malaysian family structure, which substantiates the representativeness of the sample.

3.2 Descriptive Statistics

Table 3. Constructs' Descriptive Statistics (n = 30)

Construct	Mean (M)	Standard Deviation (SD)	Scale Type
Altruistic Concern (AC)	5.9833	0.93064	7-point Likert
Biospheric Concern (BC)	5.7583	0.99239	7-point Likert
Egoistic Concern (EC)	5.8917	1.10189	7-point Likert
Perceived Credibility (PC)	5.4167	0.96366	7-point Likert
Perceived Relative Advantage (PRA)	4.0417	0.63681	5-point Likert
Willingness to Pay Premium (WTPP)	4.6875	0.95240	7-point Likert

Table 3 demonstrates descriptive statistics for each of the constructs. Basically, the means for all constructs indicated that the mean for environmental concerns (AC = 5.9833, BC = 5.7583, and EC = 5.8917), perceived credibility (PC = 5.4167), perceived relative advantage (PRA = 4.041), and WTPP (4.6875), are above the mid-point based on the seven-point or five-point Likert scales, which is consistent with findings from the previous literature. (Cruz & Manata, 2020; Singh et al., 2023). The results indicate that most of the respondents perceived sustainability-labelled packaged foods are more environmentally friendly (Minh Vu et al., 2022), relatively better than those without sustainable labels (Hosseinikhah Choshaly, 2019), the labels are credible (Moussa & Touzani, 2008; Singh et al., 2023), and they are willing to pay more for the products (Al Mamun et al., 2018, 2023; Wei et al., 2018).

3.3 Reliability and Instrument Robustness

Cronbach's alpha coefficient is used to measure internal consistency. In social science research, Constructs' internal consistency values above 0.80 are preferable, and values higher than 0.7 are considered acceptable (Nunnally & Bernstein, 1994; Hair et al., 2019). As displayed in Table 4, all constructs indicated values exceeding the 0.70 recommended threshold. BC showed the highest reliability (α=0.913), followed by EC (α=0.904), PC (α=0.901), AC (α=0.899), WTPP (α=0.890), and PRA (α=0.860). These results are consistent with prior studies done on sustainability-related measures

by Moussa and Touzani (2008) and Singh et al. (2023). The findings validate that the instrument developed to assess the antecedents of the WTPP is reliable and suitable for further comprehensive data collection.

Table 4. Constructs' Reliability Statistics (n = 30)

Construct	No. of Items	Cronbach's Alpha (α)	Interpretation
Altruistic Concern (AC)	4	0.899	Good
Biospheric Concern (BC)	4	0.913	Good
Egoistic Concern (EC)	4	0.904	Good
Perceived Credibility (PC)	6	0.901	Good
Perceived Relative Advantage (PRA)	8	0.860	Good
Willingness to Pay Premium (WTPP)	8	0.890	Good

3.3.1 Item-Total Statistics

Willingness to Pay a Premium

Table 5: Item analysis of WTPP (n=30)

Item	Range Inter-Item Correlation	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item - Total Correlation	Cronbach's Alpha if Item Deleted	Action
WTPP1	0.054 – 0.493	32.6333	48.240	0.371	0.909	Retain
WTPP2	0.452 – 0.793	32.7667	45.702	0.739	0.871	Retain
WTPP3	0.271 – 0.719	33.0333	44.033	0.729	0.870	Retain
WTPP4	0.493 – 0.748	32.9333	43.651	0.822	0.862	Retain
WTPP5	0.054 – 0.700	32.8000	47.476	0.548	0.887	Retain
WTPP6	0.362 – 0.748	32.8667	44.395	0.823	0.863	Retain
WTPP7	0.216 – 0.680	32.6667	44.092	0.621	0.882	Retain
WTPP8	0.279 – 0.793	32.8000	43.545	0.796	0.864	Retain

As shown in Table 5, the Cronbach's Alpha if Item Deleted for eight WTPP items range between 0.862 to 0.909, which suggests that all items strengthen the internal consistency and are deemed reliable, as they are well above the cut-off of 0.70 (Hair et al., 2019; Nunnally & Bernstein, 1994). The adjusted item-total correlations for the eight items exceeded the suggested threshold of 0.30, indicating that the items exhibit strong internal consistency (Al Mamun et al., 2023; Ramu et al., 2023). Accordingly, all eight items were retained.

Environmental Concerns

Table 6a: Item analysis of BC (n=30)

Item	Range Inter-Item Correlation	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item - Total Correlation	Cronbach's Alpha if Item Deleted	Action
BC1	0.632 - 0.862	17.4333	8.185	0.788	0.900	Retain
BC2	0.669 – 0.862	17.3333	9.126	0.829	0.877	Retain
BC3	0.632 – 0.910	17.2333	9.564	0.805	0.887	Retain
BC4	0.657 – 0.910	17.1000	9.610	0.813	0.885	Retain

From Table 6a, all corrected items-total correlations for the four BC items were above 0.78, surpassing the 0.30 threshold (Ramu et al., 2023). Each item improved the internal consistency of the BC, with the 'Cronbach's Alpha if Item Deleted' values ranging from 0.877 to 0.900, which were lower than the overall alpha of 0.913 if any of the items were deleted. As a result, the scale demonstrated good reliability, and all four items were kept (Nunnally & Bernstein, 1994; Hair et al., 2019).

Table 6b: Item analysis of EC (n=30)

Item	Range Inter-Item Correlation	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item - Total Correlation	Cronbach's Alpha if Item Deleted	Action
EC1	0.708 – 0.713	17.7667	9.702	0.785	.890	Retain
EC2	0.680 – 0.760	18.0000	11.379	0.794	.873	Retain
EC3	0.708 – 0.760	17.5333	11.775	0.823	.866	Retain
EC4	0.680 – 0.755	17.4000	12.248	0.790	.879	Retain

As indicated in Table 6b, all corrected item–total correlation values were over 0.78, exceeding the suggested minimum cutoff of 0.30 (Ramu et al., 2023) for four EC items. The 'Cronbach's Alpha if Item Deleted' values (ranging from 0.866 to 0.890) confirmed that each item contributed positively to the internal consistency of the scale, as deleting any of the items resulted in a lower than the construct's overall alpha value of 0.904. Therefore, all four items in the EC construct were maintained, as they showed that they are all reliable (Hair et al., 2019; Nunnally & Bernstein, 1994).

Table 6c: Item analysis of AC (n=30)

Item	Range Inter-Item Correlation	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item - Total Correlation	Cronbach's Alpha if Item Deleted	Action
AC1	0.594 – 0.816	18.1667	7.937	0.789	0.864	Retain
AC2	0.536 – 0.816	18.3000	7.390	0.813	0.856	Retain
AC3	0.536 – 0.759	17.5333	9.499	0.688	0.902	Retain
AC4	0.677 – 0.771	17.8000	7.407	0.834	0.847	Retain

As shown in Table 6c, all values for Corrected Item-Total Correlations were above 0.68, exceeding the minimum value of 0.30, which means all items were strong indicators of the overall construct and should be retained (Ramu et al., 2023). The Cronbach's Alpha if Item Deleted values for all four items will be below the overall Cronbach's Alpha of 0.899 for AC, signifying that each item contributes to the construct reliability. Therefore, all four AC items were retained (Hair et al., 2019; Nunnally & Bernstein, 1994).

Perceived Relative Advantage (PRA)

Table 7: Item analysis of PRA (n=30)

Item	Range Inter-Item Correlation	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item - Total Correlation	Cronbach's Alpha if Item Deleted	Action
PRA1	0.046 – 0.724	28.1000	20.507	0.571	0.846	Retain
PRA2	0.086 – 0.626	28.3333	20.437	0.512	0.854	Retain
PRA3	0.328 – 0.761	28.2333	20.047	0.785	0.826	Retain
PRA4	0.315 – 0.631	28.4333	18.737	0.662	0.836	Retain
PRA5	0.252 – 0.529	28.6333	19.895	0.550	0.851	Retain
PRA6	0.329 – 0.761	28.1667	20.075	0.795	0.825	Retain
PRA7	0.086 – 0.711	28.1000	21.197	0.543	0.849	Retain
PRA8	0.046 – 0.711	28.3333	21.264	0.522	0.851	Retain

As demonstrated in Table 7, the Corrected Item Total values range from 0.52 to 0.80, well above the minimum recommended threshold of 0.30 (Ramu et al., 2023). The Cronbach Alpha if_Item Deleted values for the PRA construct range between 0.825 to 0.854, which means that if any item were deleted, it would result in a lower alpha than the construct alpha of 0.860, demonstrating that all items contribute positively to the reliability of the PRA construct. The analysis confirmed that the PRA construct exhibited high internal consistency, justifying the decision to maintain all eight items.

Perceived Credibility (PC)

Examination of Cronbach's alpha in Table 8 revealed that values are between 0.865 and 0.898. Deleting any of the items will reduce the Cronbach alpha value for the PC construct, which is now at 0.901, implying that the removal of any of the items will reduce the reliability of the construct. The Corrected Item-Total Correlations also demonstrate that all items exceed the 0.30 recommended by Ramu et al. (2023). As such, it is confirmed that all items significantly contribute to the internal consistency as well as reliability of the construct.

Table 8: Item analysis of Perceived Credibility (PC) (n=30)

Item	Range Inter-Item Correlation	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item - Total Correlation	Cronbach's Alpha if Item Deleted	Action
PC1	0.498 – 0.779	27.3000	23.114	0.807	0.872	Retain
PC2	0.466 – 0.625	26.9667	25.344	0.668	0.892	Retain
PC3	0.493 – 0.625	27.1000	22.921	0.707	0.888	Retain
PC4	0.466 – 0.605	27.0000	25.034	0.624	0.898	Retain
PC5	0.574 – 0.841	27.0667	22.892	0.852	0.865	Retain
PC6	0.468 – 0.841	27.0667	22.754	0.742	0.882	Retain

4. Discussion

This pilot study's result demonstrates that the adopted and adapted instruments to measure the constructs for broader research on antecedents of WTPP for sustainably labelled food packaged products meet the established reliability standards. All six constructs tested in this pilot study, namely AC, BC, EC, PC, PRA, and WTPP itself, are considered methodologically robust, as they show good internal consistency, ensuring the applicability of the instruments for a larger-scale empirical analysis. The Cronbach alpha value exceeds 0.70 for all constructs, as recommended by Hair et al. (2019). As demonstrated by the lower Cronbach alpha value, if any of the items are removed, it means that deleting any of the items will reduce the strength of the constructs. In addition, the value of Corrected Item-Total Correlations in this pilot study exceeds 0.30, as stated by Ramu et al. (2023). Therefore, it is confirmed that all measurement items need to be maintained, as they are psychometrically sound and fit for use in future empirical research.

5. Conclusion and Recommendation

This pilot study confirms that the adapted and adopted instruments exhibit acceptable reliability and are methodologically robust, as all constructs exhibit Cronbach alpha values above 0.7. This pilot study's result demonstrated that the instruments on the antecedents influencing WTPP for packaged food bearing sustainable labels are fit for broader empirical research. Nevertheless, to further strengthen the feasibility of the instruments, further empirical work is encouraged to validate the items by assessing the content validity index (CVI) of the questionnaire, using confirmatory factor analysis for the items, test-retest reliability, or discriminant validity testing for a stronger scale development. The availability of these empirically validated measurement tools can support the government's formulation of sustainable labelling policy, a third-party certification standard on sustainable labelling, and green

manufacturing incentives aimed at improving the country's competitiveness in the global green economy.

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Conflicts of Interest

Authors declare that they have no conflict of interest in the conduct of this research.

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Ethics Approval and Informed Consent

Participation was voluntary, and informed consent was obtained from all respondents. The study compiled with standard research ethics principles.

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Predictive Influence of Academic Resilience and Its Dimensions on Students' Interest in Learning Biology

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Abstract

Studies, in the 21st century, have revealed that students in secondary schools are constantly confronted with evolving psychological conditions and challenges that influence their learning outcomes. The drive to identify these conditions prompted the study on predictive influence of academic resilience on secondary school students' interest in Biology, applying a predictive correlational research design. 1,198 Secondary School Year 2 (SS2) students, obtained using multistage sampling procedure were the respondents. Two instruments; Academic Resilience Scale (ARS) and Biology Interest Scale (BIS) were employed for data collection. The adapted instruments (ARS and BIS) validated by three experts, when pilot tested, yielded reliability coefficient values of 0.81 and 0.86, established using Cronbach alpha. Data collected were analyzed using simple and multiple linear regression analyses. The findings indicated among others that academic resilience caused 13.8% variance in students' interest in Biology, revealing that academic resilience significantly and positively contributed to students in secondary schools' interest in Biology. On contributions of individual dimensions of academic resilience, it was revealed that all the dimensions of academic resilience, individually and jointly, significantly predicted students' interest in biology, except perseverance which although contributed to students' interest in Biology but the contribution was not statistically significant. Given the findings, it was suggested that education stakeholders should organize orientation programmes, counselling sessions and seminars in schools to educate students on strategies that can be employed to strengthen their resilience in academic settings.

