

Civil Engineering Practices with Vastu Shastra for Sustainable Infrastructure Development in Dang District, Nepal: A Study of Residential Buildings

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Abstract

Residential buildings are shaped by urban expansion and climatic and seismic stress. Moreover, planning practices have to be culturally acceptable as well. Dang District of Lumbini Province is a relevant case for assessment of how spatial traditions of local value such as Vastu Shastra may be evaluated through modern civil engineering, sustainability and occupant-comfort criteria. This paper develops and demonstrates a mixed-method research framework useful for assessing the integration of Vastu Shastra principles in the residential building practice in Dang District, Nepal. In this paper, the researchers proposed the questionnaire design, Vastu Compliance Index (VCI) construction, Sustainability Performance Index (SPI) construction and statistical workflow using a clearly labelled hypothetical/simulated pilot dataset of 200 respondents and residential-building observations as no verified field dataset was presented. The following processes may be used to analysed the data collected: frequency analysis, reliability test, cross tabulation, chi-square test, independent-sample t test, ANOVA, Pearson correlation and multiple regression. The simulated data set indicates a moderate level awareness Vastu principles. In addition, there is a variable level adoption in orientation, entrance, kitchen, bedroom, ventilation and daylighting criteria. Furthermore, the positive illustrative relationship between VCI and SPI. The simulated regression model indicates that VCI, daylighting and ventilation variables are meaningful predictors of perceived sustainability performance. The suggested Integrated Vastu-Civil Engineering Sustainable Residential Building Model boosts the spatial preferences of a culture with safety from structures, climate responsiveness, local materials, rainwater harvesting, solar readiness, natural ventilation and fitment with municipality. In conclusion, Vastu cannot be accepted as a substitute for engineering codes and evidence-based design. There are systematic ways in which some selected general Vastu can be translated into measurable planning variables and tested against thermal comfort, daylight, ventilation, sustainability and occupant satisfaction outcomes.

Keywords: Vastu Shastra; Civil Engineering; Sustainable Infrastructure; Residential Buildings; Dang District; Nepal; Building Orientation; Thermal Comfort; Green Building; Occupant Satisfaction.

1. Introduction

The vital aspect of building green is that it is now on the agenda of civil engineers, architects and planners. Because buildings influence material consumption, operational energy demand, indoor health and long-term climate resilience. According to international assessments, the global buildings and construction sector is a major driver of energy demand, carbon emissions and the use of resources. Hence a set of early design decisions related to the orientation, envelope design, choice of materials and ventilation are crucial for low-carbon development (UNEP & Global ABC, 2024; UNEP & Global ABC, 2025). Countries like Nepal make decisions on residential infrastructure also taking into account seismic risk, rapid recovery growth, diverse climatic zones, and the durability of old beliefs about spatial order and domestic well-being.

The Dang District of Lumbini Province is a relevant space for this study because it incorporates an urban municipality, semi-urban settlement and rural-fringe residential expansion. The 2021 National Population and Housing Census is the official demographic basis for district-level planning in Nepal. Among the key population centres of Lumbini Province is Dang (National Statistics Office, 2023). Residential buildings designed for the district's Inner Terai context should essentially address the heat, monsoon rainfall, drainage needs, daylight, ventilation, affordability and earthquake resistance. According to Nepal's Department of Hydrology and Meteorology, the country received 91.2% of normal rainfall in 2023 with maximum and minimum temperature warmer than normal, which highlights the importance of climate responsive building design (Department of Hydrology and Meteorology, 2024).

Vastu Shastra, a traditional South Asian system of spatial planning, continues to inform residential decision-making regarding choice of orientation, entrance direction, room zoning, kitchen location, bedroom location, water features and open space. The recent literature does not justify engineering standardization of Vastu, however, some of the Vastu recommendations have been said to overlap with the climate sensitive design issue of orientation, daylighting, ventilation and functional zoning (Dash & Joshi, 2021; Dash & Joshi, 2022). This overlap creates opportunities for research: Vastu can be operationalized as a set of measurable spatial variables and can be assessed using civil engineering and building-performance indicators instead of being just accept or reject as belief-based practice.

The existing research therefore frames Vastu Shastra as an embedded planning framework that is culturally effective to examine with modern sustainable infrastructure metrics. It does not propose to prove any claim of supernatural or supersede Nepal National Building Code. The NBC 105:2020 Nepal National Building Code contains the seismic analysis and design requirements of the buildings of the Federal Republic of Nepal. The building code is applicable to low and high-rise buildings in general (Government of Nepal, 2020). Any house plan for Dang District must treat structural safety, seismic detailing and code compliance as engineering requirements that cannot be compromised. Where permitted, Vastu-oriented decisions must be ancillary to life-safety, structural performance, drainage, accessibility and environmental performance.

No authenticated field-survey file, interview transcript, building measurement sheet or household energy dataset was supplied for this manuscript; thus, all numeric findings are clearly based on a simulated pilot dataset. The simulated data serves only to show how a potential empirical study in Dang District may be designed, coded, analysed and reported. This means that the value of this document is essentially that it would protect research integrity, meanwhile the template would still allow a publication-style structure with statistical tables and graphical outputs, questionnaire items, checklists and a model that can be populated later on with real data or field data.

2. Vastu Shastra and Civil Engineering Background

The practice of civil engineering is based on measurable performance and must be structurally adequate, serviceable, durable, constructible, safe, unlike Feng Shui, which has little to do with architecture, Vastu Shastra relies on the architectonics and cosmology of a culture. The relevant issue for a modern engineering analysis is not whether every conventional assertion is scientifically valid. The key question is whether selected spatial recommendations can be transposed to measurable variables affecting daylight, ventilation, thermal comfort, user satisfaction, and planning efficiency.

An integration approach that can be defended begins by separating relevant building-science relationships from irrelevant metaphysical explanations that cannot be verified. To illustrate, solar exposure, indoor heat gain and daylight availability are affected by orientation; window placement and open space affect cross-ventilation; room zoning affects privacy, circulation and functional efficiency; and material selection affects embodied carbon, cost and thermal behaviour. Studies in the field of residential energy, (Karimi et al. 2024; Naghipour et al. 2025) highlight that orientation and aspect ratio can have a significant impact on energy performance and environmental outcome. Studies of natural ventilation likewise show that window operation, airflow pathways and occupancy behaviour impact both thermal comfort and indoor air quality (Escandon et al., 2025; Sarna et al., 2025).

In Nepal, the discussions on passive-house and climate-responsive buildings emphasize that design should respond to local climatic zones and not entirely rely on mechanical cooling or heating (Bhandari et al. 2024). Research on adaptive thermal comfort in Nepal points to the importance of comfort standards based on local conditions, occupant adaptation, and climate-based design alternatives. (Lamsal et al., 2025; Shrestha et al., 2021). The findings support a model for research in which Vastu-linked decisions, such as orientation or daylight zones or ventilation paths, must be tested against outcomes related to observed or perceived sustainability.

