ISSN: 2458-8989

Natural and Engineering Sciences

NESciences, 2024, 9 (2): 213-233 doi: 10.28978/nesciences.1569562

The AI-assisted Traditional Design Methods for the Construction Sustainability: A Case Study of the Lisu Ethnic Minority Village

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Abstract

In recent decades, economic and technical advancements have surged tremendously, accompanied by non-regulatory and unsustainable use of non-renewable assets. The ecological field of toxicology has garnered considerable focus on elucidating the impact of harmful substances on people's wellness. Environmental hazardous chemicals induce many illnesses, posing a heightened danger to youngsters, pregnant women, the elderly, and anyone with preexisting health conditions. Air pollution adversely impacts human health, leading to heightened morbidity and death, necessitating intensified toxicological investigations on industrial air pollution affecting the general populace. It is necessary to develop a computerized Ecological Toxicology-based Air Pollution Management System. Constructive social development is driven by cultural education. It can guarantee a sustainable future, protect national history, and unleash community potential. This study examines Chinese architects' perspectives and understanding of sustainability in village revitalization and conservation. It incorporates traditional Lisu building techniques and materials in Hunan, China. To close research gaps, this study looks at the contributions made by architects to traditional practice integration and environmentally conscious architectural design. This study proposes an IoT-enabled Environmental Toxicology platform for air pollution surveillance, utilizing artificial intelligence (AI) techniques to mitigate the limits of standard monitoring systems and lower total costs, enhancing human wellness. The research examined the intricate interaction between architects' understanding of sustainability, Lisu building techniques and materials, and sustainable architectural designs in village preservation and revitalization programs using path analysis on data from 326 architects in Hunan Province. Lisu building practices and materials strongly correlate with architects' awareness of and attitudes toward sustainability. According to the research, these characteristics are necessary for sustainable architectural solutions that support village revival and preservation. This study has significant theoretical and practical ramifications for academics, lawmakers, and architects. To evaluate the air quality monitoring efficacy of the suggested approach, a comprehensive series of simulation analyses is conducted, and the results are assessed at durations of 5, 15, 30, and 60 minutes. The experimental results demonstrate the superior efficacy of the suggested model compared to current methodologies. These findings could lead to the

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creation of sustainable design solutions that advance rural development. A thorough overview of upcoming studies on sustainable design approaches in Chinese contexts rounds out this talk.

Keywords:

Air pollution, building, sustainability, environment.

Article history:

Received: 22/05/2024, Revised: 19/07/2024, Accepted: 25/08/2024, Available online: 30/09/2024

Introduction

Air pollution is the contamination or alteration of the surroundings or resources by pollutants threatening humans and other organisms (Turner, 2020). Air pollutants, including gases, particulates, and natural macromolecules, manifest in many forms. The significant increase in contaminants in the air has led to elevated tropical temperatures, advancements in human consumption due to population growth, and a rise in industrial and mining operations. Air pollution induces ailments, including myocardial infarction, pulmonary illness, persistent bronchitis, and respiratory problems. While continuous exposure has serious repercussions, air pollution can cause immediate problems, such as coughing and coughing. Air pollution leads to global warming, increasing temperatures, extreme weather, food supply limitations, and increasing greenhouse gases, resulting in fewer tangible health effects (Ukaogo, 2020).

Cultural education preserves national legacy by fostering identity and cultural history. According to (Alqahtany & Aravindakshan, 2022) and Alim et al. (2022), recent years have seen a rise in the popularity of sustainable architectural design. The primary causes are the growing global environmental concern and the pressing need to solve urbanization-related issues. People are moving away from native towns because cities proliferate (Qu et al., 2021; Ye, 2020). In this study, the way Chinese builders think about revitalizing and preserving villages and how they understand sustainability are looked at. The study will focus on traditional Hunan Lisu building materials and methods.

Several studies have helped make designs that last, keep cultural traditions alive, and incorporate customs into the built world (Munaro et al., 2020). Li et al. (2021) say that analyzing how builders feel about and understand sustainability can help make design more sustainable. Gao et al. (2020) discussed the importance of using long-lasting restoration methods and keeping traditional towns safe as cultural jewels. Additionally, studied long-term growth and preserving art. He talked about the benefits of mixing modern and traditional style features. Even though past studies made essential advances, contradictions need more research. A big problem is that traditional Lisu building styles and materials are used in village protection and revitalization projects, and Hunan Province's unique ecosystem needs to be considered (Lu & Ahmad, 2023). To fill this gap, this study looks at how Chinese builders feel about sustainability and what they know about it when preserving and revitalizing traditional towns in Hunan Province. The main goal of this study is to look at the unique building products and methods the Lisu community uses. A unique place in Hunan Province looks at the opportunities and problems of designing buildings suitable for the climate.

Shen & Chou, (2022) say teaching Chinese culture is essential for rebuilding China's school system. According to (Lu & Ahmad, 2023), more and more architectural designs combine cultural history with environmentally friendly building methods. Environmental awareness is becoming more and more important in architecture. Remember this when you talk about buildings. In their work on preserving and restoring Lisu Village's historical importance, Zhuang et al., (2019) discuss this method. When studying sustainable architecture, it is essential to consider the different points of view that affect the design of environmentally friendly buildings (Qu et al., 2021; Ye et al., 2020). Researchers (Zhuang et al., 2019) say that this study fills in essential gaps in knowledge and helps us understand how builders can be more environmentally responsible in their design work. This part talks about the parts of sustainable architecture used (Burleson et al., 2023), how sustainable buildings are designed (Lu & Ahmad, 2023), and the study's main goal to link these two areas. The methods used in architecture, the Chinese school system, and the cultural parts of education are all looked into in this study. The study focuses on how to keep the building style in Lisu Villages alive and well. In order to understand how sustainable building design can help protect and restore Chinese towns, you need to know these things. According to Zhuang et al. (2019), China's traditional towns are falling apart and being left empty, which is terrible for the country's culture and infrastructure. say that these communities support national identity, healthy practices, and the well-being of the local people. This study looks into what Chinese builders think about restoring and protecting old towns in a way that does not harm the environment. The pros and cons of combining traditional and modern sustainable design are looked at in this study. To create environmentally friendly building practices and help keep and improve traditional communities, looking at how builders make decisions can be helpful. Policymakers, academics, and builders can learn much about rural China and sustainable design concepts from this study.

This study uses artificial intelligence (AI) (Zhai et al., 2021) and the Internet of Things (IoT) to create an environmental toxicity system for tracking air pollution. The goal is to improve people's health. The suggested method uses many sensors to check the amounts of eight contaminants and sends the information to a cloud server through links to analyze it. The suggested method checks the air quality in real-time through a cloud-based server and sends a message when it finds amounts of dangerous pollutants in the air. The Artificial Algae Method is an improvement approach inspired by the cellular processes of microalgae, which employs a method of optimization based on algorithmic evolution influenced by nature.