Keywords: academic interest, academic resilience, biology, secondary school students

1. Introduction

Education, in today's modern society, has been recognized as the greatest asset any nation can invest in to bring about development and socio-economic progress in their society. Acknowledging the premise, developing countries like Nigeria has redesigned their school curriculum that students on entrance into the senior secondary school level are exposed to a variety of new subjects, social roles and psychological

conditions, that often at times become overwhelming for them and others. Shafiq et al. (2024) stated that these overwhelming demands of academic life, in efforts to overcome them, can have an impact on oneself and others, causing students to become vulnerable in the face of academic challenges. Recognizing the premise, researchers (Nwuba et al., 2024; Omaka, 2025) in the 21st century, in the quest to identify factors that could be influenced to overcome these demands for academic gains, have emphasized on the need to reposition efforts from environmental factors to student personal factors, given that these individual factors significantly influence enthusiasm, passion, and psychological health, that could help students overcome challenges and stemming demands of academic life, for enhanced learning outcomes. In the course of literature review, the researchers flagged resilience as an individual variable that helps individuals withstand hardships, overcome obstacles, surpass hurdles, and successfully cope with stress and demands, and thus was motivated to ascertain its influence on learning outcomes, when applied in education.

Resilience, in education today, has been identified as a psychological variable that influences learning outcomes, as it explains a person's capacity to develop despite the hardships and challenges, he experiences. In academic context, it refers to the capacity of a learner to cope with negative experiences in a manner that optimizes their potential for resilience and achievement (Ramadhani & Sagita, 2022). Rachmawati et al (2024) opined that academic resilience in students enable transformation of academic difficulties into opportunities for growth and transformation, empowering individuals to overcome feelings of helplessness and become agents of change. As a multifaceted construct, Nandal et al (2021) posited that academic resilience has become a vital tool in education as it implies positive psychosocial skills such as positivity, trust in oneself, self-strength and control, mental evaluation, emotional balance, a willingness to learn, an absence of denial, effective coping techniques, a feeling of direction and the capacity to discover meaning, that influences learning outcomes. Supporting the premise, Alumulla (2024) asserted that academic resilience consists of elements that inspire students to do better; like drive, self-assurance, the capacity to reach objectives, effective stress management, and a feeling of wellbeing. In a more comprehensive and condensed form, Cassidy (2016) classified academic resilience into three core dimensions namely; Perseverance (ability to demonstrate diligence, not give up easily and exhibit persistence when confronted with challenges), reflective and adaptive help-seeking (ability to assess ones strengths, inadequacies and proactively look for support and encouragement from others in order to adjust to different circumstances), and negative affect and emotional response (including anxious feelings, hopes and fears, worry, and the recognition of unfavorable situations that people encounter in their lives), that drive individuals to strive and overcome challenges to achieve their goals. A glance through these attributes of resilience, informs one that the concept is a constructive component that helps people grow in the midst of hardship, bad circumstances, and unforeseen circumstances. In the classroom, Almulla (2024) stated that academic resilience nurtures skills of problem-solving and an eagerness for risk-taking, helping learners in creative and critical thinking, exploration of novel

concepts, and discovery of inventive answers to tough situations. Almulla explained that academic resilience empowers students to tackle problems, stay committed to their learning, build new capabilities, and ultimately add to the growth of a knowledge-centered economy and a thriving tomorrow. Academic resilience are facilitators in any learning activity as the attribute assist learners find relevance in their studies, support learning sustainability, promote personal growth, foster positive emotions, increase academic engagement and enhance understanding of course content (Karabıyık, 2020). Similarly, Bittmann (2021) affirmed that resilience allows students to have improved contentment with their success, get good marks and lastly report stronger desire to continue their education on time. In support of the premise, Amzil (2022) proposed that developing resilience, determination, and efficient stress-management techniques, amidst difficulties, in addition to increasing a learner's odds of succeeding academically also safeguards his/her psychological wellbeing and reduces their susceptibility to psychological crisis, dread of failing, and ultimately decline in a highly competitive world and particularly in efforts to meet the demands of a stressful academic life. Concluding, Mwangi et al (2018) reiterated that academic resilience is key to determining students' success as academic resilient students are naturally driven, upbeat, self-controlled, adaptable, exhibit intentionality toward being solution-focused, practice reciprocity, are resolute, obstinate, and have strong interpersonal abilities.

Recognizing these benefits of academic resilience, interest of education stakeholders has been piqued about the concept, evidently shown by the number of empirical studies conducted by researchers to ascertain the influence of the construct on learning outcomes. For instance, Ojeleye et al (2023) explored the influence of self-esteem and academic resilience on students' academic performance in Federal Polytechnic Kaura-Namoda, Zamfara state, adopting a survey and cross-sectional research design. The study revealed that self-esteem and academic resilience have positive and significant effect on students' academic performance. In another study, Oyoo et al. (2018) investigated the extent to which academic resilience predicts academic burnout among secondary school students in Homa-Bay County, Kenya. The results revealed a statistically significant negative correlation exists between academic resilience and academic burnout. Habib (2019) examined the influence of academic resilience on academic motivation and academic confidence of secondary school students in Kashmir, India, revealing that a positive statistically significant correlation exists between academic resilience and academic motivation as well as between academic resilience and academic confidence of secondary school students. In his study, Karabıyık (2020) explored the interaction between academic resilience and academic achievement in university students in Ankara, Turkey, adopting a cross-sectional survey research design and revealed that positive correlations existed between students GPA and perseverance as well as with reflecting and adaptive help-seeking, while a negative correlation existed between students' GPA and negative affect and emotional response. The multiple regression analysis's findings also showed that the sole significant predictor of GPA was reflecting and adaptive help-seeking. Anosike and Okigbo

(2023), in their study, explored the co-predictive influence of academic resilience and emotional intelligence on secondary school students' performance and attitude in Physics in Enugu State, Nigeria, adopting a predictive correlation research design. The study indicated that academic resilience and emotional intelligence jointly influenced students' attitude towards Physics, but however jointly failed to predict performance of students in Physics among other outcomes. A read through the reviewed empirical reviews confirms the assumption that academic resilience benefits learning outcomes. However, based on available literature, no similar study known to the researcher has been conducted, specifically on students' interest in learning Biology in Anambra State, Nigeria to determine if academic resilience influences students' interest in learning the subject, the rationale behind the study.

Interest, in education, has been identified as one of the psychological traits that influences the instructional process, as it drives one to achieve goals. Jumasih (2023) defined it as a feeling of choice and connection to something or activity, with no one telling you to. In academics, interest is a potent motivating factor that propels education, directing academic and professional paths for success (Mbaegbu et al., 2023). As a powerful source of human motivation, Nwuba et al. (2023) noted that interest is capable of arousing and sustaining concentrated effort, lending credence to the reason why education stakeholders have recognized it as a significant driving element, related with the development and control of behavioral goals, that can influence learning and performance. Interest creates instant awareness, aids focus, curbs disruptions, enhances instructional materials connection, and lowers learning monotony (Triarisanti & Purnawarman, 2019). In learning Biology specifically, interest has been recognized as an important factor that motivates students to learn the subject, taking cognizance of the bulky nature of its curriculum. Obimalume (2021) asserted that interest improves students' involvement in biology lessons and sustain their concentration during classroom teaching, boosting their grasp of the topic and in the long run, enhance academic accomplishment in biology. Supporting the premise, Awosika and Okoli (2023) stressed that considering the cumbersome nature of biology as well as the abstractness and difficulty in remembering its concepts and terminologies, students' interest in the subject is the strongest strength for predicting their academic performance in the subject as interest keeps learners focused, retentive, purposeful, committed as well as collaborate in the learning process, with their peers and teachers. Concluding, Nwafor and Oka (2018) asserted that sparking students' interest in learning biology, is the only way of getting them eager to learn the subject, master its knowledge and techniques better as well as inculcate and enhance in them the scientific spirits and attitudes. Recognizing the contributory influence of students' interest to the learning of Biology and its complex concepts and difficult terminologies, the researchers' interest was piqued to determine factors that could be influenced to help students sustain their interest in the classroom. In the course of literature review, the researchers identified academic resilience as a student construct that can help them overcome academic stress, surmount academic pressure and navigate the excessive demands of

academic life and thus, was motivated to ascertain its predictive influence on interest of students in learning Biology.

2. Research Questions

The following research questions guided the study:

1. Does academic resilience predict secondary school students' interest in biology?
2. Do individual dimensions of academic resilience (perseverance, reflective and adaptive help-seeking, and negative affect and emotional response) predict secondary school students' interest in biology?

3. Hypotheses

1. Academic resilience is not a significant predictor of secondary school students' interest in biology?
2. Individual dimensions of academic resilience (perseverance, reflective and adaptive help-seeking, and negative affect and emotional response) are not significant predictors of secondary school students' interest in biology?

4. Methodology

A predictive research design was employed for the study. A predictive research design, according to Cresswell (2012), is a type of correlational research design that seeks to not only ascertain the relationship, that exists between variables, but also attempts to predict or understand future behavior to identify the independent variable(s) that predict the dependent variable(s). The respondents were 1,198 students, drawn from the 24,102 SS2 students offering Biology in the 265-government owned secondary schools in Anambra state, in the 2024/2025 academic session, using multi-stage sampling procedure. A 30-item Academic Resilience Scale (ARS) adapted from Academic Resilience Scale (ARS-30) developed by Cassidy in 2016.and Biology Interest Scale (BIS) adapted from the original Academic Interest Scale for Adolescents (AISA) developed by Luo et al in 2019, were employed for data collection. ARS and BIS revalidated by experts were subjected to pilot testing to yield a reliability coefficient of 0.81 and 0.86 respectively, estimated using Cronbach Alpha formula. Data collected were analyzed using regression analyses (simple and multiple regression).

5. Results

Research Question One

Does academic resilience predict secondary school students' interest in biology?

Table 1: Prediction of Secondary School Students' Interest in Biology by their Academic Resilience

Model	R	r^2	Adjusted r^2	Unstandardized coefficients (B)	Std. Error
Constant	0.371[a]	0.138	0.137	61.661	
Academic Resilience				0.274	7.513

[a] *Predictors: (Constant), Academic Resilience (AR).*
Dependent Variable: Interest in Biology (IB).

Table 1 data analysis shows an R-value of 0.371 (indicating a moderate positive relationship between AR and IB) and an R^2 (coefficient of determination) value of 0.138. The coefficient of determination (r^2) value obtained reveals that 13.8% variance in students' interest scores in biology is predicted by their academic resilience. Also, the unstandardized coefficient *B* of 0.274 shows that a unit rise in academic resilience, increases students' interest in biology by 27.4%.

Null Hypothesis One

Secondary school students' academic resilience does not significantly predict their interest in biology.

Table 2: Significance of Prediction of Students' Interest in Biology by their Academic Resilience

Model	Sum of Squares	Df	Mean Square	F	P-value	Decision
Regression	10803.969	1	10803.969	191.398	< .001	Sig.
Residual	67511.343	1196	56.448			
Total	78315.312	1197				

Dependent Variable: Interest Score in Biology.
Predictors: Constant, Academic Resilience.

Data in Table 2 reveals that at an F-value (Df 1 and 1196) of 191.398, the Probability value is < .001. Since the Probability value is less than 0.05 alpha levels, the null hypothesis is rejected, indicating that secondary school students' interest in Biology is significantly predicted by their academic resilience. Since academic resilience is a significant predictor of students' interest in Biology, the regression model (Y = a + bx) for the prediction of students' interest score in Biology as obtained from Table 1, where constant is 61.661 and b value is 0.274 is:

$$\mathbf{ISB = 61.661 + 0.274\ (AR)}$$

Where, **ISB** = Interest Score in Biology and **AR** = Academic Resilience Score

Research Question Two

Do individual dimensions of academic resilience (perseverance, reflective and adaptive help-seeking, and negative affect and emotional response) predict secondary school students' interest in biology?

Table 3: Individual Dimensions of Academic Resilience Contributions to Secondary School Students' Interest in Biology

Model	Unstandardized Coefficients		Standardized Coefficients		
	B	SD. Err.	Beta	T	Sig.
(Constant)	62.838	1.189		52.858	.000
Perseverance	.101	.055	.059	1.849	.065
Reflective & Adaptive Help Seeking	.494	.063	.280	7.823	.000
Negative Effect & Emotional Response	.188	.066	.094	2.831	.005

Dependent Variable: Interest Score in Biology.

Data in table 3 shows the standardized beta coefficients that show the predictive correlation between the variables, and the unstandardized B coefficients that indicate the predictive value of the relative contributions of each dimension of academic resilience to students' interest score in Biology. The table reveals that a unit rise in perseverance increases students interest score by 10.1%, a unit rise in reflective and adaptive help-seeking increases interest score by 49.4% and finally, a unit rise in negative effect and emotional response increases interest score by 18.8%. Based on the table, the order of contributions of each dimension of academic resilience to students' interest score in biology from highest to lowest is; Reflective and adaptive help-seeking (49.4%), followed by negative effect and emotional response (18.8%) and lastly, perseverance (10.1%).