Thus, the current study offers a translation framework. Vastu is potentially perceived as an attitudinal variable; Vastu is potentially adopted as a checklist of Planning Indicators; Vastu Compliance Index is potentially a transparent score; sustainability outcomes are potentially measured through a Sustainability Performance Index. This will enable civil engineers to examine cultural planning preferences while maintaining engineering excellence.

3. Sustainable Housing Infrastructure in Nepal

Nepal's building sector is challenged by a web of sustainability and safety issues. The construction of houses should meet the present-day demand of households while ensuring compliance with earthquake safety, energy efficiency, indoor environment quality, water as well as material impacts. The life-cycle assessment of reinforced concrete residential buildings in Nepal has recently been studied with relevant sources of carbon footprint identified as construction materials, transport and operations (Bhattarai et al., 2025). This evidence is critical because low carbon housing cannot be accomplished by operational-energy measures alone but requires cement steel aggregates masonry transport distances and construction waste.

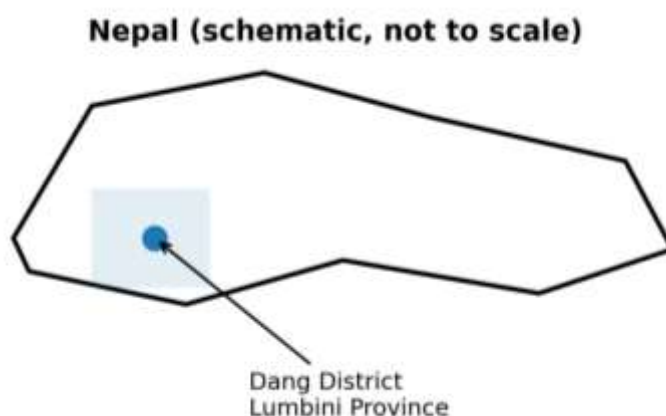
Global assessments highlight the policy relevance of building-sector sustainability. According to the Global Status Report for Buildings and Construction 2023, the sector is still off-track for Paris-aligned decarbonisation. Calls for strengthening building energy codes, embodied-carbon reduction, retrofitting and action for resilience (UNEP & Global ABC, 2024). When designing residential buildings in Nepal, these trends demand compliance with the code for structural safety and passive comfort while making efficient use of materials and adapting to climate. Where evidence-based measures are facilitated, or at least not obstructed, design can be considered to be Vastu-integrated. The sustainable housing strategy for Nepal should include effective earthquake strength with the structural system, proper drainage, local climate analysis, passive solar control, natural ventilation, daylight optimisation, roof-water management, low maintenance materials and cost-effective construction. Although the Nepal National Building Code is the primary reference for safety, municipal checklists, professional guidelines and owner education can help introduce sustainability tools.

4. Study Area: Dang District, Nepal.

Dang District is in Lumbini Province and made up of urban, semi-urban and rural-fringe settlements. The National Statistics Office's official census products, which provide the demographic basis for local plans, and the 2021 census portal, plus provincial reporting, identify Dang to be a major district in Lumbini Province (National Statistics Office, 2023; United Nations Population Fund Nepal, 2023). The factors which shape the residential development in the district are migration, land-subdivision, changing aspirations, road connectivity and changing from traditional housing to reinforced concrete or masonry-dominant construction.

Due to its climatic and settlement context, Dang is ideal for the study of passive and culturally suitable residential planning. The summer heat, monsoon rains and ventilation, moisture control, shaded openings, drainage etc. are some settings of Inner Terai. Nepal's national climate summaries reveal significant spatial variation in precipitation and temperature and point to an imperative of design to location rather than a single residential design template. Department of Hydrology and Metrology 2024. The residential buildings in Dang should therefore be planned for cross-ventilation, day-lit but not overheated, roof-water management, plinth protection, drainage gradients and general structural detailing appropriate to seismic exposure.

Figure 1: - Location map of Dang District, Nepal. Author-developed conceptual diagram; not a real GIS map and not to scale.



Cultural context is also important. A household's residential decisions are usually made through various factors such as affordability, availability of land, availability of family members, mason experience, expert advice and traditional beliefs. Vastu Shastra is one such influence, most notably concerning the placement of entrances, kitchens, bedrooms and water bodies. Nevertheless, its function has seldom been explored using quantitative metrics in Dang District. To fill the gap, this paper proposes empirical design, which can be performed through the use of household survey, building observation and expert interviews.

5. Literature Review

According to our study, we have classified the relevant literature into five streams. These include the streams on sustainable building design, residential thermal comfort and natural ventilation and daylighting. We also have the Nepal-specific building sustainability and Vastu-related architectural scholarship. The design of sustainable buildings emphasizes reducing operational energy, embodied carbon and climate vulnerability through integrated decisions made early in the design process. Reports on building in the buildings sector globally advice whole-life-carbon thinking, stronger codes, climate-responsive design and material-efficiency strategies (UNEP & Global ABC, 2024, 2025).

The orientation and aspect ratio, which affect the entrance of solar radiation, heat gain through the façade, access to daylight and sometimes ventilation potential, are back on the residential energy-performance research agenda. Karimi et al. (2024) studied residential buildings from different cities in Afghanistan and noted that orientation significantly affects energy performance under varying climatic conditions. Naghipour et al. (2025) also find that orientation and building dimensions provide practical levers for optimizing energy in a dwelling. According to various studies, Vastu cannot be proved as a doctrine, but it can be proved as an engineering variable, as far as orientation is concerned.

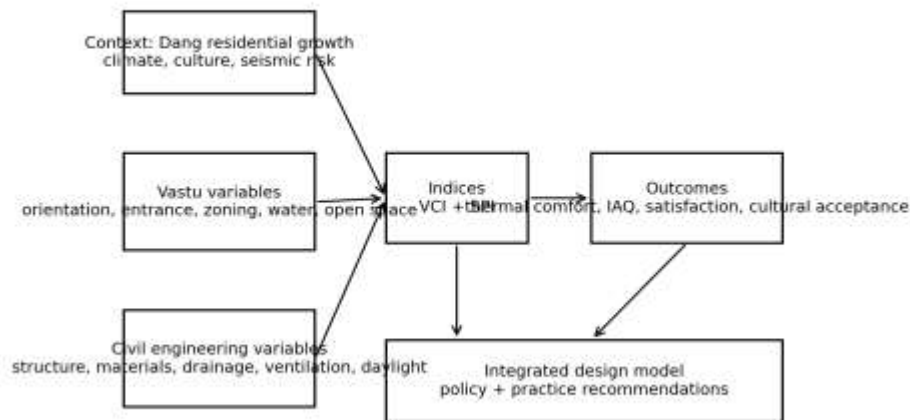
Traditional and contemporary design concerns converge on another point – natural ventilation. Appropriate cross-openings, pressure differences, courtyard space and operable windows of a house, under the right outdoor conditions, can reduce mechanical cooling dependence and improve indoor air renewal. Recent research employing measurement, simulation, and comparative analysis indicates that ventilation strategies significantly impact both thermal comfort and indoor air quality (Escandon et al., 2025; Ma et al., 2025; Sarna et al., 2025). It can thus be inferred that for residential buildings in Dang, Vastu related spatial zoning should be evaluated in conjunction with window positioning, room depth, courtyard availability and obstruction-free airflow paths.