Literature Review

Through promoting awareness, fostering appreciation, and preparing future stewards, cultural education aids in preserving the country's legacy. The traditional villages of China have attracted attention lately (Shen & Chou, 2022). These communities are acknowledged for their potential for growth and cultural value. This literature review looks into the long history of Lisu ethnic architecture and how it uses traditional building techniques and materials to create sustainable architectural design for village revitalization and preservation. This study examines academic articles, case studies, and previous research to comprehend the subject (Labadi, 2021). A range of computer techniques are employed to preserve a human-like writing style.

Several civilizations value Lisu architecture: The Lisu people, who inhabit the hilly regions of Yunnan and Sichuan, are known for their distinctive architectural heritage. This architectural style has been passed down through the generations (Wang, 2021). According to (Dingley & Catterall, 2020) research, the architecture of the Lisu people reflects their religious beliefs, traditional ways of life, and intimate relationship with nature. In the opinion of (Duan et al., 2021), these structures represent the people's historical, social, and spiritual aspects. Shen & Chou, (2022) recommend adding Lisu architectural characteristics to contemporary architecture to maintain cultural diversity and strengthen rural economies.

Asad et al., (2021) introduced a sophisticated pedagogical method for using this strategy as a resource for experiential learning in health locations while also addressing the effectiveness and challenges of this instructional approach. An undergraduate classroom project initiated a health mapping course to provide students with practical training and real-time information utilizing modern approaches. (Agarwal & Mustafi, 2021). employ IoT techniques to assess the emission rates of cars. A predictive module is constructed using current global data to predict carbon monoxide levels. Rana et al., (2022) tracking technique provides vehicle data, such as its location. It informs the owner regarding the current pollution levels in their vicinity and the car's pollution level contributing to atmospheric conditions. The Machine Learning (ML) component is employed to forecast the carbon footprint of the vehicle's location based on historical and current data obtained from sensors. Otoom et al., (2020) propose an IoT for prediction and monitoring.

An attack-detecting approach is applied to the acquired sensor data to ascertain whether it has been compromised. Tagliabue et al., (2021) proposed a system for predicting and tracking indoor air quality utilizing contemporary IoT sensors and ML capabilities, facilitating the assessment of various indoor pollutants. An IoT node is equipped with many sensors to detect eight contaminants (Laghari, 2021). Different ML algorithms were utilized to determine interior air quality, with the neural network module achieving an accuracy of 99.1%.

Sharma et al., (2020) suggested a deep learning (DL) architecture for forecasting air quality over the next 24 hours utilizing time series extended short-term memory networks. The module optimally determines the time lag for achieving sliding forecasting with multilayer bi-directional Long Short-Term Memory (LSTM). Castelli et al., (2020) employed the prevalent ML approach, Support Vector Regression (SVR), to forecast contaminant and particle levels and estimate the Air Quality Index (AQI). Among other evaluated alternatives, the Radial Basis Function (RBF) kernel enabled SVR to forecast accurately. RBF systems are a category of neural networks commonly employed for approximate function challenges. Radial basis functional interconnections distinguish themselves from other neural networks by offering extensive estimate capabilities and accelerated learning rates. Luo et al. projected the 8-hour average surface-level ozone (O3) concentration using a DL model incorporating a recurrent neural network with LSTM. The LSTM can forecast the duration of the ongoing 03 exceedings. The missing information was allocated using a novel technique that averaged smaller gaps relative to eight-time intervals, with the step size increasing based on the first-order variability of the adjacent time frame.

Concerns About Chinese Architects' Environmental Responsibilities

The current situation, perception, contextual factors, and anticipation make up the independent variable in this study. The word "anticipation" describes architects' vision of the benefits and drawbacks of environmentally conscious design. The 2020 study by Boarin et al. discovered that architects' work and schooling affected how they understood sustainability. Say that impression looks at what builders think about how important and how it affects their work. Lastly, the status quo examines how sustainable Chinese builders are and how they work (Lu et al., 2021).

Anticipation

Anticipation looks at what architects think will happen with the pros and cons of green building in town revitalization and preservation. Zhuang et al., (2019) look at how this study will improve community life, protect traditional assets, and make the environment more sustainable. Agree with the builders that there are problems with limited resources, technology, and people not wanting to change.

Professional Background

Following, this sub variable examines how architects' work and schooling affected their sustainability knowledge. A study by examines how professional training, college programs, and sustainable design affect architects' knowledge and skills. For architects to learn more about sustainability, (Burleson et al., 2023) say they should look at case studies of sustainable design and building, attend classes and conferences, and take specialized courses.

Perception

Zhang et al., (2022) say that perception in building design is the architects' thoughts on how sustainability affects the protection and renewal of villages. Feria & Amado, (2019) say that sustainability could be a duty to society, a moral problem, or a chance to develop new ideas. A study of how architects relate to sustainability and are dedicated to green design concepts.

Status Quo

Fan et al., (2023) look at the work of modern Chinese builders and how they use sustainable design concepts in the status quo sub-variable. This study looks at how committed architects are to sustainability, how often green buildings are certified, and the rules and laws that govern sustainable design. Based on a study by Bao et al. from 2023, knowing how things are now can help you understand the difficulties and opportunities for environmentally friendly building design in preserving and remaking villages.

1. Sustainable Architectural Design in Village Preservation and Renewal

Shen et al., (2023) say that the dependent variable is a number that shows how sustainable building design is used in efforts to save and restore villages. Says that it is a complete system that includes economic, social, and environmental parts that are secondary. Chung & Lee, (2019) say that sustainable design affects the health and well-being of locals, the preservation of traditional assets, and the unity of the community. Cost-effectiveness, local economic growth, and livelihood enhancements are the three significant factors for judging sustainable design. According to (Bonoli et al., 2021), environmental concerns include reducing carbon emissions, using resources best, and protecting natural features through environmentally-friendly design.

Social Perspectives

Chung & Lee, (2019) say that the social aspect of sustainable building design includes residents' health and happiness and the society's unity. Leporelli & Santi, (2019) say this sub-variable looks at how sustainable design improves health, national identity, and social connections. The study looks at how to create village-specific public spaces, neighborhood services, and housing that encourage community.

Economic Perspectives

The economic sub-variable examines how eco-friendly building design affects the recovery and protection of villages' finances (Kweon & Youn, 2021). This study looks at how cost-effective sustainable design solutions are by looking at how much energy they save, how much they cost to build, and how much they cost to maintain over time. Sustainable design can help the local economy by encouraging eco-friendly travel and supporting local artists.