Null Hypothesis Two

The relative contributions of the individual dimensions of academic resilience (perseverance, reflective and adaptive help-seeking, and negative affect and emotional response) to secondary school students' interest in biology is not significant.

Table 4: Significance of Prediction of students Interest Score in Biology by the Individual Dimensions of Academic Resilience

Model	Sum of Squares	Df	Mean Square	F	Sig.	Decision
Regression	11225.475	3	3741.825	66.593	< .001	Sig.
Residual	67089.837	1194	56.189			
Total	78315.312	1197				

Dependent Variable: Interest Score in Biology
Predictors: (Constant), Negative Effect & Emotional Response, Perseverance, Reflective & Adaptive Help Seeking.

Result in Table 4 reveals that all the individual dimensions of academic resilience jointly are significant predictors of students' interest scores in biology, since the p-value obtained is less than 0.05 alpha levels, at an F-value (3 and 1194) of 66.593. Further analysis of data contained in table 3 reveals that, individually, perseverance is not a significant predictor of students' interest scores in Biology, since the p-value (0.065) obtained at t-value (3,1194) of 1.849 is greater than 0.05 alpha levels, while reflective and adaptive help-seeking (< .001) and negative effect and emotional response (0.005), on their own, predicted students' interest scores in biology significantly, since their p-values is less than 0.05 level of

significance at t-values (3, 1194) of 7.823 and 2.831 respectively. Thus, the only significant contributors to students' interest scores in biology in the order of significance are reflective and adaptive help-seeking and negative effect and emotional response. However, since all the dimensions of AR jointly predicted students' interest scores in biology significantly, the equation for the regression model ($Y = a + bx_1 + cx_2 + dx_3$) derived from table 3 can be written as:

ISB = 62.838 + 0.101 (P) + 0.494 (RAHS) + 0.188 (NEER)

Where, **ISB** = Interest Scores in Biology**, P** = Perseverance, **RAHS** = Reflective and Adaptive Help Seeking, and **NEER** = Negative Effect and Emotional Response

6. Discussion

The present study's findings revealed that academic resilience positively and significantly predicted Biology students' interest in learning Biology. This positive and significant prediction of Biology students' interest can be linked to the attributes of determination, glee, internal recognition and sense of control, self-motivation, self-confidence, problem-solving skills, assistance from others, as well as having aims and aspirations, associated with academic resilience. Academic resilient students through the dimensions of negative effect and emotional response, perseverance and reflective and adaptive help seeking, learn how to be more tolerant, avoid depression, deal with anxiety and other mental/emotional health issues that may occur during schooling, positively influencing their interest in biology. The present findings accede to that of Oyoo et al (2018) who reported that academic resilience negatively and significantly predicted students' academic burnout, meaning that as student' resilience increases, their academic burnout decreases. Also supporting the current study, is the findings of Habib (2019) who reported that that academic resilience positively and significantly correlated with students' academic motivation and confidence. Dokobe et al's (2024) findings also agree the current study's findings that academic resilience positively and significantly correlated with students' school satisfaction, but however disagrees that the positive correlation is weak and not moderate as reported in the current study.

On the contributions of academic resilience, individual dimensions, to the interest of students in learning Biology, the analyzed results revealed that the three dimensions of academic resilience positively and jointly contributed to students' interest in Biology, significantly. Individually, the findings however revealed that only reflective and adaptive help seeking (RAHS) and negative effect and emotional response (NEER), on their own, were significant predictors, and not perseverance (P). This significant prediction by RAHS and NEER could be linked to their respective attributes of instilling in students the ability to examine their talents, limitations and actively seek guidance and support from others as well as acknowledging and controlling their feelings of anxiety, negative emotions, and optimism-pessimism, that positively influences their interest. The insignificant prediction by P reaffirms the already stated assertion that students may persevere in Biology because of career goals, not necessarily

because of interest. The present findings concur with Chan et al.'s (2022) findings that the dimensions of academic resilience positively and jointly contributed to students' academic motivation. The study however disagrees with Chan et al. on their report that perseverance, individually, also significantly predicted students' academic motivation.

7. Conclusion and Recommendations

The study investigated the predictive influence of academic resilience and its dimensions on school students' interest in learning biology adopting a predictive correlational research design. Given the findings, the study affirmed that social intelligence and its dimensions are positive and significant contributors to school students' interest in Biology, except for perseverance which positively predicted student' interest in Biology although the prediction proved statistically insignificant. The study adds to existing body of knowledge that when academic resilience is fostered through when fostered through sensitization and counselling sessions, significantly enhances students' interest in learning Biology. The following recommendations were made, considering the findings:

1. Periodic trainings, counselling sessions, sensitization and orientation programmes should be organized by school counsellors, for students, to educate them on techniques that can be adopted to foster academic resilience.
2. Biology teachers, during the implementation process, should design classroom instructions to create atmospheres that are collaborative, interactive and friendly enough for students to express their affective learning through healthy emotional expressions.
3. Schools should organize workshops for parents, led by experienced psychologists and counsellors, to counsel them on how to help foster their children's resilience levels at home, as a positive and calming home environment during early childhood can enhance resilience among children in their later lives.

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Conflicts of Interest

The authors declare no conflict of interest.

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Ethics Approval and Informed Consent

Ethical clearance was obtained from the relevant institutional authority. Permission was secured from school authorities, and informed consent was obtained from participants and/or their guardians. Participation was voluntary and confidential.

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Integrating Updated Google Street View and Aerial Imagery to Enhance Buyer Trust and Sustainable Marketing in Malaysian Real Estate

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Abstract

Digital marketing tools have been widely adopted across various industries worldwide, as well as in Malaysia. These tools have enabled Malaysian property developers to obtain real-time insights into purchasers and create a valuable channel for communicating with customers more effectively. Platforms such as iProperty and PropertyGuru, as well as Google Search and Maps, and micro websites that embed virtual tours are the first interactions buyers build with developers. Yet there is often a mismatch between the online information available through the satellite or street view and what real estate agents or developers show. Available Street View and satellite images seen by the public often show outdated representations of projects, which do not necessarily correspond with reality but have had a significant impact on many developments. This inconsistency often undercuts buyer confidence and dilutes the faith in the credibility of developments' digital marketing efforts. The study aims to examine how customized updates of Google Street View and Aerial View photos raise accuracy, transparency, and reliability in Malaysian real estate marketing. Hence, this paper furthermore contains a case study involving the M Legasi Show Village launched recently by Mah Sing Group. According to findings, custom-developed GSV clarifies the project condition as the latest imagery captured and may enhance marketing sustainability by reducing unnecessary printed materials and travel to the site. To summarize the findings, it shows that the updated GSV and AV content offer an elevated level of transparency in marketing and enhance buyer perception within the Malaysian real estate sector.

Keywords: Malaysia, google street view, aerial view, real estate marketing, buyer trust, sustainability

1. Introduction

In Malaysia, property buyers' first impressions usually appear online. Buyers visit Google Maps, Street View, and developer websites to evaluate new projects before visiting the sales galleries in person. When these platforms display outdated images of undeveloped land or missing access roads, it creates confusion, undermines trust, and delays purchase decisions or disappoints residents after handover. Recently, some Malaysian developers have reported repeated buyer complaints about inaccurate maps and incomplete access routes after project handovers. Outdated SVI images result in critical challenges undermining the accuracy and reliability of the project communication between physical development progress and online representation on any platform.

To address this issue, some of the developers learn the lesson on how to have an updated Custom-developed Google Street View (GSV) and Aerial View (AV) imagery to reflect and be align with the project conditions, which won't be lag behind current construction status. Custom-developed GSV imagery allows developers to publish up-to-date visuals directly onto Google Maps through the appointed agency. This study explores how these types of updates improve transparency between buyers and developers, boost marketing credibility, and align with sustainable marketing practices by minimizing travel and printed collateral.

The research provides experimental data from the Fresnel Group's extensive GSV imagery archives, and a case study of M Legasi Show Village offers a peek into the appearance and visual characteristics of the surroundings of the current development, something that is not available in other datasets, which shows that augmenting the models with GSV imagery increases their marketing performance and visitation to their sales gallery.

2. Literature Review

2.1 Google Street View & Aerial View

Google Street View (GSV) is the most well-known and common service providing Street View Imagery all over the world. Google Street View acquires its imagery from two primary sources: Google's own collection efforts and contributions from the public. Google uses specialized equipment and vehicles to capture imagery on a massive scale (Anguelov et al., 2010). Since its launch in 2007, Google Street View reached coverage of more than 100 countries, expanding also into indoor spaces. Street View has been used for research in fields like urban analytics and geographic information science, and is associated with many other research projects on different topics. On the other hand, there is another method of contribution, which is by appointed third-party exclusive partners or public contributions (User-Generated Content). By combining these methods, Google can provide a virtual representation of surroundings on a universal scale.

Somehow, the update frequency varies by many factors, such as the following list:

- Urban Areas or Major Cities: Expect more frequent updates, often yearly or every couple of years, as these areas are high-priority.
- Rural or Less Populated Areas: These areas can see much longer gaps between updates, sometimes three years or even longer.
- Traffic & Big Changes: Google focuses on areas with significant new developments or high user interest.
- Driver or Vendor Schedules: Updates rely on Google's Street View cars (or third-party providers) driving the streets, so timing isn't fixed.
- Country Policies: Local regulations can affect how often imagery is captured.

2.2 Related Works

Nowadays, Augmented Reality (AR) & Virtual Reality (VR) technologies are broadly used in creative marketing and recent studies have highlighted the growing usage of AR technologies in marketing innovation (Mitrovic et al., 2021). In marketing techniques, either AR or VR helps companies in related fields to stand out by providing unique ways to offer their property or products (Biljecki & Ito, 2021). Exclusive marketing practices tend to make potential buyers feel more interested in the promotions, which directly improves the marketing strategy of the company (Naik et al., 2014). The implementation of AR or VR in the marketing process is a form of innovation that will continue to grow in the future. Sales & marketing communication among the property development industry is based on several theories and models which explain a series of steps that prospective buyers go through, such as social media and online promotions as the first contact point, and how it affects buyers' decision-making in purchasing products, and second step make a physical appointment to visit the sales gallery for further more comprehensive details. For instance, (Rehman et al., 2014; Wijaya, 2012) discussed several response hierarchy models. Regardless of differences between these response hierarchy models, it shares a common idea on the buyer's behavior with marketing promotions, which could be streamlined into three main behavioral phases, such as cognitive-affective-conative (C-A-C). Cognitive refers to a mental activity that reflects personal thought about the aspect of their world, while affective is defined as the degree of feeling and emotion, and lastly, conative is related to intention to perform behavior (Wijaya, 2012). Since our study is more behavioral, we can separate it from some other recent studies from Naik et al. (Naik et al., 2014; Liu et al., 2017; Law et al., 2017), who have begun to leverage the availability of large-scale street image data to extract urban knowledge. For example, both (Liu et al., 2017; Law et al., 2017) used machine vision techniques to retrieve geographical knowledge such as street frontage quality. In contrast, Naik et al. (Naik et al., 2014) used Street View images to estimate the perceived safety of streets. However, to our best knowledge in the real estate context, there are either limited studies or none that investigate whether outdated SVI can change the trust and the influence of

the house buyers, as accuracy, transparency, and credibility will be questioned. We suggest that more studies need to propose and compare outdated SVI with the customized GSV & AV of the same project to understand the increase in buyer interest and their response to the promotional materials.

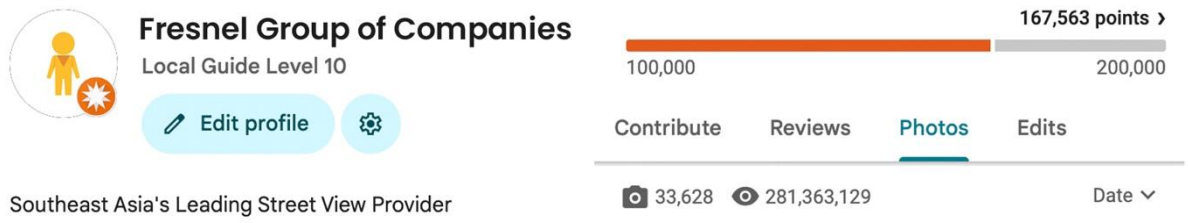
2.3 Real Estate and Buyer Perception

AR & VR technology makes the process of buying and selling property more innovative. The implementation of augmented reality and virtual reality in the real estate sector is a revolution that makes it easier for buyers and sales agents to carry out the process of buying and selling property (Parman et al., 2023). Property's online marketing has gained a strong momentum, and respectfully buyer's trust is significantly influenced by that. When potential buyers encounter outdated conditions through Street View or satellite imagery, they may view developers' advertisements as unreliable (Biljecki & Ito, 2021). A few detailed examples of studies follow. For example, Malaysian studies confirm that online visuals play a key role in shaping emotional connection and purchase intention (Low et al., 2020; Law et al., 2017) is another example of a study where GSV imagery is used in combination with other data (e.g., housing attributes) to predict house prices. The traditionally used housing attributes, such as location accessibility, explain most of the variance of house prices, but augmenting or superimposing the actual models or 3D models with imagery increases their performance. Accurate GSV or AV imagery helps buyers to imagine accessibility, nearby amenities, and environmental quality, or even the view of the house balcony, all of which affect their sense of confidence. Outdated imagery of the urban or rural areas from Google Street View reduces marketing efforts by representing conditions that do not align with the current developments and promotions of developers. Prospective buyers encountering empty lots or absent road connections frequently doubt the validity of timelines for projects and commitments regarding infrastructure. Companies like OSK Property have faced buyer confusion for Iringan Bayu Phase 12 project when certain road names or recently constructed neighborhoods were not visible on Google Maps, resulting in numerous inquiries and negative feedback from new home purchasers. These discrepancies underscore the necessity for a more proactive strategy in managing GSV imagery.