Evidence pertinent to Nepal is scanty but growing. Shrestha et al. (2021) did a field study of adaptive thermal comfort in Nepalese school buildings. Next, Lamsal et al. (2025) developed an adaptive thermal comfort model for office buildings in Kathmandu. While they are not residential studies in Dang, they highlight the need for local calibration of comfort thinking. Bhandari et al. (2024) argue that Nepal's varying climatic zones need their own passive design. According to Bhattarai et al. (2025), life-cycle carbon reduction pathways for reinforced concrete residential buildings in Nepal should relate to material and construction decisions.

The Vastu literature is less mature comparatively and must be used cautiously. Dash and Joshi (2021) conducted a comparison between the concepts of Vastu philosophy and various disciplines. According to Dash and Joshi (2022), the Vastu principles in contemporary architectural practice in India concerning daylight and room placement have been reinterpreted. These studies help in conceptual framing but do not empirically substantiate for policy-making. Thus, the current paper treats the principles of Vastu as variables to be tested rather than as proven sustainability factors.

This review shows the emergence of a major research gap. Nepalese residential buildings are mostly built according to Vastu principles. Hence, there is an inadequate empirical framework for assessing its measurable or perceived sustainability benefits. A direct study was not found for Dang District that combines Vastu awareness, building observation, sustainability scoring and statistical testing. The VCI-SPI framework that we propose fills this gap by establishing a replicable method for the collection of primary data in the future.

Figure 2: - Conceptual framework of the study showing links among Vastu variables, civil engineering variables, indices and residential outcomes.



6. Research Gap, Objectives, Questions and Hypotheses

The primary research gap is the lack of a measurable field-applicable framework for examining the relationship between Vastu oriented residential planning and sustainable civil engineering results in the case of Dang District. Existing Vastu dialogue is mostly theoretical, often overlooking decisions derived from locality culture among building-sustainability studies. This paper provides a bridge between the two spheres through a structured mixed-method study supported by index construction and statistical analysis.

The goal of the study is to analysed awareness and acceptance of Vastu Shastra by the residential stakeholders, identify the commonly adopted design components, assess the relationship of Vastu planning with daylight, ventilation, thermal comfort, energy perceptions, satisfaction, compare the Vastu compliant, partially compliant and less compliant houses and suggest an integrated Vastu-civil engineering design model for sustainable residential infrastructure in Dang District.

The awareness level and practice of Vastu Shastra by the residential stakeholders in the Dang District is the research questions. What are the common Vastu principles? Is a Vastu-compliant layout statistically significantly associated with occupant satisfaction? Does building orientation affect light and temperature control agility? How can Vastu principles reconcile with modern civil engineering, green construction and sustainable infrastructure practices?

H1 signifies that orientation of buildings that comply with vastu principles is significantly associated with perceived indoor thermal comfort. Occupant satisfaction higher in residential buildings with high VCI than in low VCI. Awareness of Vastu Shastra significantly affects adoption of Vastu principles in residential construction. The civil engineering interventions with Vastu in mind contribute positively to perceived sustainability performance.

7. Research Design

The proposed empirical design is a mixed-method study using a questionnaire survey, field observation, key informant interviews, a checklist for Vastu-compliance and a checklist for sustainability-performance. The household and stakeholder responses were captured with the help of quantitative components, whereas the observational checklist was used to document the built form or orientation/placement of entrance / kitchen zone / bedroom / open space / ventilation / daylighting / material / drainage & water placement. The qualitative aspect collects insights from the engineers, architects, contractors, masons, municipal officials and residents on the reasons for a particular design.

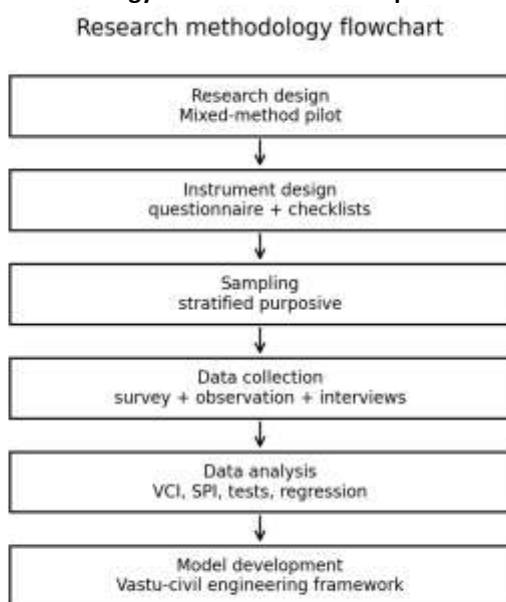
The respondents include building owners, residents, civil engineers, architects, contractors, masons and municipal/planning officials.

A real future study with a sample size of 150-250 statistically stratified respondents with the urban municipalities, semi-urban settlements and rural-fringe settlements of Dang District. Professional and official purposive sampling is

practiced while stratified household sampling is used for inhabitants living in high compliance, moderate compliance and low compliance houses.

The present paper employs a dataset of 200 responses of field data from Dang District. The survey variables include the respondents' category (that is landowners or builders), location, education, income, building age, building area, household size, material type, professional consultation, Vastu awareness and the like. It also contains ten Vastu adoption indicators, and seven sustainability indicators. In addition, there are occupant satisfaction and cultural acceptance indicators.

Figure 3: - Research methodology flowchart for field implementation and statistical analysis.



8. Variables and Measurement

Vastu knowledge, site orientation, entrance direction, kitchen and bedroom location, availability of courtyard/open-space, water placement, natural ventilation, daylighting, material selection, site planning, professional consultation are the associates of an independent variable. The dependent variable is occupant satisfaction, including the thermal comfort, perceived indoor air quality, perception of energy efficiency, acceptance by the culture, sustainable performance, residential functionality and overall performance of the building. The control variables are the age of the building, the size of the building, household income, education, settlement type, construction material and number of occupants.