Environmental Perspectives

Norouzi et al., (2021) say that the environmental part needs to look at how sustainable building design takes care of the climate and uses resources well. Examine how waste management, renewable energy, and energy-efficient building systems might help lower carbon pollution. To protect the environment, people are also pushed to use eco-friendly building materials, rainwater gathering systems, and ecological landscaping methods (Kurtaslan, 2020).

Traditional Lisu Building Techniques and Materials as a Mediating Variable

Zuo et al., (2023) say that traditional Lisu building methods and materials act as a bridge between architects' knowledge and views about sustainability and sustainable architecture design in village preservation and regeneration. This interaction influences how builders think about sustainability. Traditional building materials like wood, bamboo, stone, and thatch can be used to make better patterns for the environment (Kumar, 2022). This study (Chen et al., 2022) shows that traditional Lisu building is essential for its cultural, historical, and natural value. Says builders can protect cultural assets using environmentally friendly design elements. Keeping and changing traditional building methods is how this is done.

This study looks at what Chinese builders know and think about sustainability and how they use sustainable design in their work to preserve and revitalize villages. To understand how builders think about sustainability, consider sub-variables like intention, background, image, and status quo. When you look at the social, economic, and environmental sub-variables of sustainable building design, it is easier to understand what might happen with sustainable design solutions. Sub-variables are parts of dependent variables. It is emphasized that using traditional Lisu building techniques and materials can help achieve sustainability goals and protect Chinese cultural heritage (see Figure 1).

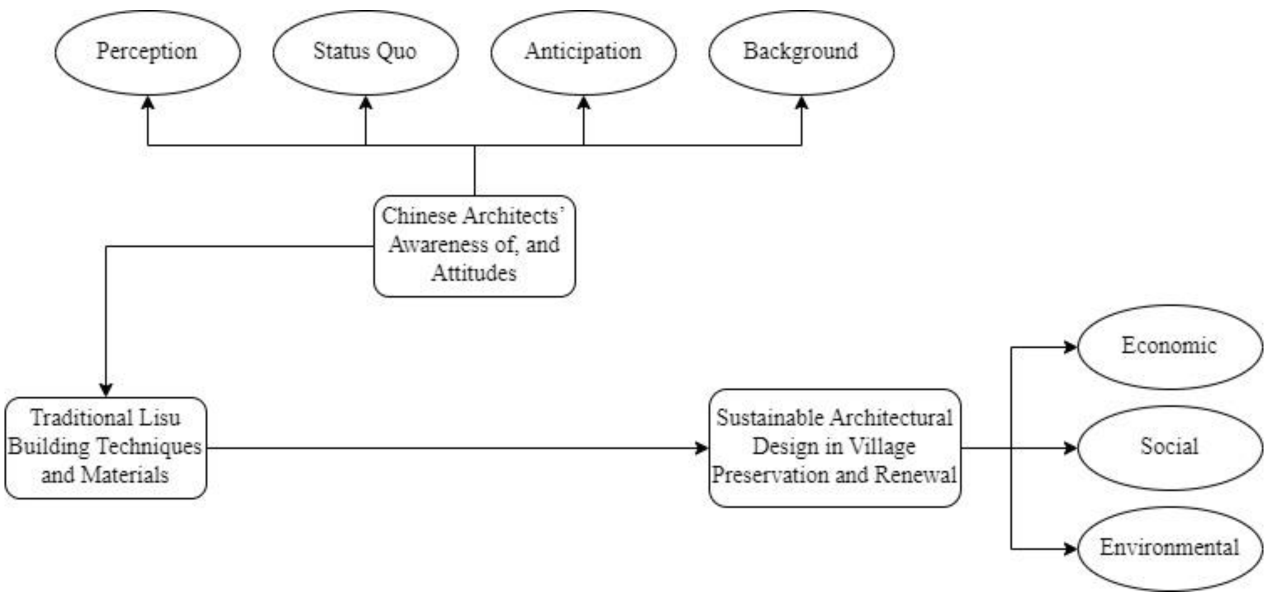

Figure 1. Conceptual Model

H1: Chinese architects' awareness and attitudes towards sustainability significantly influence the traditional Lisu building techniques and materials.

H2: Traditional Lisu building techniques and materials significantly affect sustainable architectural design in village preservation and renewal.

H3: Traditional Lisu building techniques and materials significantly mediate the relationship of Chinese architects' awareness and attitudes towards sustainable architectural design in village preservation and renewal.

2. *Proposed System for Air Quality Monitoring*

The IoT primarily utilizes the advantages of the Open System Interconnections (OSI) layered architecture to connect smart devices to the Internet. This work presents wireless nodes for regulating air quality monitors employed in monitoring contaminants in the air loads. All air sensors are linked to a compact integrated system that links to the Internet, forming a global network of interconnected devices. The sensor information is documented and transmitted to the cloud via an AI system to obtain information via IoT. The system design is illustrated in Figure 2.