2.4 Custom-developed GSV Imagery as a Trust-Building Tool

According to data from Fresnel Group (2025), since 2015, overall 33,602 images associated with 1,357 projects led to a total of 281,258,265 views (Fig. 1). We find this interest highlights how visual precision influences buyer engagement and information seeking. By incorporating customized GSV and AV of the recent situation from the project at the job site, developers can keep their online presence aligned with the real-world construction activity. The enhanced images can improve accuracy and the trust level of the stakeholders.

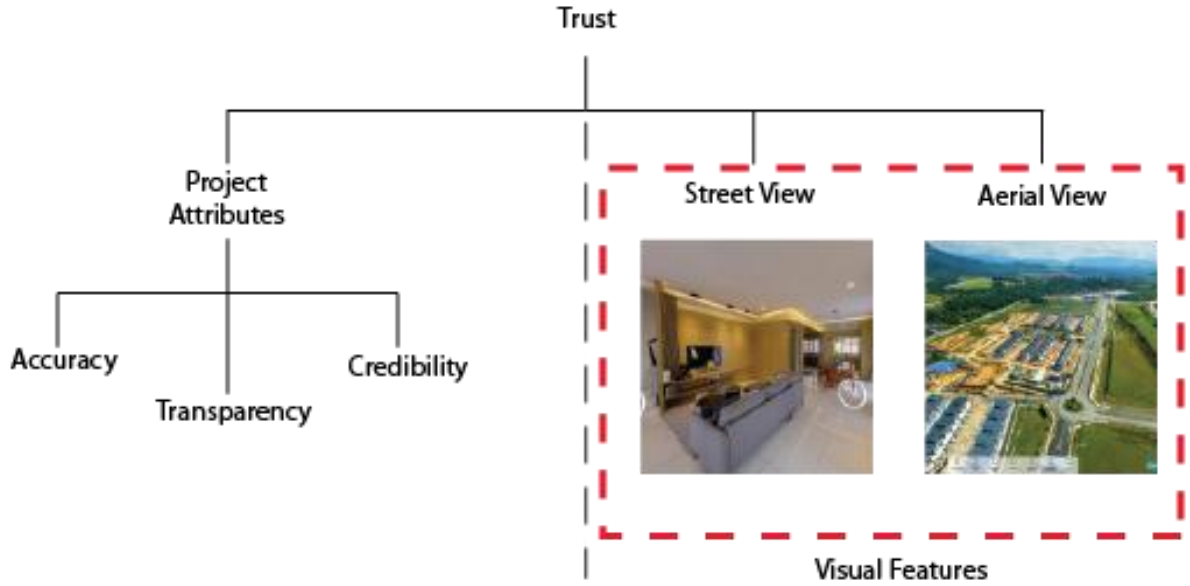
Fig. 1. Data from Fresnel Group since 2015



2.5 Conceptual Framework

The conceptual framework explains how customized GSV and 360 AV augmented imagery may influence the way buyers perceive and respond to the new property promotion and the future development itself. When digital visuals closely reflect what is actually happening on the ground or how the future development may look like at the site location, buyers gain more understanding and confident of the project details such as the building design, masterplan of the facility area, and the layout plan of the units, as well as the surroundings and amenities, and the distance to the project. These clearer visual supports accuracy, transparency, and credibility factors more among the genuine buyers. In practical terms, the availability and easy access to the VR or AR of the project will enable potential buyers to independently cross-check information and data provided by developers through their marketing channels or GSV feature from either their sales gallery or job site location through Google search, which will assist in reducing information asymmetry in real estate marketing collateral. When accuracy and transparency contribute together, they play an important role in establishing credibility (Azmi et al., 2021). As these factors are aligned, buyers generally shows more higher level of trust, and they feel more confident when considering long-term purchasing decisions. In this sense, customized GSV and AV imagery serve more than a promotional purpose: they operate first as strong marketing tools and secondly to boost buyer confidence and enable faster decision-making within the Malaysian property market.

Figure 2. Conceptual Framework



Conceptual Framework showing how GSV and AV imagery as Visual Features shape buyer trust over the project attributes, for more long-term decision making through the accuracy, transparency, and credibility.

3. Methodology

This research employs an exploratory single-case study design approach, incorporating content analysis of imagery from Google Maps along with performance analytics obtained from the Fresnel Group (2025) dataset.

3.1 Case Selection: M Legasi Show Village

The M Legasi Show Village, a development by Mah Sing Group, is located in Semenyih, Selangor. In early 2025, based on Google Maps imagery showed the location of the site as a thick forest (Figure 3), even though clearing of the land and partial construction were ongoing. On June 9, 2025, Fresnel Group published an updated 360-degree aerial view photo of the area on Google Maps, which marked the boundaries of the land and highlighted all the nearby amenities for future development (Figure 4). Within a few months of sample collection update, the project achieved 14,291 views organically on Google Maps, reflecting increased visibility and more viewer engagement (Figure 5).

Figure 3. Satellite Imagery

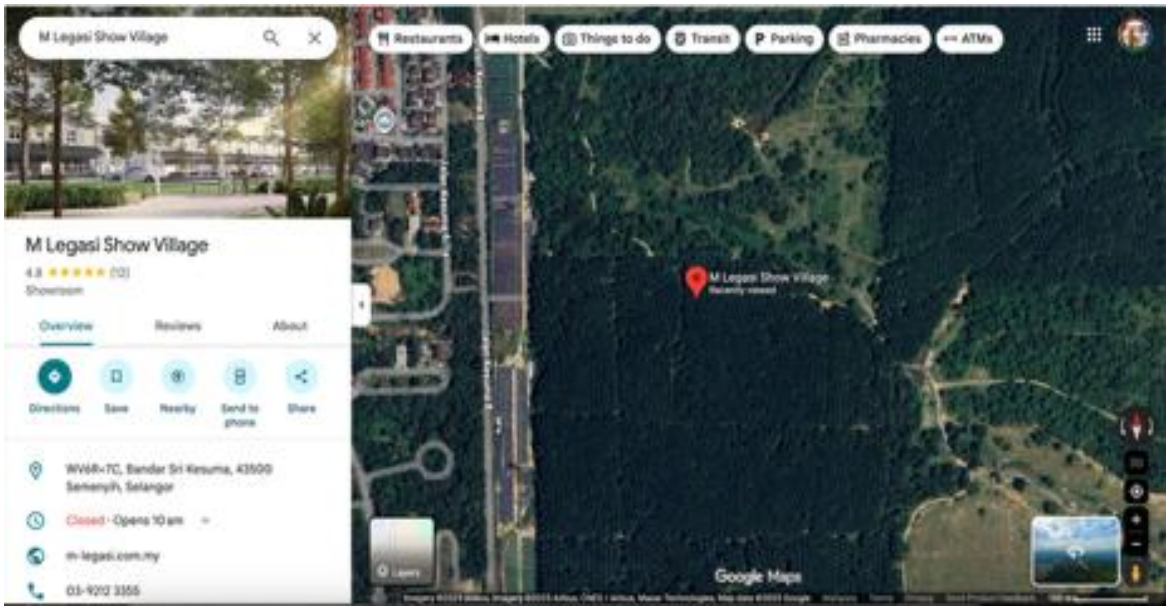
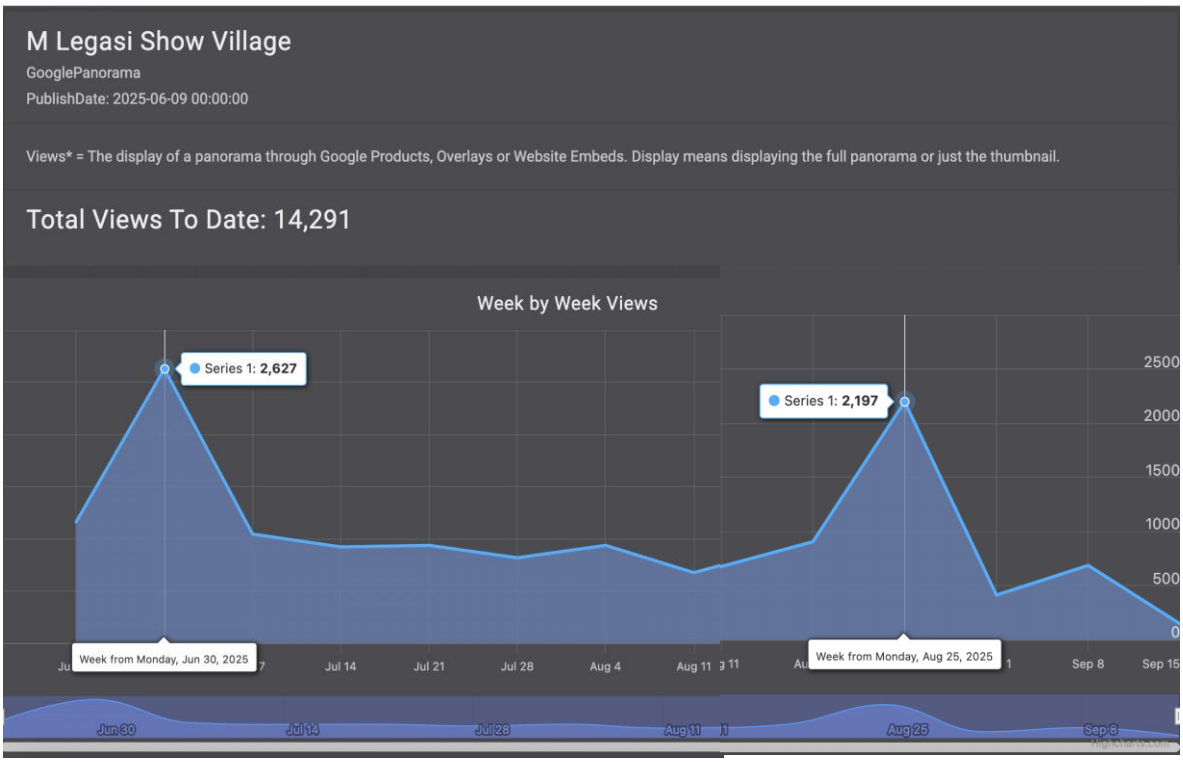


Figure 4. Customised Aerial Drone Imagery

Figure 5. The analysis shows viewer engagement through updated 360° imagery



3.2 Data Sources and Analysis

This research relies on primary data taken from Fresnel's (2025) internal analytics, including total published photos, view counts, and the total number of projects published in Google Maps. To support this data's, secondary sources of data were reviewed from other developers' case studies and findings from earlier research (Biljecki & Ito, 2021; Azmi et al., 2021; Low et al., 2020). The analysis reveals a pattern of interactions between viewers and potential buyers through customized GSV and 360-degree AV imagery across three main dimensions:

- Accuracy: the correspondence between real-world conditions and online images.
- Transparency: the clarity in representing infrastructure and accessibility.
- Credibility: buyer engagement assessed through Google Maps view statistics and feedback from developers.

4. Findings and Discussion

This study examined how the response to updated and customized GSV & 360-degree AV imagery related to purchase intention within the property sector. Analysis of Fresnel Group's (2025) internal data reveals mixed yet meaningful patterns. One consistent finding across the case study confirms that outdated imagery from SVI & Satellite view creates tangible communication barriers between developers, property agents, and potential buyers. When buyers encounter inconsistency between the

digital presentation and the physical site condition, trust declines. Fresnel's data (2025) further shows that updated GSV & 360-degree AV imagery generates a higher level of engagement. On the other hand, developers also reported lower post-handover complaints related to unknown or unclear roads and access routes after they intended to update the new roads prior to project handover to the buyers.

Updated imagery also contributes indirectly to sustainability outcomes. Accurate digital walkthroughs reduce the need for repeated in-person visits and help to minimize the travel frequency and marketing waste, such as scale models, ID design mock-ups, and decorative items that are solely used for promotional purposes.