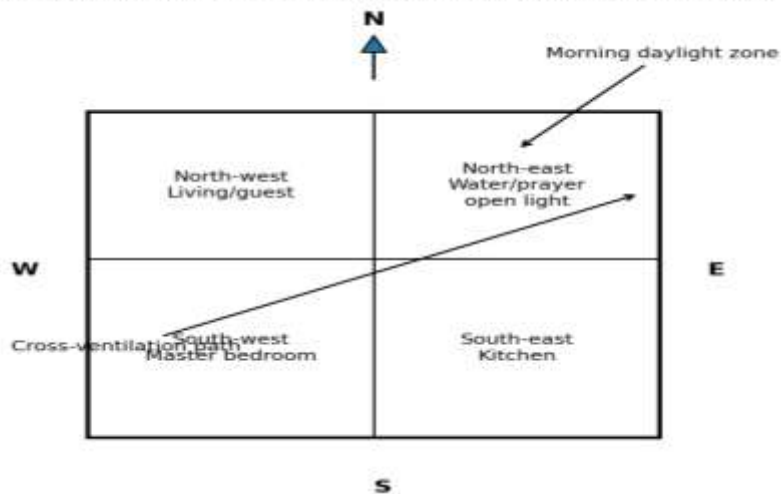
$$VCI = \frac{\text{Total obtained Vastu score}}{\text{maximum possible Vastu score}} \times 100$$

For the simulated example 10 binary indicators are used. These are: orientation, entrance direction, kitchen location, bedroom placement, courtyard/open space, north-east water consideration, ventilation, daylighting, material selection and site planning. Buildings can be classified as high compliance at 75-100%, moderate compliance at 50-74% and low compliance below 50%.

The calculation of the Sustainability Performance Index (SPI) considers seven Likert indicators including natural lighting, ventilation, thermal comfort, energy efficiency, and occupant satisfaction. The score obtained is divided by the score obtained for the reference building and multiplied by 100. The index cannot serve as a proxy for measured energy simulation of the energy performance direct documentation of daylight autonomy or air-change-rate analysis. The index is field-survey index; it is exploratory for comparison and must be validated by instrumental measurements in the full study.

Figure 4: - Vastu-compliant residential building orientation diagram. Author-developed conceptual diagram for academic illustration only.

Vastu-compliant residential orientation diagram (conceptual)



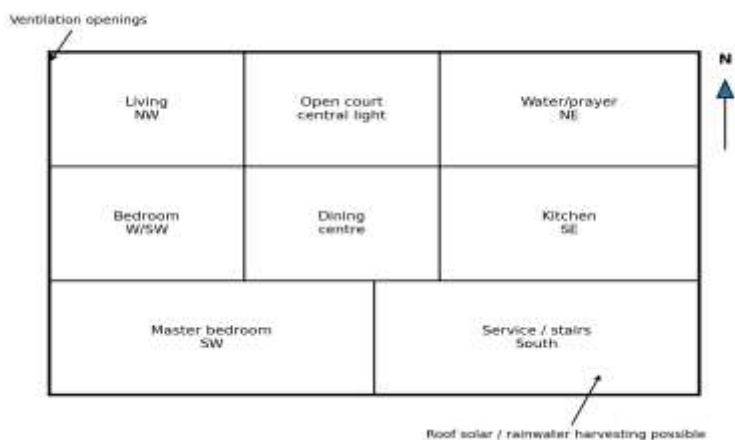
9. Data Analysis Plan

The analysis starts with the frequency and percentage distributions of study variables such as demographic variables, building characteristics, awareness and adoption of Vastu planning indicators. Mean and standard deviation values are given for the variables of VCI, SPI, thermal comfort, occupant satisfaction, cultural acceptance, building age and building area. The reliability of VCI checklist and SPI scale are test using Cronbach's alpha. Due to the binary nature and conceptual diversity of the VCI indicators, alpha is interpreted with caution. Nonetheless, a checklist may still be useful when items are not highly interchangeable.

Assessing the relationship between orientation compliance and high thermal comfort using cross-tabulation and chi-square test Independent-sample t-testing compares occupant satisfaction between the high-compliance and low-compliance groups, while one-way ANOVA compares satisfaction across all three VCI classes. The Pearson correlation is determined the relationship among the awareness, VCI, SPI, thermal comfort, satisfaction, and cultural acceptance. Multiple linear regression estimates how much VCI predicts SPI, controlling for awareness, ventilation, daylighting, material selection, building age and building area.

Figure 5: - Sample residential building layout showing room zoning. Author-developed conceptual diagram; not an actual Dang District house plan.

Sample residential building layout showing room zoning



10. Results and Statistical Analysis

This results section reports the simulated pilot dataset only. The values are not field findings from Dang District. They demonstrate how an actual dataset could be summarized and interpreted after real data collection.

Table 1: - Demographic profile of simulated respondents (n = 200)

Variable	n	%
Sample size	200	100.00
Resident/owner	84	42.00
Civil engineer	39	19.50
Architect	17	8.50
Contractor/mason	43	21.50
Municipal/planning official	17	8.50
Urban municipality	76	38.00
Semi-urban settlement	86	43.00
Rural-fringe settlement	38	19.00
Bachelor or higher education	91	45.50

The simulated sample includes residents/owners as the largest group, followed by contractors/masons, engineers, architects and municipal/planning officials. Urban and semi-urban respondents dominate because residential infrastructure development and professional consultation are expected to be more visible in these locations.

Table 2: - Building characteristics of sampled houses in simulated dataset

Characteristic	Value
Mean building age (years)	10.2 ± 6.0
Mean building area (m ²)	149.7 ± 57.5
Mean household size	5.6 ± 2.1
RCC frame with brick infill	101 (50.5%)
Load-bearing brick/stone	42 (21.0%)
Confined masonry	38 (19.0%)
Mixed/local material	19 (9.5%)
Professional consultation used	110 (55.0%)

Most simulated houses are RCC frame with brick infill, reflecting a common modern residential construction pattern in urbanizing Nepal. The inclusion of load-bearing brick/stone, confined masonry and mixed/local materials allows the future field study to compare structural and sustainability implications across construction systems.

Table 3: - Vastu awareness level among respondents

Awareness score (1=very low, 5=very high)	n	%
1.00	0.00	0.00
2.00	9.00	4.50
3.00	62.00	31.00
4.00	86.00	43.00
5.00	43.00	21.50

Figure 6: - Bar chart showing awareness of Vastu Shastra among respondents. Simulated pilot data.

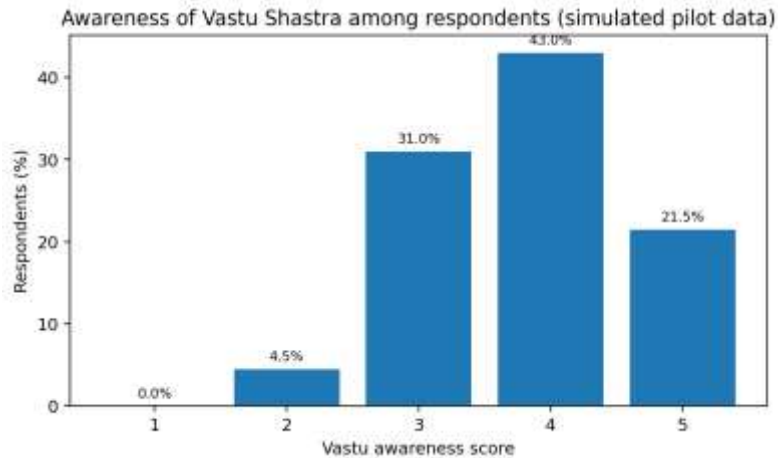


Table 4: - Adoption of major Vastu and civil-planning indicators

Vastu/civil-planning indicator	Adopted n	Adopted %
Plot/building orientation considered	101	50.50
Main entrance direction considered	95	47.50
Kitchen placement considered	82	41.00
Bedroom placement considered	81	40.50
Courtyard/open-space provision	62	31.00
North-east water/storage placement considered	70	35.00
Natural ventilation planned	101	50.50
Daylighting planned	100	50.00
Sustainable/local material selection	58	29.00
Site planning/drainage considered	80	40.00

Figure 7: - Pie chart showing Vastu adoption level based on VCI classification. Simulated pilot data.