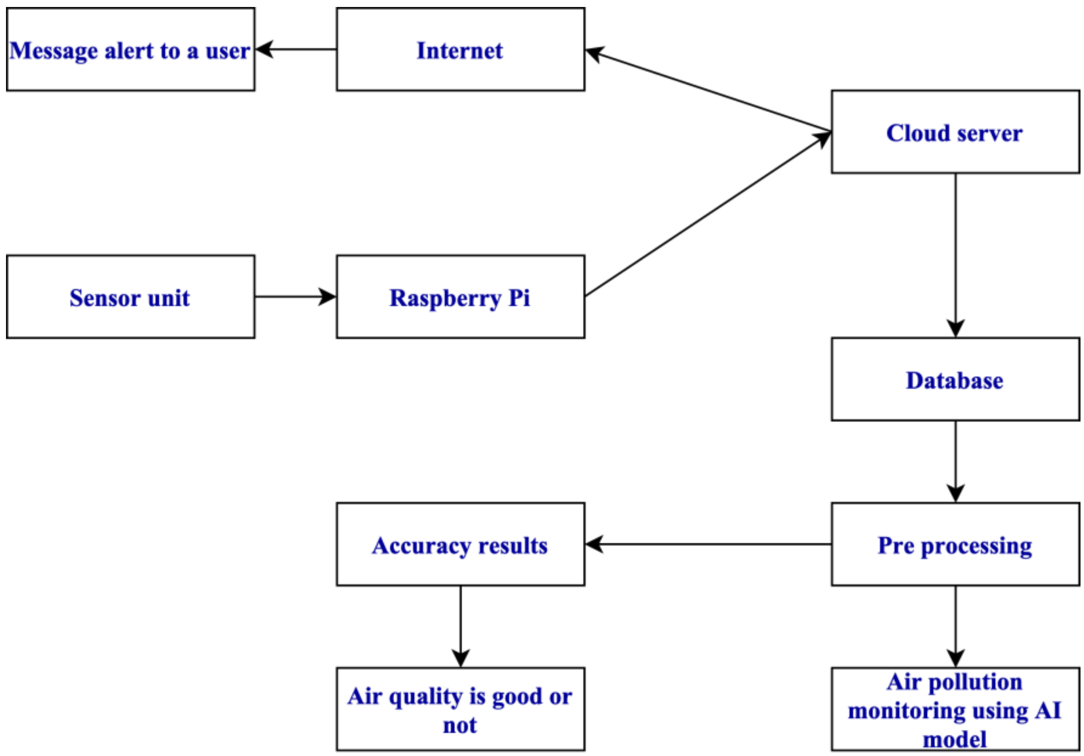

Figure 2. IoT-based air quality monitoring system

- ***Collection of Air Quality Data***

An IoT gadget comprises a gas detector, microcontroller, Raspberry Pi, air quality detectors, and a PM2.5 particle detector. The air quality detector assesses the AQI, while the PM2.5 particle detector identifies nanoparticles smaller than 2.5 microns in size. The Gas Sensor measures quantities of CO_2, SO_2, and NO_2. The detector acquires the required information, and the Microcontroller is connected to the detectors. After gathering data, it is sent to the cloud via the controller component. The collected data serve as a test database for the AQI to forecast the upcoming hours. The microcontroller module processes details and performs program piles, closely collaborating with a sensing gadget for interaction, which is compatible with many data transmission methods.

- ***Preprocessing***

The data from various sources contain inconsistencies, missing figures, and redundant data. The database requires cleansing to get accurate predictive accuracy; value gaps must be addressed by removal, imputation, or alternative methods utilizing mean values. Redundant information must be eliminated to prevent skewed outcomes. Databases contain abnormalities or outliers that must be removed to ensure an accurate estimate.

The categorization techniques and other forms of mining information will only operate if all necessary data pre-processing is conducted. Logistic Regression (LR) is employed alongside the categorizing method for data preparation to eliminate duplicate knowledge.

- ***Flowchart Model***

The model's primary objective is to assess an area's air quality index and predict its value to mitigate air pollution concerns. As depicted in Figure 3, information was gathered from different kinds of sensors and afterward transmitted to the Raspberry Pi plane, where the AQI value is calculated. The data then gets sent to the public cloud, where AI forecasting techniques are employed to forecast potential values. A notification is dispatched to the relevant individual when amounts exceed a specified threshold.

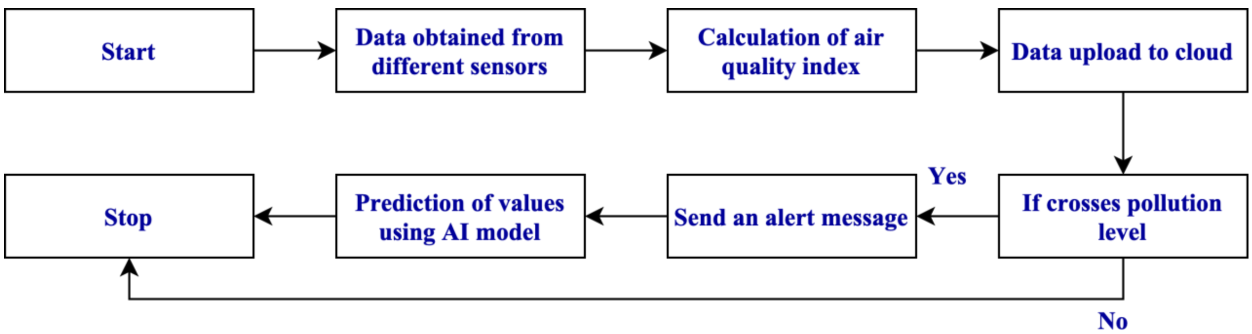

Figure 3. Flowchart of the air quality index prediction

Methods

Three hundred twenty-six architects in Hunan submitted data for this study. Convenience sampling was employed to find consenting and available study participants. A survey on sustainability and the effect of sustainable architectural design on village revitalization and preservation was conducted among Chinese architects. The data analysis tool utilized was PLS-SEM 4.0. With this approach, it assesses structural models and measurements at the same time. The understanding and attitudes of architects about sustainability, sustainable architectural design, and traditional Lisu building methods and materials were all examined in this study using PLS-SEM as mediators. Scales from previous studies were employed in this investigation. A nine-part scale for sustainable project management was created by (Chow et al., 2021). This scale assesses the attitudes and level of environmental awareness among Chinese architects. The scale developed by effectively evaluated traditional Lisu building materials and processes (Sang, 2021; Xiang, 2021). The scale proposed by was applied. Convenience sampling was employed in this study to collect data from 326 students in Yunnan (see Table 1). The following parameters were used to determine the sample size calculations: statistical power of 0.80, the estimated proportion of 0.40 after the intervention, the estimated proportion of 0.60 before the intervention, and statistical significance of 0.05. To evaluate variable correlations and analyze the data, PLS-SEM version 4.0 was employed.

The scales used in the study were created based on past research to guarantee their accuracy and consistency. Only architects aged 20–65 with bachelor's or master's degrees were included in the study. Professionals in architecture ranging in experience from zero to more than fifteen years were assessed. Hunan and other Chinese architects were among the requirements for admission. Those over 65, those without a bachelor’s or master’s degree in architecture, and those without professional architectural accreditation were not included in the study. Architects with less than 0 or 15 years of experience were also disqualified. The exclusion criterion remained unchanged regardless of the individual's location inside Hunan Province.

Table 1. Demographic Information of Architecture Respondents

Demographic Characteristic	Count
Gender	
Gender (Male)	180
Gender (Female)	146
Age	
Age Group (20-30)	112
Age Group (31-40)	144
Age Group (41-50)	52
Age Group (51 and above)	18
Education	
Educational Level (Bachelor's Degree)	188
Educational Level (Master's Degree)	138
Experience	
Years of Experience (0-5)	68
Years of Experience (6-10)	84
Years of Experience (11-15)	78
Years of Experience (16 and above)	96
Residents	
Hunan Province Natives	285
Non-Hunan Province Natives	41

This research's ethical considerations, data gathering, and analysis methodologies must be stated. The study followed ethical rules and got informed consent from all subjects. Data anonymity and secrecy were strictly preserved, protecting respondents' privacy and rights. The research team conducted a pilot study to test the feasibility and validity of the data collection instrument. Based on pilot research input, survey items were adjusted to improve data collecting reliability and validity. The study also acknowledged convenience sampling, which restricts generalizability. However, strict inclusion and exclusion criteria mitigated these shortcomings and maintained the study's internal validity. In conclusion, this research applied rigorous and ethical data collecting and analysis to assure its findings' authenticity and integrity.