5. Conclusion

The findings of this exploratory case study explore the influence of updated and customized GSV & 360-degree AV on purchase intention within the property industry by increasing the trust factor and have several implications for digitalization in real estate marketing and sustainability. Beyond marketing effectiveness, the findings also suggest wider implications for sustainable marketing practices. With a substantial portion of the global population now covered by Street View imagery, such platforms represent an increasingly important digital infrastructure for remote exploration (Goel et al., 2018). Prior research has shown that virtual visual audits can partially substitute for physical site visits, particularly during early-stage evaluation and information-seeking processes (Badland et al., 2010; Berland & Lange, 2017). In this context, customized GSV and aerial imagery may support more resource-efficient marketing by reducing the need for repeated in-person visits and lowering reliance on printed promotional materials. Customized GSV and 360-degree AV updates, particularly when integrated and published with the augmented items into Google Maps, allow developers to control the accuracy, transparency, liability, and timeliness of their project representation. The evidence from the Fresnel Group and the *M Legasi* case suggests that such updates substantially improve digital marketing credibility and sustainability communication. Such implications align with Malaysia's broader sustainability and digitalisation objectives, including efforts to promote more efficient use of resources and digital alternatives to physical processes (Ministry of Economy Malaysia, 2023). Future studies could extend this analysis using buyer surveys to quantify how accurate imagery influences decision confidence.

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Conflict of Interest

The corresponding author is affiliated with the company that provided access to project data used in this study. The authors declare that the analysis and interpretation of data were conducted independently and without commercial influence.

The data used in this study are derived from internal company records and marketing materials. Due to commercial sensitivity, the dataset is not publicly available but may be provided upon reasonable request subject to company approval.

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Ethics Approval and Informed Consent

This study did not involve human participants, personal identifiable information, or sensitive data requiring institutional ethical approval.

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Cultivating Sustainable Motivation to Learn in Rural Students: Teachers' Strategies for Long-Term Educational Empowerment

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Abstract

This study examines the motivational strategies employed by rural secondary school teachers to foster students' motivation to learn. This study substantiates the findings from rural public secondary schools in the province of Punjab, Pakistan. Data were taken from four science subject secondary school teachers through a snowball sampling technique. The present study's findings corroborate the research questions that seven motivational strategies make learning fascinating, thereby cultivating motivation to learn. Moreover, the strategies, mainly life inspiration and encouragement, were being used as a crucial tool to cultivate motivation to learn and motivate students for higher education. The present study contributes to the cultivation of motivation to learn by elaborating motivational strategies used by rural teachers to enrich the motivation to learn in the life endeavors of rural students.

Keywords: learning motivation, motivational strategies, cultivation of motivation, rural education

1. Introduction

In Pakistan, the literacy rate of the overall rural population is 51%. The growth in literacy is at a slow pace compared to the growth of the urban population, according to the Ministry of Federal Education and Professional Training, Government of Pakistan. According to the National Education Policy 2017 of Pakistan, only 27% of adolescents in the Punjab province are enrolled in secondary classes (Ministry of Federal Education and Professional Training). In Pakistan, the bulk of the illiterates are born poor and live in underdeveloped and far-flung rural areas and urban slums. The majority of the illiterates are women. Hence, motivation to learn can remove illiteracy, which is more pronounced among peasants, laborers, ethnic, linguistic, religious minorities, nomads, disabled people, prisoners, etc. It is not poverty in some pockets of the country but illiteracy and demotivation to learn, specifically among rural students. Hence, motivation can overcome the illiteracy of new generations.

Teachers play a remarkable role in attracting adolescents to embrace themselves with education. Engagement in Education does not only increase subject matter learning; however, it also promises

erudition. Motivation is the ignition to start the learning process, and even it sustain learning of those who are already in the process to cope with the hardships while learning (Palmer, 2009).

A key source of motivation to learn is a teacher who cultivates or suppresses a student's learning interest. Highly motivated students were discovered to have a higher interest in learning than those who have a lower motivation. Teachers design learning activities according to the students' internal interest to foster intrinsic motivation, and consequently, extrinsic motivation comes in the form of outcome (Vibulphol, 2016). The outcome could be a prize and/or distinguished academic achievement.

"Amotivation" is another state of motivation; in this situation, a student lacks learning activities and does not feel excited for the meaningful learning activities and efforts (Vibulphol, 2016). The effects of motivation yield are different from the learning of students. Students with a high degree of intrinsic motivation are better process-oriented (Garn & Jolly, 2014), and more persistent for self-development and learning, compared to the low level of intrinsic motivation. Ultimately, they become better learners. On the other hand, external motivation serves as a springboard when educational learning activities are not gratifying and intriguing novelties. By designing the learning activities, teachers can engage students in learning by pointing out the significant role of the activity in their real-life and linking it with their interests and goals. Consequently, students with high amotivation engage themselves in learning (Noels, Pelletier, Clément, & Vallerand, 2000). However, the question is how to put these subjects into practice primarily in the rural context, where awareness about education's importance is dissatisfied.

The games and activities help students learn the stuff, mainly complicated subject matters, effectively and simply. Game-based learning has a positive effect and relationship with students' learning achievement (So & Seo, 2018; Sung, Chang, & Liu, 2016). Such learning games and activities are beneficial to form constructive competitions among students. Students learn to deal with challenges, cooperation, teamwork by helping each other. Hayat, Hasan, Ali, and Kaleem (2017) stated that the activity-based learning process enhances critical thinking, logical reasoning, self-direction, and cooperation among the students.

Thusly, the teachers can reinforce students to positively develop their skills and knowledge, uplifting students' academic achievements. Good grades in group activities, admiration, and prizes come under the positive reinforcement, and ignorance of nasty occurring accounts for the negative, however pleasant reinforcement (Slavin, 2019). The positive reinforcement should be preferable over the negative reinforcement, particularly praising words that cultivate learning motivation and increase students' academic achievements.

Constructive class competitions in an achievement orientation environment stimulate winning aspiration and uplift the performance. Improperly planned class or/and overall school competitions may provoke jealousy and conflict among the students. Therefore, well organized and fair competitions add spirit and motivation to win as individuals and teams.

Teamwork develops a sense of collaboration for common goals' achievement and mutual learning. It spurs the confidence of students, mainly when students are creative. The creativity motivates students to take an interest in new concept learning and idea-sharing. To learn and explain the same concept or lesson in a new way is an advantage of novelty, which fosters knowledge expansion passion for a successful future (Liu, Horton, Olmanson, & Toprac, 2011; Moos & Honkomp, 2011; Stipek, 2002).

Fewer teachers encompass collaboration for common learning goals' accomplishment as a learning strategy to enhance motivation and add interest to learning. Educational learning components are sociocultural factors, constructivist, and learner-centered (Bonk & King, 2012). Explicitly, it is a process that maximizes the success, performance and brightens the future of individuals and teams.

Environment and Methodology are the central sources of collaborative learning that cultivate novelty and talent. These central sources incorporate teachers' and students' relationships, face to face conversations and debates, teamwork and consultation, group study, projects, and more. In simple words, collaborative learning gives the sense of responsibility, performance, and academic achievement multiplication of an individual and a team. Likewise, it adds motivation and passion for learning. Teacher and student interaction, community, and school culture and context dramatically influence the learning passion and motivation of students in and outside class experiences. Specifically, in the rural context, student motivation is a shared obligation of parents, teachers, community, and more; however, teachers have direct significant and inspirational affiliation with student motivation. Therefore, a dire need to explore comprehensively motivational strategies used by rural teachers to cultivate motivation to learn in the students is required.

Abbas and Khurshid (2013) reported the impact of motivational techniques employed by primary school teachers, on student academic achievements of five male and five female primary schools of Islamabad, Pakistan. Fifty male and fifty female teachers participated in the research. Stratified sampling was adopted to approach the teachers: eleven multiple-choice and twelve open-ended questions comprised 21 items of a positive reinforcement questionnaire. Furthermore, B-Ed training, the grade of a teacher, demographics, and income level were accounted for as questionnaire indicators. Findings depict that high academic qualified teachers mostly used positive reinforcement strategies compared to B-Ed training program holders. Knowledge grading strategy was likely to be used by those teachers who had a high percentage in results rivaling to the lowers. Moreover, federal teachers were habituated to adopt negative reinforcement as a motivational strategy contrasting to others.

Hardre, Sullivan, and Roberts (2008) verified effective motivational strategies employed by secondary teachers of public high schools of U.S.A. southwestern rural states. The data was generated through mixed methods in two years. A total of 75 teachers and 625 students participated in the survey. Likewise, 66 teachers appeared in interview sessions from 19 rural schools. The study blended the perspective of students and teachers of the same rural high schools. A particular study finding was that rural students' motivation is a shared responsibility of the society and community. The study suggested

the most successful strategies informed by both teachers and students, i.e., (a) support for learning and future goals; (b) establish the relevance of the content, connecting it to students' interests; (c) treat students as uniquely valued individuals; and (d) foster student valuing and perceived competence.

Whether these studies and other related studies conducted on learning motivation, generally reported the relationship and/or effects of teacher motivational strategies on student learning. Moreover, they were conducted in different contexts and/or level. Notably, prior researches ignore the cultivation of motivation to learn in the rural educational context. Thus, it is unclear from the previous studies to understand the cultivation of motivation to learn in students by rural education, which serves as a critical gap in knowledge.

In response to this dire need, this study was conducted to explore the cultivation of motivation to learn under rural education. The strategies used to cultivate motivation present a new perspective to cultivate and enhance the motivation in rural adolescent students to learn, including in what ways teachers can cultivate motivation to learn in rural students.

2. Materials and Methods

2.1 Study Design

A phenomenology research approach was used in this study. This study design suggests the understanding of phenomenon exclusive experience and viewpoints of study participants. The phenomenological study reflects the perception and experience of participants on phenomena in certain situations. (Lester, 1999; Van Manen, 2016). Therefore, this research design was enormously fine to approach the study aim.

2.2 Ethics

As for ethics, the pseudonyms were used for all four participants' place of their real names (Table 1). The pseudonyms ensured personal privacy. Data encryption tackled information privacy encompasses audio recording and transcribes. Additionally, the participants voluntarily took part in the present study; they were free to withdraw their viewpoints at any stage of the present study before write-up; all the collected and generated information, including an analysis of the extracts, were used only for the academic purpose.

2.3 Participants

A sample of four rural secondary school science teachers was drawn through a snowball technique, and this investigation is centered on four rural teachers' experiences and viewpoints. The first teacher, "Teacher A," was pointed out two further participants. They had served in the rural public secondary

schools as science subject teachers. The snowball sampling procedure was adopted to get the pure viewpoint of rural teachers and to follow the present study purpose. Teacher A helped voluntarily to recruit two more rural SST teachers, and Teacher B provided the contact detail of his colleague who also had served as a rural SST in a rural secondary school. All the four study participants had served earlier from 3 to 4.5 years as SST in different rural public secondary schools of the Lahore region in the province of Punjab, Pakistan.

Table 1. Teacher Pseudonyms

Teacher	Pseudonyms
First Teacher	Teacher A
Second Teacher	Teacher B
Third Teacher	Teacher C
Fourth Teacher	Teacher D

2.4 Instrument

A semi-structured interview guide was used to collect the data. The interview guideline is as follow; (i) teaching to rural kids is not an easy task, how did you motivate your students, (ii) what techniques you were using to develop their interest in learning, and (iii) if a student is not performing well then how do you tackle and motivate him. The interview guide was checked by two senior professors of the faculty and three doctoral candidates. After their comments and recommendations, the guide's final version was edited accordingly, and later used in the study.

2.5 Data collection

All four interviews were conducted through WhatsApp/Skype during May 2020, and all interview sessions were recorded with the interviewees' permission. During sessions, key points were noted by the author. There was no time limit set for interviews. However, each interview session took fifty to ninety minutes.

2.6 Analysis

All recorded interviews were transcribed and rechecked by the authors. Later all transcriptions were sent to interviewees for confirmation to maintain validity. As we received their replies with confirmations and very few minor changes, we started further analyses of the data. Key ideas were classified and coded interviews first individually and then collectively. Through this process, investigator triangulation was used to ensure the validity of inter-observer reliability. Ma, Yin, Tang, and Liu (2009) has substantiated this procedure for qualitative data analysis.

3. Explanation of Findings

As a teenager, student moves from the middle section into the secondary section to get a systematic formal education. The school, and an individual personality, i.e., teachers, transform a teenager into a brilliant learner. If a student has a slight spark of learning aptitude and gets the right motivation softly, then a teacher can frame learning willingness and shifts the overall paradigm of an adolescent in the education and schooling period. This transformation even can turn an average student into a brilliant learner (Merchie & Van Keer, 2016; Wisner & Starzec, 2016).

Motivation plays a vital role in heightening the learning process. Numerous publications have been recorded on learning motivation and/or rural education (Abbas & Khurshid, 2013; Ghazi, Ali, Shahzad, & Khan, 2010; Hardre et al., 2008). However, the available data about motivation to learn in particularly rural education is still limited. Rural schoolchildren are unique in learning aptitude, awareness, and more. Therefore, the motivational strategies used by a public secondary school teacher are required to cultivate motivation to learn in rural students.