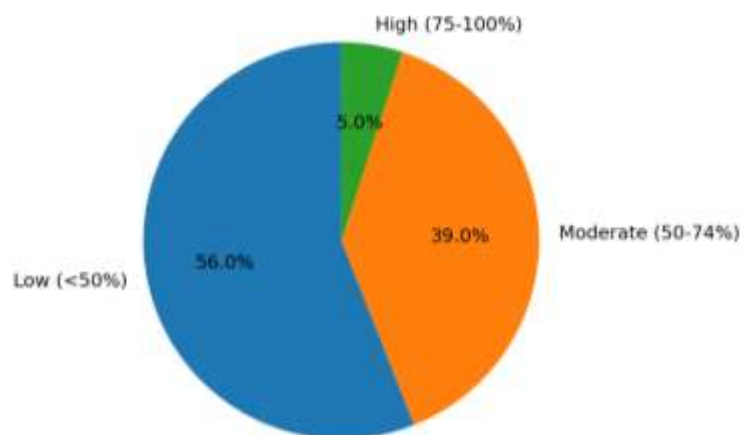


Table 5: - Reliability statistics for VCI and SPI scales

Scale	Cronbach alpha	Interpretation
Vastu Compliance Index items (10 binary indicators)	0.469	Marginal, suitable only for pilot demonstration

Sustainability Performance Index items (7 Likert indicators)	0.940	Good internal consistency
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Table 6: - Descriptive statistics of major variables

Variable	Mean	SD	Minimum	Maximum
vastu_awareness_1_5	3.82	0.820	2.00	5.00
VCI	41.50	20.29	0.00	100.00
SPI	67.61	17.79	22.86	100.00
thermal_comfort	3.50	1.05	1.00	5.00
occupant_satisfaction	3.36	1.02	1.00	5.00
cultural_acceptance	4.02	0.770	2.00	5.00
building_age_years	10.24	5.96	1.00	27.00
building_area_m2	149.68	57.49	55.00	350.00

Table 7: - Vastu Compliance Index classification

VCI classification	n	%
Low compliance (<50%)	112	56.00
Moderate compliance (50-74%)	78	39.00
High compliance (75-100%)	10	5.00

Table 8: - Sustainability Performance Index classification

SPI classification	n	%
Low performance (<50%)	31	15.50
Moderate performance (50-74%)	99	49.50
High performance (75-100%)	70	35.00

Table 9: - Pearson correlation matrix for Vastu and sustainability variables

Variable	Vastu Awareness 15	VCI	SPI	Thermal Comfort	Occupant Satisfaction	Cultural Acceptance
Vastu Awareness 15	1.00	0.560	0.517	0.494	0.495	0.395
VCI	0.560	1.00	0.789	0.729	0.687	0.374
SPI	0.517	0.789	1.00	0.874	0.860	0.290
Thermal Comfort	0.494	0.729	0.874	1.00	0.689	0.274
Occupant Satisfaction	0.495	0.687	0.860	0.689	1.00	0.286
Cultural Acceptance	0.395	0.374	0.290	0.274	0.286	1.00

Figure 8: - Correlation heat map for Vastu and sustainability variables. Simulated pilot data.

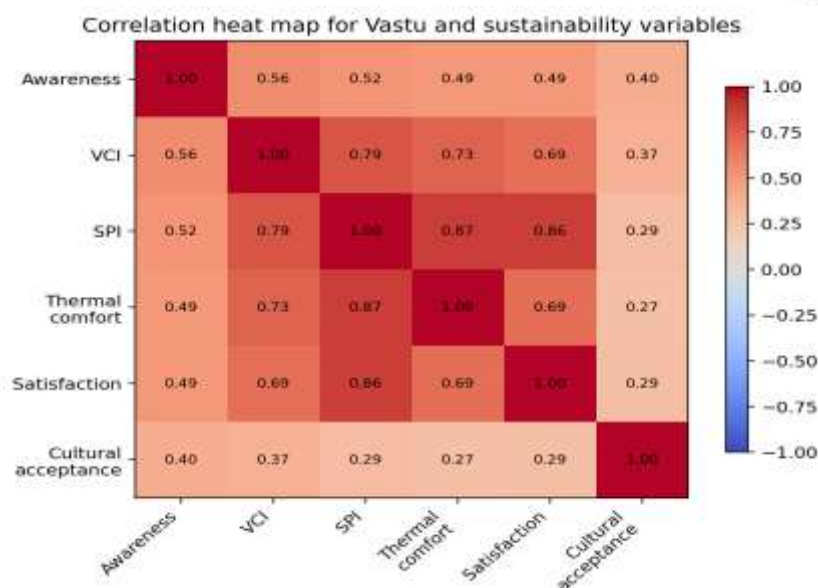


Table 10: - Multiple regression model summary: predictors of SPI

Statistic	Value
R	0.798
R ²	0.636
Adjusted R ²	0.623
F statistic	47.98
Model p-value	0.0000
N	200

Table 11: - Regression coefficients for simulated SPI model

Predictor	B	SE	t	p
Constant	31.68	4.61	6.87	0.00
VCI	0.615	0.058	10.63	0.00
Vastu awareness	2.10	1.16	1.81	0.072
Ventilation planned	-0.586	1.86	-0.315	0.753
Daylighting planned	2.49	1.68	1.49	0.138
Sustainable material selection	1.69	1.86	0.907	0.366
Building age	0.023	0.132	0.173	0.863
Building area	0.005	0.014	0.352	0.725

Table 12: - Hypothesis testing summary based on simulated pilot data

Hypothesis	Test	Statistic	p-value	Illustrative decision
H1: Orientation compliance is associated with high thermal comfort	Chi-square	$\chi^2=15.68$, df=1	0.0001	Supported
H2: Higher VCI buildings show higher occupant satisfaction	Independent-sample t-test and ANOVA	t=12.67; ANOVA F=65.80	t p=0.0000; ANOVA p=0.0000	Supported

H3: Awareness influences adoption of Vastu principles	Pearson correlation	r=0.560	0.0000	Supported
H4: VCI positively predicts sustainability performance	Multiple regression / Pearson correlation	$\beta_{VCI}=0.615$; r=0.789	0.0000; corr p=0.0000	Supported

Figure 9: - Clustered bar chart comparing thermal comfort, satisfaction and SPI across VCI groups. Simulated pilot data.