Results

This study's internal consistency with the scales was assessed using Cronbach's Alpha (CA). Most variables are reliable, according to data (table 2). The scale measuring Chinese architects' sustainability awareness and attitudes had 0.820 CA, showing internal solid consistency. This scale's sub-variables have trustworthy CA values, from 0.747 for background to 0.859 for perception. For the dependent variable of sustainable architectural design in village preservation and regeneration, the scale had a high CA of 0.910. The scale's economic, environmental, and social sub-variables had CA values of 0.719, 0.753, and 0.834. The mediator of traditional Lisu building techniques and materials had a CA rating of 0.915, indicating high internal consistency. This suggests that examining traditional methods and materials in sustainable building design for village preservation and revival is reliable.

Table 2. Statistics of CA

Constructs	CA
Anticipation	0.854
Background	0.747
Chinese Architects’ Awareness and Attitudes towards Sustainability	0.820
Economic	0.719
Environmental	0.753
Perception	0.859
Social	0.834
Status Quo	0.812
Sustainable Architectural Design in Village Preservation and Renewal	0.910
Traditional Lisu Building Techniques and Materials	0.915

Table 3 presents the research's reliability and validity construct measures. Composite reliability (CR) and average variance extracted (AVE) were calculated to evaluate the study's evaluation scales (figure 4). Chinese Architects' Awareness and Attitudes Toward Sustainability obtained 0.861 CR and 0.485 AVE, showing internal solid consistency and convergent validity.

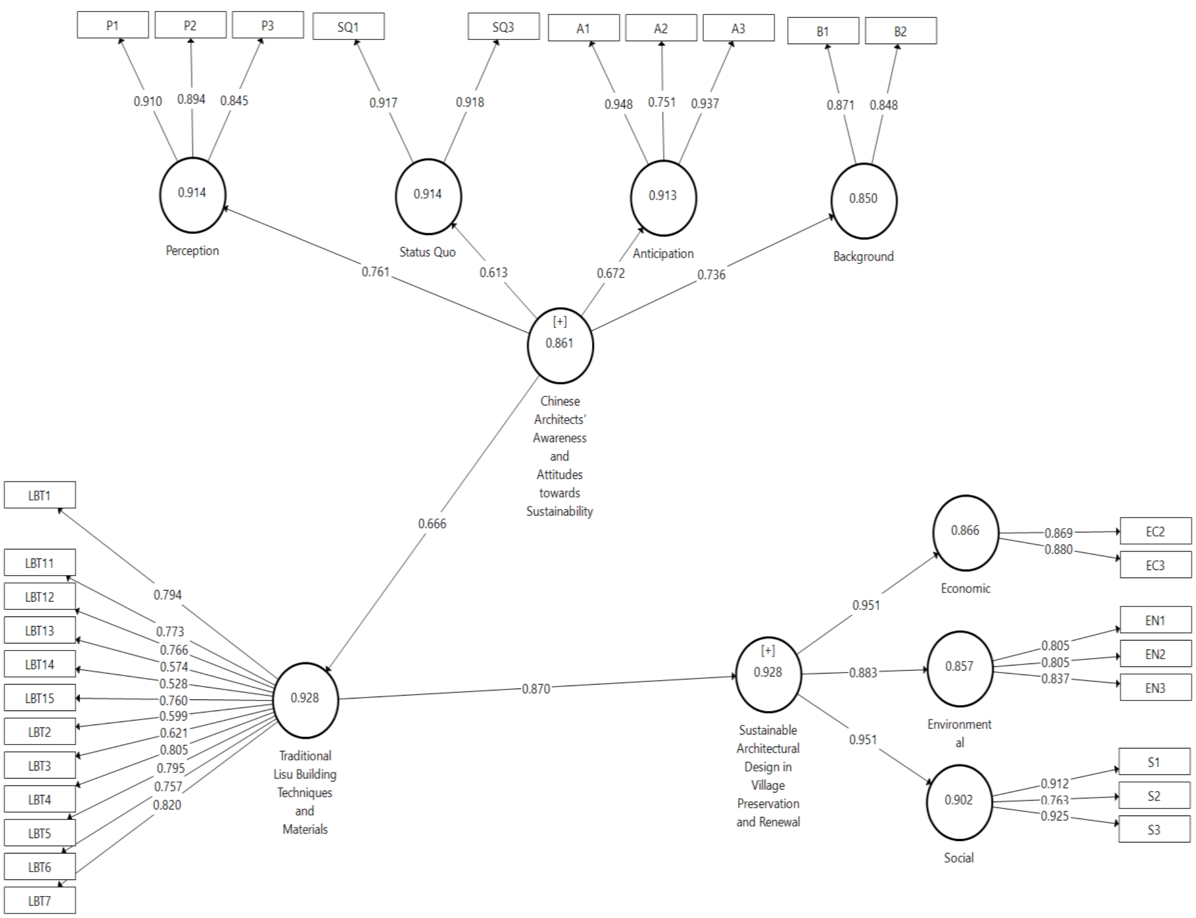

Figure 4. Structural Model Estimations

The Anticipation sub-constructs CR of 0.948, and AVE of 0.780 demonstrated strong reliability and convergent validity. Background and Perception sub-constructs had comparable profiles, with CR of 0.871 and 0.910 and AVE of 0.739 and 0.781. Status Quo sub-construct CR was 0.917 and AVE 0.842, showing internal solid consistency and convergent validity. Sustainable Architectural Design in Village Preservation and Renewal got 0.928 CR and 0.620 AVE, indicating reliability and convergent validity. The Social, Economic, and Environmental sub-constructs exhibit internal solid consistency with CR ratings of 0.912, 0.869, and 0.805. AVE values of 0.756, 0.764, and 0.666 for these sub-constructs showed convergence. Finally, Traditional Lisu Building Techniques and Materials had a CR score of 0.928 and an AVE of 0.523, demonstrating dependability and convergent validity. The study's measuring scales were reliable and valid based on internal consistency and convergent validity. This proves the research study's various data points' dependability and validity.