Finally, following seven themes incorporating several categories and sub-categories were developed: (1) fostering reading and art atmosphere, (2) ownership and reflection, (3) open communication and sharing encouragement, (4) learning styles of individuals, (5) Game-based Learning, (6) life inspiration and encouragement, and (7) teaching methods. The selected examples are illustrated in the following table from two themes in the refined coding system.

Table 2. Refined coding system: themes, categories, and subcategories

Themes	Categories	Subcategories
Learning Enhancement	Individual learning styles	Make the concept clear Take an interest in learning
Involvement in learning	Design activities	Foster cognitive and not-cognitive abilities Demonstrating new ideas by doing or visually

3.1 Fostering Reading and Art Atmosphere

Reading is an instrumenting success (Bus, Van Ijzendoorn, & Pellegrini, 1995; Kassow, 2006). Some people are in favor of this argument, while some may not. The teachers claimed that learning comes through minimum reading (Houle, 1981; Richardson, Morgan, & Fleener, 2012). Learning is a triumph key to life. The reading habit of children nurtures a love for learning. It fancies students to learn new knowledge or modern technological concepts as reading boosts learning capacity.

The brainstorming and development of mental maps guide them to deal with novelty. Furthermore, these components train children to process new ideas and concepts. Students learn to handle all their academic and life affairs due to reading conflagration informal education. Eventually, this habit boosts children's brain beyond the limits and further their lives and academic performance. Art and language curricula provide an opportunity to develop this habit in children. Teachers trust that reading enriches the ability to teach all subjects, especially technical subjects, i.e., science, mathematics, etc.

"Logically and commonsensical, the reading enables children to transform and communicate the ideas and concepts into words" (Teacher A).

Additionally, with the collaboration of teachers, the schools were struggling to create an atmosphere that encourages reading. Teachers furnish personal demonstrations through reading participation. There were also some prizes to reinforce the reading and embrace it as a hobby or fun. There was a poster reading competition twice a year; the winner becomes a class monitor and receives the prize money. If s/he wins two competitions continually, later s/he gets a new school kit that encompasses uniform and shoes and a certificate.

On the other hand, if a student does not like to participate in a reading activity, then s/he may participate in art activities. In the art period, the art teacher teaches them sketching and painting. The students need to paint or sketch different things they see in their daily lives or think about or inspire.

"Generally, science *major students draw modern technological stuff or gadgets. Furthermore, major art students draw natural sceneries or some gorgeous designs" (Teacher B).*

Teacher C mentioned an alumnus who was good at house drawing. He is doing a bachelor's in architecture from a prestigious university. He won many art competitions in the school. The art winner is awarded the same prize as the readers. Notwithstanding these motivational activities, the academic drawing and readings are part of the irregular curriculum. There is no particular class for it. It is an essential part of the corresponding course.

3.2 Ownership and Reflection

External and third person (parents and teachers) control over childhood experiences may lead to learning withdrawal. However, gentle guidance and a friendly environment can cultivate learning motivation. Proper motivation leads to a moderate personality. This kind of personality gives control to children over the physical and psychological state. For instance, a teacher's words were.

"We have friendship with our *students…. and adore them the same as our kids" (Teacher C).*

The students have to reflect on their experiences and control their learning experience by themselves, whether they are in and outside the classrooms or at home. By keeping eyes on this purpose, the school provides opportunities to paint different sketches with proper guidelines. These sketches were increasingly involved with the level of class. The painting activity specifies physical control and uplift creativity. Likewise, freedom in choosing writing topics gives control over the thinking. Students are

free to select their writing projects freely while assigning the projects. Similarly, the students have the liberty to pick up extracurricular activities on their own. Ultimately, students, especially adolescent students, get control over their affairs and own their choices. It was explored in interviews as

"Each student explores a minimum *of five topics according to their own choice and interest. Later, gives reasons why s/he chose the topics and which one is the most favorite and why. This empowerment cultivates motivation to learn, which engages students in learning" (Teacher B).*

3.3 Open Communication and Sharing Encouragement

The open and flexible environment creates comfort for sharing. The students can share their opinion openly in a friendly and relaxed environment. The positive discussion on their interests stimulates student motivation. A teacher mentioned it as

"It is the nature of young students to follow that person who listens to them attentively and leaves positive comments" (Teacher C).

The teachers build up friendly relationships with our students and sustain the open and respective environment. Therefore, the students remain comfortable sharing their opinions about their lives, study matters, and learning processes. Teachers were reassuring students' opinions for correction through discussion and other methods politely in the studied schools.

"Definitely… we do not judge them over their opinion because they are rural kids. They do not have much experience as metropolitans. They are sensitive and easy to bully by others. Therefore, we also have some private spaces … if required for them" (Teacher D).

3.4 Learning Styles of Individuals

Unquestionably, there are different learning methods and styles. These styles keep the children engage in learning. Teachers motivate children to adopt their favorite best-suited learning styles.

"A student with a science major…. he always draws pictures to memorize the stories and essays" (Teacher B).

A teacher can help a student to identify the best-fitted style of learning. The style could be one or a mixture of more than one style, i.e., logical, physical, verbal, audio, and visual learning styles. For instance, the explanation of concepts is suitable *for* auditory learners because they are good at memorization by listening. Enthusiasm for learning, especially for new things, catches the interest of students. A teacher stated as

"We teachers, enhanced learning with enthusiasm for science, mathematics, and social subjects specifically for the concept building of subject matters to sustain students' interest in learning. A mixture… Alternatively, a specific learning style with enthusiasm makes learning enjoyable. We motivate students to learn complicated subject matters, particularly new concepts in their way and techniques" (Teacher B).

Interview findings show that teachers' primary job is to polish the learning style and put the students on the right learning track for lifelong learning. Teachers were personally enthusiastic about students' learning styles. Sometimes, even teachers learn new teaching techniques from them because they are rural youngsters and, occasionally, teachers' techniques were not working in studied schools. A teacher's words were

"I prefer to adapt student learning styles *to teach them, which cultivate motivation to learn" (Teacher D).*

3.5 Game-based Learning

In the 21st century, Game-based Learning is a famous learning tool and strategy (Plass, Homer, & Kinzer, 2015; Qian & Clark, 2016). It develops students' cognitive and non-cognitive abilities and a deeper understanding of learning (Anguera & Gazzaley, 2015; Chee, 2011). It especially nurtures students' interest and motivates them for learning. The students and youngsters get pleasure through Game-based Learning. The games engage a student's mind to learn newness while experiencing amusement, the amusement supplements students' motivation. Therefore, rural students have a strong desire for Game-based Learning because it entertains them along with learning. Findings revealed that classes were routinely divided into two to three teams for Game-based Learning activity in studied schools. This division of class makes learning fascinating, particularly in terms of imperceptible absorbability. It arouses motivation along with competition. Teachers were found to conduct healthy learning competitions among the students.

"The competition among students intensifies individual and team achievements… specifically, academic achievements. Additionally, students learn collaboration, success, and failure… that makes their nerves efficacious" (Teacher D).

"My students endeavor to compete with their companions… they celebrate their achievements and support ordinary mates" (Teacher C).

One student's strength may overcome the weak points of another one, i.e., the student who is competent in mathematics may help those who are inefficient in it. Findings reveal that teachers focus on their promises, especially motivating them to share their endowments for slow learners' cognitive capacity building.

3.6 Life Inspiration and Encouragement

Life ambition and bright future envisaging make life glowing. Generally, rural students and youngsters have limited acquaintances about education. Teachers knowledge them with an educational expedient and prosperous future life. The findings revealed that teachers develop students' mental maps by demonstrating a luxurious life. For instance, the army lieutenant has a luxurious life. The distinguished Faculty of Science (FSc) is the only approach to be the lieutenant. Likewise, the distinctive FA (Faculty

of Arts) and BA (Bachelor of Arts) subsequently are the road map toward the CSS (Central Superior Service) exam for executive or white color career commencement.

"Generally, I draft the sketch of valuable parents' struggle for their most exceptional education and learning, especially the schooling… Moreover, extracurricular activities related subject matters accelerate motivations i.e., shower soap making activity" (Teacher A).

Furthermore, self-responsibility is an enigma among rural adolescents. A teacher's contribution to the realization of students' responsibilities plays a central and pivotal role in the cultivation of motivation to learn.

3.7 Teaching Methods

Alluring pedagogical methods foster learning enthusiasm in students (Council, 2003). Interactivity magnetizes the pupils to acquire knowledge mainly, diverse dynamics of subject matters. The novelty in teaching methods and mystery catch students' attention and trigger the exciting environment in a class. The praise in the mates' presence or in front of other teachers motivates teachers. Admiration in the response of class participation precisely, questioning the confidence of student forwards.

"I deliver the lessons in a conversation form, and students enjoy witticisms… lessons outside the classroom, lesson relatedness with the routine circadian life, making tactful mistakes while teaching, and smart moves make the lesson delightful and motivate students to learn by grabbing their interest" (Teacher D).

The pleasant conversation is a charismatic tactic to nourish the attentiveness. To ask an interesting question of common sense or general knowledge in a lesson startup makes youngsters' minds active, present, and entice the learning motivation.

4. Conclusion

Motivation plays a significant role to heighten knowledge and eradiation enhancement. Therefore, this study was designed to narrate the inclusive experience of rural teachers about the cultivation of motivation to learn, which are brightening the present and future of rural students. In a rural educational context, motivation to learn was being cultivated using seven strategies; fostering reading and art atmosphere, ownership and reflection, open communication and sharing encouragement, learning styles of individuals, Game-based Learning, life inspiration and encouragement, and teaching methods. Furthermore, these strategies were playing a dynamic and central role in the lives of students and the future. Life inspiration and encouragement strategy are playing a vital role in cultivating motivation to learn. Additionally, rural students realized the value of education due to these strategies. Notably, the cultivation of motivation to learn was enhancing their erudition as learning for life in rural students' endeavors.

Primarily, the current investigation is restricted to four teachers' limited resources. Secondarily, the inclusive interviews were the only source of the data. Large-scale research should be conducted in the future, and multiple data collection methods should be used for comprehensive understanding. Similar research should also be carried out in different contexts, areas, cultures, and levels, especially to have a comparative study.

Conflicts

The authors declare no conflicts of interest.

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Ethics Approval and Informed Consent

Ethics procedures, including anonymization and informed consent, are described in Section 2.2.

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Public Cultural Perception and Evaluation of the San Su Shrine Based on Big Data Analysis

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Abstract

The San Su's culture constitutes an integral component of Chinese cultural heritage. The San Su Shrine, as its primary vehicle, serves to preserve and manifest the culture ethos, functioning as a pivotal site for public engagement. This study analyzes tourist reviews from major platforms through term frequency, sentiment analysis, and historical-cultural perception analysis. Findings indicate that tourists primarily perceive the temple's cultural identity through its garden architecture, emphasizing familial relationships and literary essence, crystallized as a "family-centered, literature-infused, and temple-garden embodied" framework. While tourist sentiments are predominantly positive, critical assessments target ticket pricing and service management. Cultural perceptions exhibit dual spatial foci, temporal continuity, and multidimensional perspectives. Key deficiencies include insufficient representation of family ethos, stronger ancestral lineage awareness than biographical contextualization of Su Shi, and inadequate dynamic technological exhibits and immersive experiences. Recommendations propose targeted service improvements, immersive family ethos IP development via low-frequency keywords, digital interactive scenarios, and interregional cultural synergies using digital mapping and metaverse technologies to enhance dynamic cultural representation and experiential depth.

Keywords: San Su Shrine, San Su's culture, public perception, big data analysis, tourist experience

1. Introduction

The culture of the San Sus constitutes a vital component of Chinese civilization, representing a cultural treasure in the history of ancient China. It embodies profound traditional wisdom, literary value, and moral philosophy. As one of the most significant carriers of the San Su culture, the San Su Shrine plays a pivotal role in preserving and manifesting the spiritual legacy and cultural achievements of the Su family. It serves as a key venue and invaluable resource for the public to engage with the heritage of the San Sus, thereby contributing significantly to the inheritance and promotion of China's outstanding

traditional culture (Yang, *et al.,* 2024). In January 2018, the United Nations Educational, Scientific and Cultural Organization (UNESCO) awarded the San Su Shrine the "Honorary Certificate for Cultural Heritage Protection," acknowledging its remarkable contribution to the dissemination of Chinese culture worldwide (Guo, *et al.,* 2024). Despite its profound historical status and research value, scholarly investigations on the San Su Shrine and its cultural transmission remain relatively limited, with insufficient academic attention. Further research on this subject therefore holds considerable theoretical and practical significance.

2. Literature Review

In China, studies on the culture of the Three Sus (San Su culture) have a long-standing history and have produced a considerable body of scholarship. Statistics indicate that between 1911 and 2017, approximately 24,000 papers, bibliographic records, and related documents on San Su culture were published (Library of Leshan Normal University, 2020), with the majority focusing on Su Shi and his literary works. By contrast, research specifically dedicated to the San Su Shrine remains relatively limited, rendering it a less-explored subfield within San Su cultural studies, though it has exhibited rapid growth in recent years. A systematic review reveals that existing studies on the San Su Shrine primarily fall into the following categories.