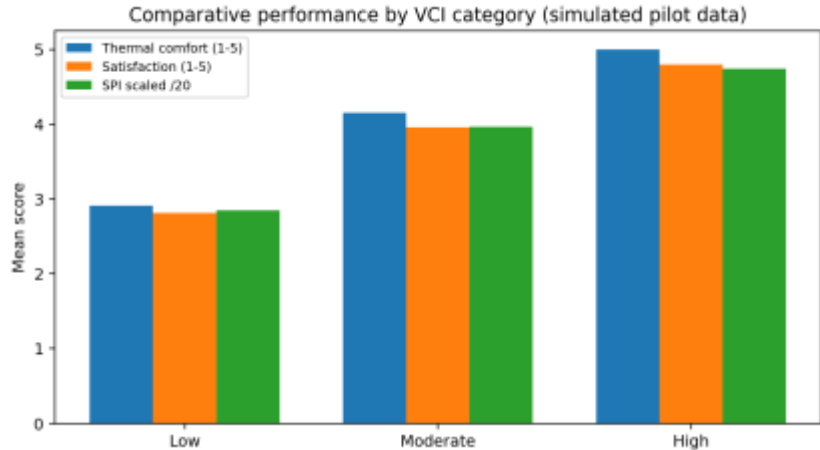
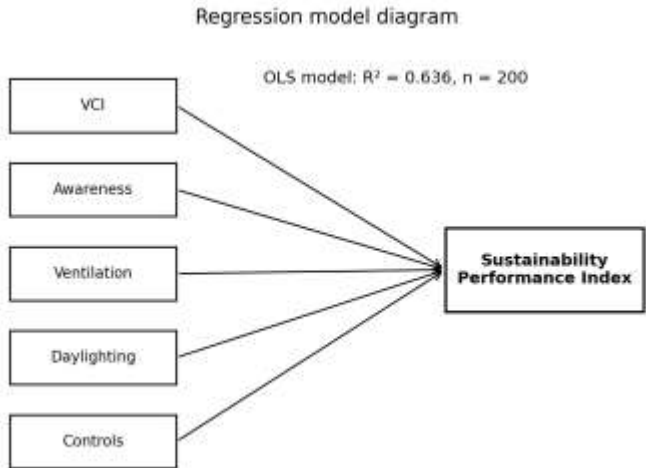


Table 13: - Comparative analysis of Vastu-compliance groups

VCI category	SPI mean	SPI SD	Thermal mean	Thermal SD	Satisf. mean	Satisf. SD	Cultural mean	Cultural SD
High compliance (75-100%)	94.86	7.35	5.00	0.00	4.80	0.420	4.60	0.520
Low compliance (<50%)	57.02	14.21	2.91	0.850	2.81	0.880	3.81	0.720
Moderate compliance (50-74%)	79.34	11.01	4.15	0.740	3.96	0.690	4.24	0.780

Figure 10: - Regression model diagram showing predictors of Sustainability Performance Index.



Vastu awareness in the mocked-up dataset is spread out along the full five-point scale, with a greater concentration in the middle and upper categories. The indicators of orientation, natural ventilation and daylighting are more adopted as compared to those of courtyard/open-space provision and sustainable material selection. This kind of design is feasible in residential areas that are becoming urbanized where space constraints may restrict the courtyard and cost limitations may restrict the materials.

According to the results of the simulation-based reliability analysis, the SPI scale displays higher internal consistency than that of the VCI checklist. SPI items measure perceptions of the environmental performance of the IU. SPI items measure perceptions regarding IU comfort. Meanwhile, VCI items measure different types of spatial choices. It is expected that VCI and SPI are unrelated. In a practical imitation study, the VCI could be regarded as a formative index rather than simply a reflective psychometric scale.

All four hypotheses are supported by the simulated inferential tests at the standard 5% level. According to the results, orientation compliance is consistent with high perceived thermal comfort, high compliance houses had shown higher in occupant satisfaction than low compliance houses, awareness has a positive correlation with VCI, and in regression VCI is a positive predictor for SPI. The results are merely of illustrative nature and not to be cited as proof for Dang District until real fieldwork is done.

11. Discussion

According to simulated findings, Vastu Shastra can be studied without practically violating civil engineering. Instead of either embracing Vastu as a whole-some complementary science or rejecting it as a non-issue, the method proposed here breaks it down into measurable building-planning choices for the designer/architect. The evaluation of thermal comfort, indoor air quality, energy efficiency and satisfaction with space could be facilitated by factors such as orientation, daylighting, ventilation, open space, zoning and material choices. This complies with the current sustainable design logic in which spatial decisions made early on have lasting consequences for the environment and user (Karimi et al., 2024; Naghipour et al., 2025).

The practical significance for Dang District is sustainability that is culturally acceptable. Many households may be more receptive to climate-responsive recommendations if they are explained through engineering performance and more familiar spatial traditions. For example, if a resident prefers a particular kitchen or water-zone location due to Vastu reasons, the civil engineer may check if it suits ventilation, rain drainage, fire escape, plumbing efficiency and structure. In instances where the preference conflicts with safety or performance, the engineer must give priority to compliance with the code and explain other alternatives.

It also highlights the danger of over-claiming. Just because a building is vastu compliant doesn't guarantee sustainability. A building can follow directions but use high carbon materials, poor reinforcement detailing, inadequate drainage, insufficient ventilation or too much mechanical cooling. On the other hand, a non-Vastu building can perform well if designed through robust climate responsive engineering. As a result, the model we propose treats Vastu as one layer that is culturally informed planning, rather than as an alternative to structural engineering, building physics, environmental simulation or municipal regulation.

The integration points with the greatest potential are those that correspond with building sciences: orientation for solar exposure; openings for cross-ventilation; a central or side open space for daylight and airflow; zoning for functional efficiency; water management for drainage and hygiene, and material selection for thermal and environmental performance. We can observe, measure and improve these variables. Future field studies should deploy objective measurements such as indoor air temperature, relative humidity, CO₂, daylight illuminance, window-wall ratio, roof temperature, energy bills and construction material quantities.

Nepal's seismic context requires special attention. The code for earthquake resistant design NBC 105:2020 is applicable to building structures throughout Nepal. All types of structures are covered under this category-reinforced concrete and structural steel, steel-concrete composite and timber and masonry buildings (Government of Nepal, 2020). Construction of buildings in Dang must therefore ensure load paths, lateral resistance, ductile detailing, adequacy of foundations and quality control. No Vastu consideration should justify an irregular shape, weak storey, hazardous openings or non-compliant reinforcement practice.