Table 3. Measurements of Constructs for Reliability and Validity

	Factor	**Original Sample**	**CR**	**Average Variance Extracted (AVE)**
Chinese Architects' Awareness and Attitudes towards Sustainability			0.861	0.485
Anticipation	A1	0.948	0.913	0.780
	A2	0.751		
	A3	0.937		
Background	B1	0.871	0.850	0.739
	B2	0.848		
Perception	P1	0.910	0.914	0.781
	P2	0.894		
	P3	0.845		
Status Quo	SQ1	0.917	0.914	0.842
	SQ2	0.918		
Sustainable Architectural Design in Village Preservation and Renewal			0.928	0.620
Social	S1	0.912	0.902	0.756
	S2	0.763		
	S3	0.925		
Economic	EC2	0.869	0.866	0.764
	EC3	0.880		
Environmental	EN1	0.805	0.857	0.666
	EN2	0.805		
	EN3	0.837		
Traditional Lisu Building Techniques and Materials	LBT1	0.794	0.928	0.523
	LBT11	0.773		
	LBT12	0.766		
	LBT13	0.574		
	LBT14	0.528		
	LBT15	0.760		
	LBT2	0.599		
	LBT3	0.621		
	LBT4	0.805		
	LBT5	0.795		
	LBT6	0.757		
	LBT7	0.820		

Table 4 includes model fitness metrics such as Q2predict, RMSE, and MAE. Statistics evaluate the model's expected accuracy and performance. Model Q2predict is 0.571, indicating modest predictive performance. The model explains 57.1% of outcome variable variation, showing good prediction. To verify model fitness, RMSE and MAE were measured after Q2predict. Model predictions and dataset values often differ by RMSE 0.055. Lower RMSE values indicate more excellent model performance and more accurate forecast values. This model's RMSE of 0.055 suggests accurate predictions. MAE = 0.070 is the average absolute difference between expected and actual values. Model performance improves with lower MAE and RMSE. This model's MAE of 0.070 shows a slight average difference between expected and actual values, indicating accuracy. Model fitness statistics reveal moderate predictive capacity, with RMSE and MAE values showing some accuracy. More analysis and review are needed to assess the model's performance and study applicability.

Table 4. Model Fitness Statistics

Q^2predict	RMSE	MAE
0.571	0.055	0.070

Table 5 shows construct-level Fornell-Larcker criterion correlation coefficients. Anticipation and background correlated by 0.192, lower than the square roots of the AVE for both constructs (0.883 and 0.860, respectively), and Economic and Environmental variables correlated by 0.756. Discriminant validity is further shown by the correlation coefficient between Traditional Lisu Building Techniques and Materials and all other constructs smaller than the AVE's square root. In conclusion, the Fornell-Larcker criterion results suggest that model structures have credible discriminant validity. The correlation coefficients between constructs are generally less than the square root of the AVE values, indicating that they assess different dimensions.

Table 5. Values of Fornell-Larcker Criterion

	1	2	3	4	5	6	7	8
Anticipation	0.883							
Background	0.192	0.860						
Economic	0.786	0.177	0.874					
Environmental	0.612	0.173	0.756	0.816				
Perception	0.142	0.736	0.133	0.169	0.884			
Social	0.767	0.175	0.906	0.719	0.145	0.869		
Status Quo	0.401	0.211	0.343	0.334	0.235	0.336	0.918	
Traditional Lisu Building Techniques and Materials	0.883	0.226	0.839	0.759	0.215	0.826	0.415	0.723

The discriminant validity requirements of the heterotrait-monotrait (HTMT) model component are shown in Table 6. Chinese architects' sustainability awareness and attitudes, traditional Lisu building methods and materials, and sustainable architectural design in village preservation and renewal. HTMT scores of 0.648 between Sustainable Architectural Design in Village Preservation and Renewal and Chinese Architects' Sustainability Awareness and Attitudes indicate good discriminant validity. This value proves the constructions' uniqueness by showing that construct correlation is less than the square root of the AVE for each construct. Traditional Lisu Building Techniques and Materials and Sustainable Architectural Design in Village Preservation and Renewal also had discriminant validity HTMT scores of 0.752 and 0.844. Construct individuality is also shown by correlations less than the square roots of their AVE values. Table 6 indicates good HTMT discriminant validity for the studied ideas. Values suggest that the study's constructs measure diverse underlying causes.

Table 6. Values of HTMT Criterion

	1	2	3
Chinese Architects' Awareness and Attitudes towards Sustainability			
Sustainable Architectural Design in Village Preservation and Renewal	0.648		
Traditional Lisu Building Techniques and Materials	0.752	0.844	

Table 7 shows that Chinese Architects' Awareness and Attitudes towards Sustainability, Economic, Environmental, and Social explain Sustainable Architectural Design in Village Preservation and Renewal with high R-squared values (0.905, 0.780, and 0.903). Anticipation, Background, Perception, and Traditional Lisu Building Techniques and Materials had modest R-squared values (0.443–0.579) and dependent variable effects. These findings show that independent elements matter in sustainable building design and other research.

Table 7. Statistics of R-Square

Variable	R-square
Anticipation	0.452
Background	0.542
Economic	0.905
Environmental	0.780
Perception	0.579
Social	0.903
Status Quo	0.376
Sustainable Architectural Design in Village Preservation and Renewal	0.757
Traditional Lisu Building Techniques and Materials	0.443

Table 8 shows variable connections from route analysis. First route: Chinese Architects' Sustainability Awareness and Attitudes to Traditional Lisu Building Techniques and Materials (0.666 path coefficient). The positive and meaningful links are shown by the components' high t-statistic of 6.777 (p 0.001). Traditional Lisu Building Techniques and Materials to Sustainable Architectural Design in Village Preservation and Renewal ranks second with a 0.870 route coefficient. These factors have a strong positive connection (t-statistic 17.112; p 0.001). The third method is Chinese architects' knowledge of sustainability, traditional Lisu building methods and materials, and sustainable village preservation and renewal design. A route coefficient of 0.579 indicates a high positive three-step connection. Significant correlation is revealed by the t-statistic of 5.854 (p 0.001).