2.1 Studies on Collections and Artifacts

This constitutes one of the earliest and most extensively developed themes in San Su Shrine research, yielding a relatively abundant body of literature. Scholarship in this area primarily investigates the characteristics and cultural value of the shrine's collections, such as inscriptions, couplets, calligraphy, and paintings. For example, Sai *et al.* (2024) analyzed the stylistic features of Su Dongpo's four major calligraphic inscriptions preserved in the shrine; Chen (2024) examined the Qing Dynasty Meizhou woodblock edition of The Complete Works of the Three Sus.

2.2 Studies on Garden and Architectural Arts

A total of nine publications has addressed this theme, making it one of the relatively earlier research directions. As a prominent representative of classical gardens in western Sichuan, the San Su Shrine offers valuable insights into garden design, artistic styles, and architectural aesthetics. Among the most influential contributions are those by Guo Li, *et al.* (2006, 2024), who analyzed the characteristics of the shrine's gardens and developed approaches for their digital conservation. Additional contributions include Jiang (2007) discussion of garden-making techniques, and Sun (2023) analysis of the shrine's spatial narrative and construction principles in Meishan. Collectively, these studies affirm the cultural and artistic significance of the shrine's landscape and architecture.

2.3 Studies on Cultural Heritage Protection, Inheritance and Development

This line of research focuses on heritage preservation, cultural transmission, and regional development related to the San Su Shrine. For instance, Liu (2025) emphasized the significance of promoting the Su family traditions, advancing research on Su-related legal culture, and drawing governance insights from their philosophies. From a broader perspective, Feng *et al.* (2022) investigated cultural heritage conservation and urban renewal strategies for the historical-cultural district of the San Su Shrine within Meishan city.

2.4 Studies on the Development of Cultural and Creative Products

This research direction has gained momentum in recent years, focusing on the development of cultural derivatives and creative products based on the San Su Shrine Museum. By extracting cultural elements from the shrine's historical artifacts, such efforts seek to maximize the utilization of heritage resources and promote innovative modes of cultural dissemination. For example, Pan and Wan (2016) explored principles and strategies for museum-based cultural product development using the San Su Shrine as a case study, while Wang (2023) evaluated the application of augmented reality (AR) children's picture books in disseminating Su Dongpo's culture.

Despite these contributions, research on the San Su Shrine remains relatively limited in scope and depth, with insufficient academic attention and a narrow range of disciplinary perspectives. In particular interdisciplinary investigations are scarce. Moreover, as the primary venue for the dissemination of San Su culture, the shrine still lacks studies addressing cultural perception from the perspective of the general public. Cultural perception refers to tourists' sensory and cognitive experiences of the historical and cultural connotations of a site, and its analysis is an important means to evaluate the effectiveness of cultural communication (Crespi-Vallbona, 2020). As a vital cultural heritage site and cultural resource, examining public cultural perception of the San Su Shrine carries significant implications for enhancing its communicative value and influence, and for improving its role in public cultural services. This study therefore broadens the research horizon of San Su culture, elevates its academic visibility and impact, and provides theoretical references for future scholarship. At the practical level, its findings may inform decision-making on the shrine's development, support the optimization of its public cultural services, and facilitate the wider dissemination and influence of San Su culture.

3. Research Methodology

3.1 Research Approach

This study employs a big data analytical approach based on online user reviews. User-generated online data are characterized by authenticity, timeliness, and comprehensiveness (Choudhary *et al.,* 2024),

making them valuable for capturing tourists' genuine sentiments. Compared with conventional data collection methods, this approach transcends spatial and temporal constraints and enables multi-dimensional semantic feature mining through specialized software tools (Zheng, 2024).

3.2 Data Sources

Data were collected using the Octopus web-crawling software, which retrieved user review data from major travel platforms, including Ctrip, Qunar, Tongcheng Travel, and Mafengwo. Data collection was conducted on December 19, 2024. After removing duplicates, a total of 1,427 valid review texts containing 48,372 Chinese characters were obtained as the raw dataset. Subsequent data preprocessing involved cleaning irrelevant or meaningless words and symbols, removing numbers, punctuation, special characters, and English letters, as well as correcting misspellings and converting traditional Chinese characters into simplified forms. A customized dictionary was then created to enhance analysis accuracy.

Following preprocessing, text analysis was conducted using the ROST CM6 software and the text-mining module of SPSSAU. The analyses included automatic word segmentation, word frequency statistics, and sentiment polarity assessment. In addition, content directly related to cultural aspects was extracted and examined as a dedicated theme, with the aim of further elucidating the public's cultural perception and evaluation of the San Su Shrine.

4. Results

4.1 Word Frequency Analysis

Using ROST CM6 for automated word segmentation, a customized dictionary was applied to enhance segmentation accuracy, yielding a total of 17,526 distinct words. In addition, a self-defined stop-word list was employed to filter out terms irrelevant to cultural perception, thereby improving the reliability of the word frequency analysis.

Overall, the core high-frequency words are concentrated in the following thematic dimensions:

Historical Figures

In the word cloud, the names "San Sus" "Su Shi" "Su Xun" and "Su Zhe" appear prominently. The term "San Sus" occurs 245 times, while "Su Shi" appears 209 times, indicating the high level of public attention toward the father and his two sons, particularly Su Shi, whose literary achievements have deeply resonated with people. This suggests that tourists to the San Su Shrine are largely motivated by a desire to trace the footsteps of the Su family and to experience their literary brilliance and spiritual charisma.

Cultural Atmosphere

Words such as "culture" "literature" and "cultural heritage" occur frequently. For instance, the word "culture" appears 175 times, highlighting the recognition of the San Su Shrine as a significant venue for the inheritance and promotion of traditional Chinese culture. The shrine embodies the cultural connotations of the Song Dynasty, ranging from poetry, prose, calligraphy, and painting to family traditions and the ethos of the literati, collectively showcasing its distinctive cultural charm.

Landscape and Spatial Features

Terms including "San Su Shrine" "scenic area" "attraction" "former residence" "museum" and "garden" emphasize the shrine's touristic attributes and distinctive features. "San Su Shrine" itself appears 397 times, while "environment" and "former residence" each occur 104 times, and "scenic area" appears 86 times. These frequencies underscore the shrine's dual identity as both a historical-cultural heritage site and the former residence of the Su family, attracting a large number of tourists.

Emotional Evaluations

A considerable number of positive expressions such as "good" "worthwhile" "like" "recommend" and "worth seeing" are observed. For example, "good" appears 316 times, "worthwhile" 302 times, and "like" 85 times, directly reflecting tourists' strong approval of the shrine. Moreover, terms such as "feeling" "experience" and "impression" further capture tourists' perceptions, often accompanied by positive descriptions such as "felt great" "deep impression" and "rich experience."

4.2 Sentiment Analysis

An analysis of 1,427 online reviews reveals that 981 comments expressed positive sentiment, accounting for 68.75%; 386 comments (27.05%) were moderately positive; 52 comments (3.64%) were moderately negative; and only 8 comments (0.56%) reflected negative sentiment (Table 1). These results indicate that most tourists were satisfied with their experience at the San Su Shrine and held a favorable overall impression of the site.

Within the positive comments, tourists frequently praised the shrine's profound cultural heritage, emphasizing the opportunity to appreciate the literary achievements and family traditions of the Su family. For example, one reviewer remarked: "Walking into the San Su Shrine feels like traveling through time, conversing with the ancients, and gaining a deep understanding of the vastness of Chinese traditional culture." In addition, the aesthetic qualities of the garden landscape were widely recognized. As another tourist noted: "The garden design of the San Su Shrine is remarkably ingenious, with pavilions, corridors, flowers, and trees complementing one another like a beautiful painting, creating an immersive experience."

By contrast, moderately positive comments were generally brief descriptions of the visit without strong emotional expression. For instance, a tourist commented: "Visited the San Su Shrine and learned a bit

about the history of the San Sus, it was fine."

Table 1. Distribution of Sentiment Orientation

Sentiment Orientation	Frequency	Percentage
Positive	981	68.75%
Moderately Positive	386	27.05%
Moderately Negative	52	3.64%
Negative	8	0.56%

Nevertheless, a number of tourists expressed negative sentiments. A focused analysis of the negative and moderately negative reviews indicates that the factors contributing to unfavorable evaluations are primarily concentrated in four areas (Table 2). First, ticket pricing (25 reviews), reflecting a mismatch between the admission cost and tourists' perceived value of the experience. Second, environmental management (14 reviews), suggesting that deficiencies in maintenance and upkeep negatively affected the tourist experience. Third, holiday management and services (12 reviews), indicating that the site lacks flexible management strategies during peak holiday periods, thereby diminishing tourist satisfaction. Fourth, interpretive services (11 reviews), highlighting the need for improvements in both the organization and quality of guided tours.

Table 2. Classification of Negative Reviews

Category	Number of Reviews	Example Comments
Ticket Pricing	25	"The tickets are expensive, and there isn't much to see inside."; "The admission fee is too high, and the ticket collection point is difficult to locate."
Environmental Management	14	"Too many mosquitoes."; "The environment is poorly maintained, with overgrown weeds and inadequate management."
Holiday Management	12	"During the National Day holiday, the place was overcrowded, impossible to take photos, and I left after 10 minutes without really seeing anything."; "Too many tourists during holidays, with too few staff."; "The service attitude was very poor and chaotic during the holidays."
Interpretive Services	11	"Booking guided tours takes too long; we had to wait until the previous group finished."; "Returning the audio guide was inconvenient since it had to be returned to the original pickup point."; "The group was supposed to be 15–20 people but grew to more than 50. The guide recited mechanically, lacked experience, and wasted time."

4.3 Analysis of Historical and Cultural Image Perception

By extracting culturally relevant words (frequency ≥ 3) and conducting clustering analysis according to semantic attributes, the keywords were grouped into seven categories: place, time, literary culture, family and individuals, garden and architecture, emotional experience, and tourist activities. Semantic

interpretation of these categories suggests that tourists' perception of the historical and cultural image of the Former Residence of the San Sus (San Su Shrine) can be summarized as: a cultural experience space characterized by garden and architectural landscapes as carriers, literary culture as the core, and family ethics and traditions of the Su family as the central narrative.

Specifically, the characteristics of tourists' cultural image perception can be summarized as follows:

Dual Focus of Place Perception

Two distinct types of high-frequency terms reflect spatial perception. The first type is closely related to the geographical location of San Su Shrine, such as "Meishan" (228), "Sichuan" (22), and "Shuzhong" (11), which highlight tourists' strong regional identity with the cultural homeland. The second type relates to Su Shi's official career, including "Huangzhou" (7) and "Huizhou" (4). The number of words in the first type (387) far exceeds the second (22), indicating that tourists' recognition of the Su family's roots significantly outweighs their perception of Su Shi's career trajectory. This implies that the regional cultural representation of Su Shi's life path could be further emphasized.

Diachronic Perception of Historical Continuity

Time-related terms reflect tourists' awareness of the historical evolution of San Su Shrine. Keywords such as "Northern Song" (44), "Song Dynasty" (19), and "Song" (9) underscore the cultural origins of the San Sus. References to "Ming Dynasty" (9), "Qing Dynasty" (14), and "Republic of China" (4) highlight the phases of architectural renovation and development. In addition, terms like "millennium" (16) and "through the ages" (32) emphasize the perception of cultural timelessness.

Multidimensional Perception of Literary Culture

Literary and cultural perception comprises three dimensions:

- Recognition of historical depth and cultural heritage ("history" (111), "heritage site" (17), "monument" (21)).
- Labeling of the Su family's literary status ("Eight Great Prose Masters of the Tang and Song" (33), "literary giant" (57), "poet" (6)).
- Awareness of artistic and literary forms ("literature" (39), "poetry" (25), "calligraphy" (10)).
- These patterns reveal that literary expression serves as the core medium of cultural transmission and that the literary essence of the Su family remains central to cultural recognition.

Ethical and Familial Narratives of the Su Family

Family-related terms highlight tourists' recognition of intergenerational ties and ethical traditions. Examples include "San Su father and sons" (27), "Madam Cheng" (5), "Madam Shi" (3), and "brothers" (12), reflecting both the family's educational legacy and the collective identity of the Su literary community. Such narratives embody the cultural tag of "family literary lineage." However, the relatively low frequency of terms such as "Madam Cheng" and "Madam Shi" suggests limited tourist awareness, indicating that the representation of family ethics remains insufficient.

Diverse Perceptions of Garden and Architectural Culture

Garden and architecture terms fall into two groups. The first relates to the buildings themselves, such as "San Su Shrine" (397), "former residence" (104), and "museum" (87). The second concerns garden elements, such as "courtyard" (22), "trees" (14), and "pavilions" (15). These findings highlight the central role of architecture in cultural presentation. However, tourists' perception remains largely tied to traditional garden features, suggesting a lack of integration of contemporary technological elements, which could be explored to enrich cultural display in the future.