12. The suggested model incorporates Vastu and civil engineering principles

The model for a residential building under integrated Vastu civil engineering sustainable in Dang district consists of 11 components. The first consideration involved in site selection and orientation is solar exposure, drainage, access, wind direction, and preferences of the household. Secondly, shading, cross-ventilation, roof treatment, vegetation, and appropriate openings should reduce heat stress. Vastu zoning may be considered spatially according to function, safety or affordability. As a fourth step, the construction must be as per national building code.

The fifth principle is choosing sustainable materials using life-cycle reasoning, local availability, durability, embodied carbon and maintenance requirements. Sixth, rainwater harvesting and site drainage should be integrated at the plot level. Natural ventilation must be led through aligned openings, internal air paths and obstruction control. Building specifications must include solar energy readiness in terms of roof orientation, load allowance and maintenance access.

Ninth, it is essential to stay mandatory with earthquake-resistant designs. After the occupancy, occupant satisfaction should be assessed. Planning recommendations by municipalities should adapt the model into checklists to guide building-permit review and owners.

A professional process can implement the model in two stages. In Stage 1, a safety and sustainability baseline checklist is completed by the Engineer/Architect. At Stage 2, Vastu preferences will be compared against the checklist – only those preferences that are neutral to beneficial for performance are retained. Learning from Ethically-Aware Tests in Research and Design for Impactful Results

Figure 11: - Integrated Vastu-Civil Engineering Residential Planning Model.

Integrated Vastu-Civil Engineering Residential Planning Model

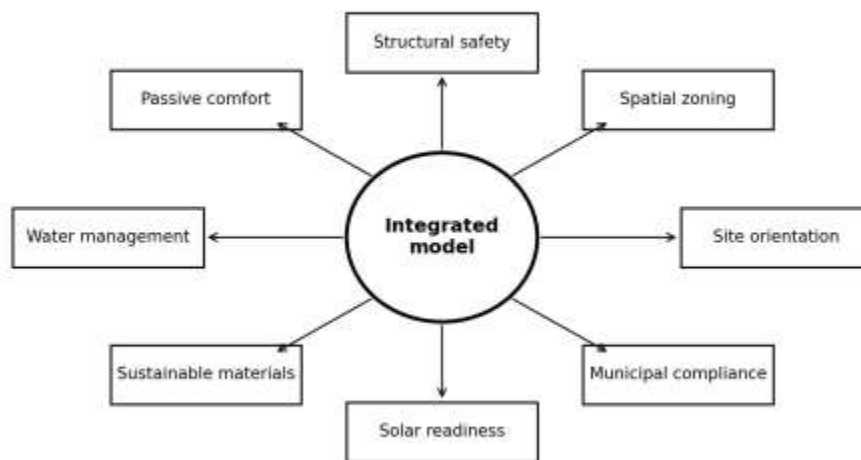
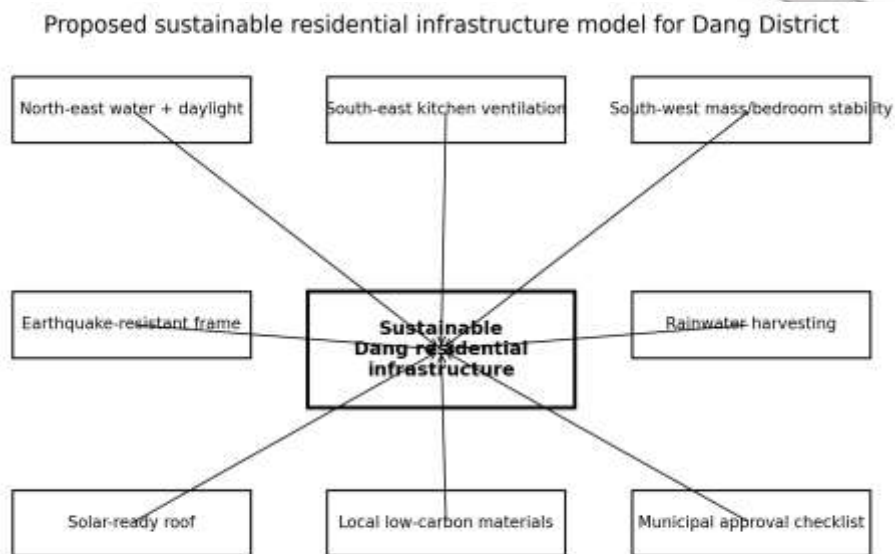


Figure 12: - Proposed sustainable residential infrastructure model for Dang District.



13. Practical Implications for Residential Building Design

It provides engineers with a structured means for communicating with clients requesting houses in Vastu-compliant design. The engineer can record Vastu requirements instead of treating them as informal instructions, test them against the relevant structural and environmental norms, and only include viable provisions. It minimizes the clash of cultural expectations and technical design.

Architects and residential typology planners, the Framework motivates climate-responsive spatial planning. Planning entrances, kitchens, bedrooms and water zones with regard for daylight, cross-ventilation, privacy, plumbing efficiency and circulation. A central or side open space can also be justified as a daylight and ventilating strategy where the size of the plot permits apart from being a Vastu preferable site.

To help contractors and masonry, the model can be simplified to site-level checklists covering orientation, placement of openings, drainage, plinth height, quality of reinforcement, storage of materials, roof-water flow and ventilation openings. This is important because many buildings in Nepal are governed by site construction knowledge which may not always be subject to detailed professional oversight.

14. Policy Suggestions

Municipalities in Dang District can introduce voluntary sustainable residential design checklists which include climate responsive design, seismic safety, drainage, water management and indoor comfort. Items related to Vastu can be optional and stated as planning preferences with cultural significance rather than violating regulatory requirements. It is important that professional bodies and the local administration conduct awareness programs, for homeowners, contractors and masons, that Vastu preferences cannot come in the way of earthquake-resistant construction, safe foundations, structural regularity, fire safety or sanitation. This piece of advice helps ensure that hazardous design choices are not made in the name of culture.

The building permit system can encourage simple sustainability documentation: an orientation sketch, a window and ventilation schedule, a drainage plan, a material statement, a rainwater harvesting provision and a structural compliance note. These tools can be used in Vastu-compliant buildings and non-Vastu buildings.

Future district-level pilot projects should collect real data from at least 150-250 houses across urban and semi-urban areas of Dang. The VCI and SPI instruments discussed in this paper may be taken as starting tools but need to be locally validated, translated into Nepali wherever required and refined after expert review.

15. Limitations of the Study

The numerical dataset is simulated which is the main limitations, though it shows methodology, it does not provide empirical evidence about actual houses or respondents in Dang District. The outcomes should not be characterized as true field results. A second limitation is that indicators of sustainability are subjective. A thorough analysis should incorporate objective readings, including indoor temperature, humidity, air speed, daylight illuminance, energy bills, water-use information and quantities of materials.