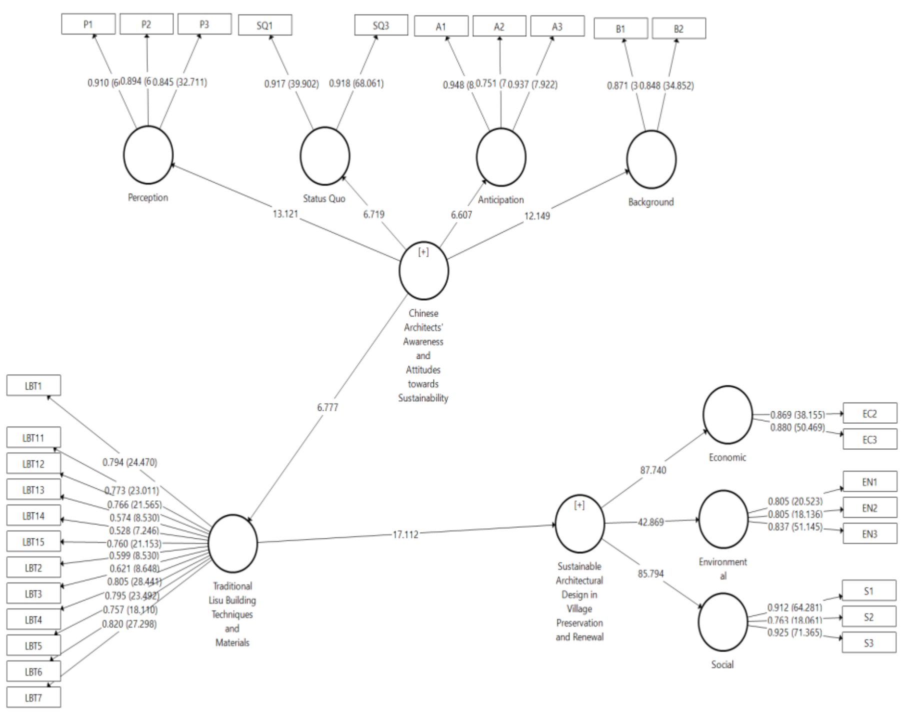

Figure 5. SEM Path Analysis Estimations

Route research demonstrates that Chinese architects' sustainability values improve Traditional Lisu Building Techniques and Materials. Traditional Lisu Building Methods and Materials Promote Village Renewal through Sustainable Architecture (figure 5). Indirectly, Chinese architects' understanding of sustainability and attitudes affect sustainable village preservation and renewal design by employing traditional Lisu building techniques and materials. This suggests that village preservation and revitalization require studying and using conventional construction methods for sustainable architectural design.

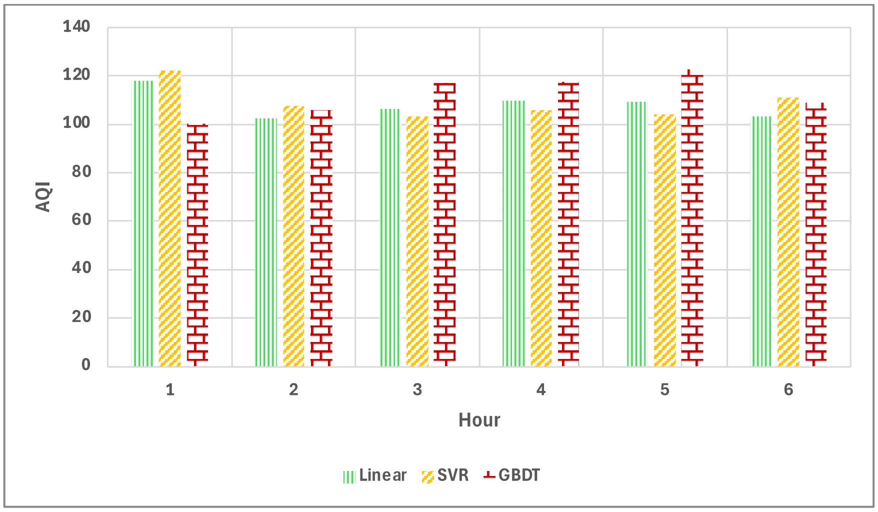

Figure 6. AQI analysis

The provided models must be evaluated using the database acquired from IoT to predict the AQI for the forthcoming hours. Figure 6 below presents the projected values. This study evaluates the performance of several models using Root Mean Squared Error (RMSE), Mean Absolute Error (MAE), and Mean Squared Error (MSE) as performance indicators. This standard method quantifies a model's inaccuracy by comparing the predicted and actual values matrix. The efficacy metrics of the framework are displayed in Figure 7.

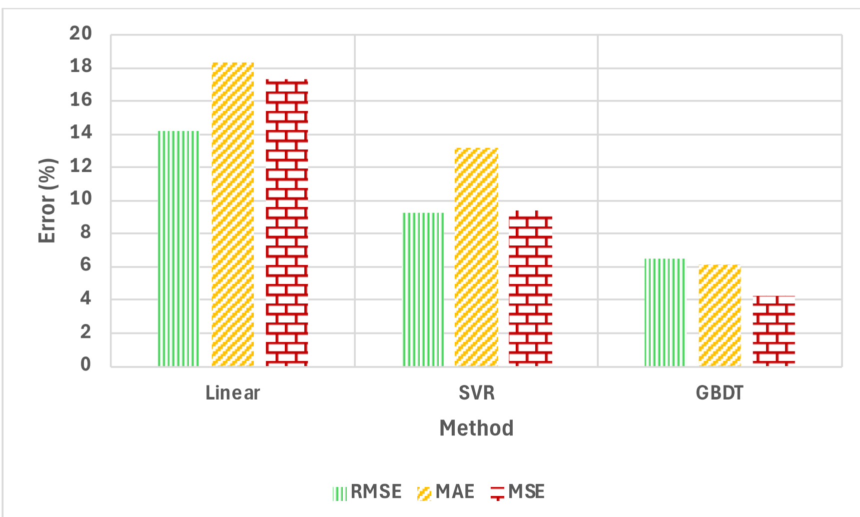

Figure 7. Error analysis

This study employs several AI techniques, such as the LR approach, SVR approach, and Gradient-Boosted Decision Trees (GBDT) ensemble approach, to forecast the AQI over the subsequent 5 hours. Upon examining the performance measurements of all designs, one identifies the minimal error level of the GBDT ensemble approach. This algorithm has been chosen to predict the region's AQI for the next 5 hours.

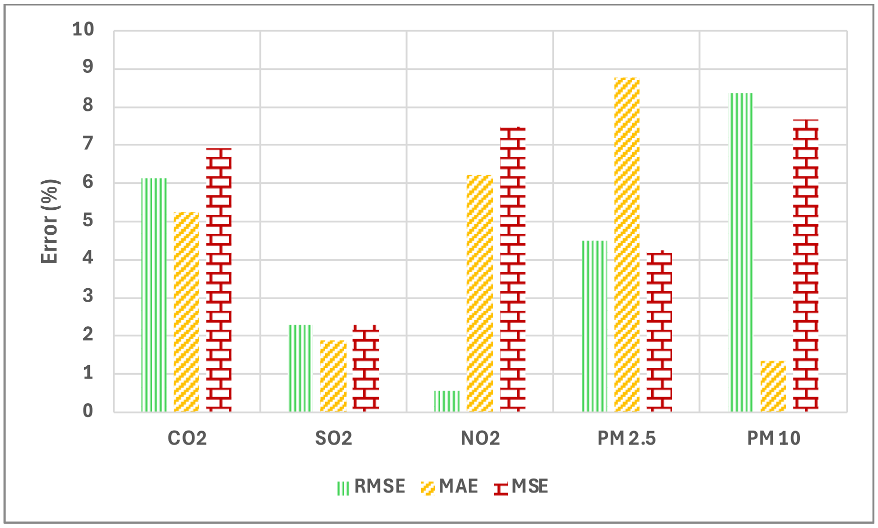

Figure 8. Error evaluation

The chosen verification data set comprises a compilation of diverse air contaminants collected through the surveillance system to facilitate a more intuitive assessment of the predicted accuracy of the LR, SVR, and GBDT ensemble methods. The efficacy of each model is assessed using three assessment metrics: MSE, RMSE, and MAE. Figure 8 illustrates that the GBDT ensemble approach has the smallest MSE, RMSE, and MAE compared to the other two methods for predicting contaminant concentrations. The GBDT ensemble approach exhibits the lowest overall forecasting error and demonstrates superior accuracy.