Hierarchical Progression of Emotional Experience

Tourists' emotional experiences exhibit a progressive hierarchy:

- Generalized evaluations, e.g., "good" (127), "worthwhile" (302), and "not bad" (316).
- Evaluations of environmental atmosphere, e.g., "beautiful" (37), "serene" (26), and "quiet" (17).
- Evaluations of cultural spirit, e.g., "profound" (11), "rich" (43), and "proud" (7).

This progression indicates that tourists' perception moves from external environmental appreciation to deeper cultural resonance, reflecting the site's capacity to inspire cultural identification and emotional engagement. Nonetheless, most environmental evaluations remain static, implying a relative lack of dynamic experiential elements in the cultural setting.

Differentiation of Tourist Activities

Tourist activity terms reveal a two-tiered pattern of engagement: "shallow contact" versus "deep experience." The former includes general sightseeing behaviors ("visit" (68), "tour" (30), "stroll" (25)), while the latter involves interactive learning and commemorative practices ("learning" (55), "commemoration" (23), "education" (20)). In addition, culinary experiences associated with Su Shi's gastronomic legacy (e.g., Dongpo pork) form part of tourist activities. However, the frequency of general sightseeing activities (344) greatly exceeds that of deep experiential activities (185), suggesting a relative insufficiency of immersive cultural programs.

Table 3 Keywords Closely Related to "Culture" (Frequency ≥ 3)

Category	Subcategory (Total Frequency)	Keywords (Frequency)
Location	Hometown of the San Sus Temple (387)	Meishan (228), Sichuan (35), Meizhou (23), Chengdu (19), Leshan (13), Shuzhong (11), Shahu Lane (11), Dongpo District (9), Original Site (9), Songcheng (8), South Street (7), Southwest (6), Hometown (5), Birthplace (3)
	Places of Su Shi's Activities (22)	Huangzhou (7), Jiangnan (6), Su Causeway (5), Huizhou (4)
Time	Historical Roots (72)	Northern Song (44), Song Dynasty (19), Song (9)
	Chronology of the San Sus Temple (91)	Qing Dynasty (14), Ancient Times (12), Ming Dynasty (9), Late Ming (9), Yuan Dynasty (8), Hongwu Year One (7), Ming and Qing (6), Era (6), Period (6), Republic of China (4), Tang Dynasty (4), Century (3), Successive Dynasties (3)
	Others (70)	For Eternity (35), Millennium (16), Lasting (7), Generations (4), Ages (4), 19th Day of the 12th Lunar Month (4)

Literature & Culture	Historical and Cultural Heritage (625)	Culture (175), History (111), Cultural Heritage (52), Humanities (42), Life (26), Cultural Atmosphere (24), Cultural Relics (22), Historical Sites (21), Relics (17), Classics (15), Life Deeds (13), Literature (12), Protection (9), Preservation (8), Collection (8), Time-Honored (7), Tradition (7), Arts (7), Exhibition (7), Handwriting (6), Cultural Creation (6), Retention (6), Relics Protection (5), Attainment (5), Chinese Culture (4), Huaxia (4), Cultural Background (3), Cultural City (3), Cultural Heritage (3), Chinese Nation (3)
	Identity of the San Sus (249)	Literary Giant (57), Writer (40), One of the Eight Great Prose Masters of the Tang and Song (33), Literati (25), Celebrity (19), Three Ci Poets (15), Three Talents (9), Official (8), Poet (6), Both Listed (6), Men of Letters (6), Model (5), Sage (5), Refined Scholar (4), Literary Circle (4), Author (4), Calligrapher (3)
	Literary & Artistic Forms (200)	Literature (39), Poetry (25), Stories (24), Essays (22), Couplets (13), Calligraphy (10), Art (9), Prose & Poetry (8), Painting & Calligraphy (8), Classical Poetry (7), Allusions (6), Verses (5), Inscriptions (5), Poetry & Books (4), Rubbings (3), Stone Carvings (3), Writings (3), Pictures (3), Paintings (3)
Family & Figures	General Relations (366)	San Sus (245), Su Family (53), One Family (24), Family Tradition (12), Family Members (8), Clan (7), Su Gate (6), The Whole Family (4), Scholarly Family (3), Family Instructions (4)
	Vertical & Horizontal Relations (163)	Children (74), The Three Fathers and Sons (36), The San Sus Father and Sons (27), Brothers (12), Father (9), Son (5)
	Individual Figures (598)	Su Shi (209), Su Dongpo (114), Dongpo (76), Su Xun (74), Su Zhe (69), Su Clan (25), Madam Cheng (5), Su Xiaomei (5), Madam Shi (3), Wang Chaoyun (3), Wang Fu (3), Su Baniang (3), Young Master (3), Ren Cailian (3)
Gardens & Architecture	Pavilions and Buildings (1018)	San Sus Temple (397), Former Residence (104), Scenic Spot (89), Museum (87), Tourist Attraction (86), Memorial Hall (48), Ancestral Hall (41), Park (40), Building (37), Exhibition Hall (9), Inscription Board (9), Wing Room (7), Xiang Hall (6), Three Courtyards (6), Siheyuan (6), Layout (6), Shops (6), Front Hall (6), Qixian Hall (5), Memorial Hall (5), Hall and Pavilion (5), Old House (4), Ancient Street (4), Ancient Ancestral Temple (4), Laifeng Pavilion (4), Su Temple (3)
	Garden Landscapes (353)	Garden (74), Courtyard (22), Pavilions (15), Yard (14), Trees (14), Towers & Pavilions (13), Small Bridge (13), Ginkgo (13), Ancient Well (12), Three-Way Water (12), Park Area (11), Pavilion (10), Ancient Trees (10), Old Trees (9), Bamboo Island (9), Garden Scenery (8), Garden Style (8), Rockery (7), Ancient Architecture (7), Inkstone Pool (7), Lotus Pond (7), Bamboo Grove (6), Lotus Pool (6), Plants (6), Stele Forest (6), Sculpture (5), Stele Gallery (4), Corridor (4), Courtyard (4), Lotus Leaf (4), Bridge over Flowing Water (4), Pavilion (4), Bamboo (3), Temple Garden (3), Stele Pavilion (3)
Emotional Experience	Overall Evaluation (911)	Nice (316), Worthwhile (302), Very Good (127), Like (85), Fun (11), Pretty Good (10), So-So (10), Good Review (9), Beautiful (7), Happy (6), Comfortable (6), Not in Vain (6), Land of Outstanding People (6), Unique (5), Great (5)
	Environmental Experience (288)	Beautiful (37), Serene (26), Spacious (24), Pretty (18), Simple (17), Quiet (17), Elegant (16), Natural (14), Picturesque (9), Peaceful in Bustle (9), Shaded with Trees (9), Clean (9), Antique (7), Classical (7), Pleasant (7), Exquisite (6), Historical Sense (6), Too Small (6), Comfortable (5), Fresh (5), Deep (5), Artistic Conception (5), Neat (4), Solemn (4), Ancient Charm (4), Open (3), Winding Path to Secluded Place (3), Lush (3), Tranquil (3)
	Spiritual Experience (208)	Strong (43), Profound (19), Interesting (18), Meaningful (13), Elegant (12), Deep (11), Graceful (9), Rich (9), Lively (13), Pleasant (8), Proud (7), Glorious (7), Poetic (7), Open-minded (6), Moved (5), Fun (5), Profound and Extensive (5), Weighty (4), Beneficial (4), Immersive (3)
Tourist Activities	Activities General Activities (344)	Visit (68), Experience (58), A Tour (34), Sightseeing (30), Travel (28), Play (25), Check-in (18), Take Photos (11), Stroll (12), Display (10), Walk Around (10), Wander (9), Watch (8), Take a Look (6), Leisure (6), Stroll in the Park (5), Glance (3), Appreciate (3)
	In-depth Experiences (169)	Learning (55), Commemoration (23), Education (20), Worship (11), Reading (8), Paying Homage (7), Sacrifice (6), Mourning (7), Collecting (7), Research (6), Cultivation (6), Tasting (5), Paying Respect (3), Food (5)

5. Discussion and Recommendation

5.1 Discussion

By employing large-scale text mining, this study established an empirical research framework to investigate public cultural perception of the San Su Temple. Through the integrated application of ROST CM6 and SPSSAU for in-depth textual analysis, the study revealed the cognitive focus and emotional tendencies of tourists regarding the cultural value of the San Su Temple.

From the perspective of tourist perception, the cultural image of the San Su Temple is shaped by its traditional garden and architectural landscape as the carrier (Guo, et al., 2024), with literary culture as the core, and centered on the historical and cultural experience space that highlights the family relations and moral heritage of the Su family.

The overall emotional tendency of tourists toward the San Su Temple is positive. Negative perceptions primarily concern ticket pricing, environmental management, holiday crowd management, and interpretive services.

Tourists' cultural perception of the San Su Temple presents several characteristics: dual foci on place-based perception, diachronic continuity within historical contexts, multidimensionality of literary culture, narrativity of family ethics, pluralism of garden and architectural culture, layered progression of emotional experience, and differentiation of tourist activities.

The intensity of tourists' perception of the Su family's genealogical roots substantially exceeds their associative understanding of Su Shi's personal life trajectory. Moreover, terms related to female family members such as Madame Cheng and Madame Shi appear less frequently, suggesting that the cultural expression of family ethics remains insufficiently emphasized (Gao & Su, 2022; Liu, 2024). Additionally, tourists' perception of the garden and architectural landscape largely focuses on traditional elements, while evaluations of the environmental atmosphere are predominantly static, indicating a lack of dynamic or technology-enhanced displays. Furthermore, general sightseeing activities dominate tourist engagement, whereas participation in immersive and experiential activities remains relatively limited, reflecting a shortage of in-depth cultural tourism offerings.

5.2 Recommendations

Special Rectification Based on Negative Sentiment Evaluations

The scenic area management authority should adopt targeted measures to address tourists' negative evaluations, thereby enhancing tourist satisfaction and strengthening the overall image of the site. First, enrich the experiential content by designing themed tour routes, such as a "Su Shi Poetry Tour", to increase cultural attractiveness and offset ticket price controversies. Second, improve service flexibility during peak holidays by allocating additional guides and volunteer staff. Third, strengthen tour guide

training to deepen historical and cultural interpretation and improve interactive communication skills; this may be complemented by intelligent interpretation systems and multiple borrowing-and-return points for audio devices. In addition, online reservations for time-slotted guided tours could be introduced to reduce queuing. Fourth, apply environmentally friendly mosquito repellents at regular intervals to improve the tourist experience.

Developing an Immersive Family Tradition Cultural IP

Using low-frequency keywords such as "Sha Hu Xing" and "Madam Cheng" as entry points, the underexplored family teachings, scholarly pursuits, and business stories of the Su family can be further excavated to foster deeper emotional resonance among tourists. For instance, professional teams could develop themed performances reenacting classic family education stories, such as "Madam Cheng Teaching Her Sons", in which tourists are encouraged to participate. In addition, collaborations with universities could lead to the development of creative cultural products inspired by family traditions, integrating Cheng's educational aphorisms and related cultural elements.

Creating Experiential Cultural Scenes

Focusing on high-frequency keywords such as "poetry and prose" and "calligraphy", multi-sensory and participatory cultural experiences should be designed to overcome the monotony of "static visiting." For example, poetry workshops and calligraphy rubbings halls could be established, alongside digital poetry games such as "Feihualing." Tourists might also engage in rubbings of classical works—such as Su Shi's Cold Food Festival Manuscript (Hanshi Tie) or Su Zhe's Luan Cheng Ji—and mount them as souvenirs. Furthermore, interactive cultural activities would diversify the modes of engagement, deepen participation, and reinforce the unique position of the San Su Shrine as a "landmark of Song Dynasty culture."

Strengthening Temporal–Spatial Connections and Cross-Regional Cultural Integrations

By utilizing keywords such as "Northern Song Dynasty," "Huangzhou," and "Huizhou," a digital map of Su Shi's life can be developed, linking San Su Shrine with other cultural sites associated with the Su family across different regions. This would promote cross-regional cultural integration and shape a broader cultural community. Complementary initiatives could include dynamic visualizations such as an interactive "Dongpo Life Map," digital sand-table displays of Su Shi's life trajectory, or even a metaverse-based interactive exhibition hall, thereby enabling tourists to engage in immersive and diversified ways to deepen their understanding of Su culture.

6. Conclusion

This study innovatively applies big data text analysis to the evaluation of cultural heritage, overcoming the limitations of traditional questionnaire-based methods. By analyzing large-scale and objective data, it reveals the diverse interpretations of the cultural significance of the San Su Shrine from the public

perspective. The findings provide empirical support for improving site management, while also offering a new reference for cultural heritage conservation and transmission. Future studies may expand data sources by integrating surveys and in-depth interviews to investigate underlying mechanisms, and compare "online–offline" cultural perceptions. Such approaches will contribute to exploring more distinctive pathways for the living transmission of cultural heritage.

Conflicts

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Not applicable.

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