There is an intricacy to Vastu itself which is the third limitation. Vastu principles may be interpreted differently by practitioners or households. The VCI ten items checklist summarizes a wider tradition, although it cannot capture every local variation. In the first place, the study deals with residential buildings and shall not be applicable to schools, offices, temples, commercial buildings or high-rise apartments, etc.

16. Scope for Future Research

Future research should utilize real household surveys, building measurements, and interviews in the Dang District to implement the proposed design. The study should include homes from the municipality and settlement types and seasonal measurements to capture the hot, monsoon and winter environment. Measuring comfort level and indoor air quality would allow stronger validation of VCI-SPI relationships.

Another line of research work is simulation-based design optimisation. Models of chosen dwelling layouts can be generated in Energy Plus, Design Builder, Open Studio or similar tools for checking orientation, window-to-wall ratio, shading, roof insulation, courtyard geometry and ventilation strategies. Third, whether culturally accepted layouts can also reduce embodied and operational carbon can be ascertained with the help of life-cycle assessment combined with Vastu-informed planning.

17. Conclusion

This paper study the use of Vastu Shastra in civil engineering practices for sustainable residential infrastructure development in the Dang District of Nepal. Vastu "should not be considered a substitute for structural engineering, building codes or environmental performance analysis", it argued. However, it is possible to incorporate selected Vastu tenets into quantifiable planning variables which can then be assessed with the help of sustainability, comfort and satisfaction indicators.

Through a simulated dataset of 200 respondents, this paper shows how to calculate a Vastu Compliance Index, a Sustainability Performance Index and carries out relevant statistical tests. The illustrative analysis indicated positive correlations between the VCI and four other variables consisting of awareness, thermal comfort, occupant satisfaction and sustainability performance. These findings are merely methodological demonstrations and need to be validated in the field.

The integrated Vastu-civil engineering sustainable residential building model is a solution that integrates cultural expectations with climate, seismic, sustainable, water, ventilation, solar and municipal compliance. The model is hoped to better align household preferences with professional design and green infrastructure development for the Dang District.

References

1. Bhandari, S., Shrestha, S. L., & Baral, B. (2024). Passive House Design: A Possible Energy Efficient Option in the Building Sector of Nepal. *International Journal of Sustainable and Green Energy*, 13(3), 58-66. <https://doi.org/10.11648/j.ijrse.20241303.12>
2. Bhattarai, B., Bhattarai, B. S., Maskey, R. K., & Bhochhibhoya, S. (2025). Life Cycle Assessment of Reinforced Concrete Residential Buildings in Nepal: Pathways to Carbon Footprint Reduction through Sustainable Construction. *Building and Environment*, 281, Article 113199. <https://doi.org/10.1016/j.buildenv.2025.113199>
3. Dash, S., & Joshi, M. (2021). A Comparative and Critical Analysis of Application of Vastu Shastra's Concepts with Philosophy, Psychology, Feng Shui, Seismic Design and Contemporary Architecture Design Principles: A Review. *Applied Ecology and Environmental Sciences*, 9(9), 838-845. <https://doi.org/10.12691/aees-9-9-8>

4. Dash, S., & Joshi, M. (2022). Redefining Vastu Shastra Principles With Reference to the Contemporary Architectural Practices in India. *Journal of Pharmaceutical Negative Results*, 13(S08), 349-358. <https://doi.org/10.47750/pnr.2022.13.S08.048>
5. Department of Hydrology and Meteorology. (2024). Nepal Climate Summary 2023. Government of Nepal, Ministry of Energy, Water Resources and Irrigation. https://www.dhm.gov.np/uploads/dhm/climateService/Annual_Summary_20232.pdf
6. Escandon, R., Suárez, R., Sendra, J. J., et al. (2025). How Do Natural Ventilation Strategies Affect Thermal Comfort in Educational Buildings? A Comparative Analysis in the Mediterranean Climate. *Applied Sciences*, 15(12), 6606. <https://doi.org/10.3390/app15126606>
7. Government of Nepal. (2020). Nepal National Building Code NBC 105:2020: Seismic Design of Buildings in Nepal. Department of Urban Development and Building Construction. https://www.lsmcebps.gov.np/UploadFiles/NBC105_2020.pdf
8. Karimi, M., Chikamoto, T., Lee, M., & Tanaka, T. (2024). Impact of Building Orientation on Energy Performance of Residential Buildings in Various Cities Across Afghanistan. *Sustainability*, 16(24), 11076. <https://doi.org/10.3390/su162411076>
9. Lamsal, P., Bajracharya, S. B., Rijal, H. B., & de Dear, R. (2025). Development of an adaptive thermal comfort model for office buildings in Kathmandu, Nepal. *Building and Environment*, 284, Article 113456. <https://doi.org/10.1016/j.buildenv.2025.113456>
10. Ma, S., Zhang, Y., & Li, H. (2025). Optimization of natural ventilation in courtyard-style residential buildings: Insights from inner Mongolian design principles. *Journal of Chinese Architecture and Urbanism*. https://accscience.com/journal/JCAU/articles/online_first/5158
11. Naghipour, P., Hosseini, M., & Farshchi, M. (2025). Energy performance analysis of residential buildings in Bandar Anzali: Influence of orientation and aspect ratio. *Energy and Built Environment*. <https://doi.org/10.1016/j.enbenv.2025.100043>
12. National Statistics Office. (2023). National Population and Housing Census 2021: National Report. Government of Nepal. <https://data.nsonline.gov.np/dataset/population-census-2021>
13. Sarna, I., Belleri, A., & Lollini, R. (2025). Natural ventilation for thermal comfort: A simulation-based comparison of manual and automated window control strategies in temperate climate housing. *Building and Environment*. <https://doi.org/10.1016/j.buildenv.2025.113581>
14. Shrestha, M., Rijal, H. B., Kayo, G., & Shukuya, M. (2021). A field investigation on adaptive thermal comfort in school buildings in the temperate climatic region of Nepal. *Building and Environment*, 190, Article 107523. <https://doi.org/10.1016/j.buildenv.2020.107523>
15. United Nations Environment Programme & Global Alliance for Buildings and Construction. (2024). Global Status Report for Buildings and Construction: Beyond foundations: Mainstreaming sustainable solutions to cut emissions from the buildings sector. United Nations Environment Programme. <https://doi.org/10.59117/20.500.11822/45095>
16. United Nations Environment Programme & Global Alliance for Buildings and Construction. (2025). Global Status Report for Buildings and Construction 2024/2025. United Nations Environment Programme. <https://www.unep.org/resources/report/global-status-report-buildings-and-construction-20242025>
17. United Nations Population Fund Nepal. (2023). 12th National Population and Housing Census 2021. <https://nepal.unfpa.org/en/publications/12th-national-population-and-housing-census-2021>
18. World Bank. (2021). Climate Risk Country Profile: Nepal. https://climateknowledgeportal.worldbank.org/sites/default/files/2021-05/15720-WB_Nepal%20Country%20Profile-WEB.pdf