Thoroughly researched studies have enhanced the comprehension of environmentally sustainable construction techniques. The architects from Hunan Province are renowned for their environmentally conscious building ideas. The study highlights the necessity for more architectural endeavors in practice, research, and education to advance traditional wisdom, sustainable principles, and socially and environmentally conscientious designs. By developing these ideas, builders help build an ecosystem that is stronger and better for the world.

Conclusion

Using modeling methods, the air quality management and forecasting system described in this study is an excellent way to deal with the complicated nature of air pollution (AQ levels). By detecting energy reductions, AI can accelerate global efforts to protect the environment and save resources. Upon the completion of the project, an analysis is conducted to evaluate the most noteworthy discoveries and their impact on sustainable design solutions for the rehabilitation and preservation of villages in Hunan Province. The conclusion of the study is presented at the end of this chapter. The report concluded that Chinese architects' understanding of sustainability and attitudes had been enhanced. The behavior demonstrates that Chinese architects possess knowledge of environmental best practices and are enthusiastic about integrating them into their projects. The study emphasizes the significance of utilizing traditional Lisu building techniques and materials to promote sustainable architecture and preserve cultural heritage. Hunan architects prioritize public health and environmental preservation when designing new buildings. They achieve this by implementing energy conservation measures and utilizing environmentally friendly products. The study's findings demonstrate the rural architects' ingenuity and durability. Ongoing architectural education and practice are necessary to promote sustainable principles and effectively incorporate innovation, sustainability, and cultural heritage into architectural design. This guarantees the implementation of environmentally sustainable architecture. The efficacy of the proposed strategy is corroborated using pollution information, and the outcomes are assessed using several metrics. The experimental results indicate that the suggested model surpasses all existing techniques across several metrics. The prediction effectiveness of the proposed model can be enhanced in the future by using sophisticated deep-learning technology (Luo, 2022).

Theoretical and Managerial Implications

It examines the theoretical and practical effects of architectural methods, cultural preservation initiatives in Hunan, China, and sustainable building design. The study aimed to comprehend Chinese architects' perspectives on sustainable conservation and community revitalization. The majority of the studies assessed academic domains. Several conclusions from this investigation highlight the need for architects to know about and implement sustainable design. These ideas enhance social, economic, and environmental well-being and are critical knowledge for architects. The study focused on including ecological components in architecture curricula and education. Architects now have the tools to address sustainability challenges in their sector because of this technique. The findings also highlight how important it is for architects who restore and preserve Hunan villages to employ traditional building techniques and materials, especially those that the Lisu people utilize. Architects can create culturally appropriate solutions using these communities' rich cultural history and knowledge. As a result, a feeling of place and community will develop.

To guarantee that projects achieve community goals, the study highlights the importance of stakeholders, participatory design, and community participation. The book promotes connections between indigenous architecture and customs. Sustainable design protects and revitalizes rural areas by putting an emphasis on social and environmental aspects and utilizing a variety of techniques. It uses energy-efficient technologies and sustainable materials to create resilient communities. Beyond Hunan, the research findings are helpful to architects and practitioners who support the preservation of global villages and the implementation of sustainable building techniques. Adapting and using these ideas in various cultural and geographic contexts could raise architectural projects’ social and environmental consciousness. To solve today's issues, architects must know about community involvement, cultural preservation, and sustainability. The study finds that community involvement and indigenous knowledge enhance sustainable design theory and practice. Architects and practitioners can benefit from the insights and suggestions that this research has produced. These concepts support an integrated approach that balances cultural heritage, innovation, sustainability, and community well-being. According to the study, these best practices and ideas might be applied in Hunan Province and other comparable circumstances across the globe, advancing the conversation about sustainable design and village preservation.

Limitations and Recommendations

The article looks closely at the study's promise and limits. The study states that research on sustainable architectural design is essential to preserving and reviving the communities in Hunan Province. It emphasized the significance of this research while acknowledging the report's shortcomings. Considering the limited sample size of 326 architecture students from five Hunan colleges, this study is essential. Despite the considerable sample size, the results might only be representative of some local architects. Future studies should involve seasoned professionals and specialists from throughout the province to remedy this. By using a more thorough approach, the research can gain a deeper understanding of the perspectives, actions, and awareness of sustainable design among architects. Another problem with using self-reported data is response bias. Researchers could blend qualitative observations or interviews with quantitative surveys to overcome this restriction and better understand architects' environmental consciousness. Examining multiple facets would disclose the difficulties architects have in incorporating sustainable design principles into municipal preservation and revitalization programs.

The study focuses on using traditional Lisu building materials and techniques by Chinese architects; however, future research should include vital participants in village restoration and preservation. Examples include politicians, locals, and professionals in the building sector. Including many points of view helps researchers better grasp the opportunities, problems, and synergies of sustainable design in rural communities. The long-term assessment of sustainable design solutions should be the main focus of future studies. Solutions' social, economic, and environmental effects could be evaluated to guide future policy and design choices. Parametric design and BIM are examples of digital technologies that could enhance sustainable architecture. Research in this field can show how these technologies improve design, sustainability, and energy efficiency, particularly in community revival and preservation. Despite its limitations, this study advanced the knowledge of sustainable architectural design for Hunan Province village preservation and revitalization. These barriers must be removed, and more studies must be conducted to educate architects, legislators, and scholars more interested in eco-friendly and inventive construction techniques. Increased sample sizes, mixed-methods approach, the involvement of multiple stakeholders, ongoing evaluation of the results, and research into digital technologies in sustainable design are all necessary to achieve this goal. In future work, the suggested AI system equipped with IoT will be assessed by the time and predictive performance of various elements. It is evaluated for different circumstances and optimized by altering the context dynamically based on system operator parameters. With numerous nodes that can perform prediction algorithms, speed, and reliability are improved.

Acknowledgment

All the architects in Hunan Province, China, who willingly participated in this study and provided unique views and viewpoints are greatly appreciated. The research team is grateful to the research institutes and organizations that provided resources and guidance throughout the project. The research also understands the academic community and mentors whose insight and mentorship shaped the research's direction and quality.

Author Contributions

All Authors contributed equally.

Conflict of Interest

The authors declared that no conflict of interest.

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