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Developing A Sustainable Construction Framework for Nueva Vizcaya, Philippines: An Assessment of Green Building Principles, Sustainability Attributes, And Industry Practices

Ar. Arjun Sharma[1], Zuneid Khan[2]
[1]Professor, School of Architecture,
[2]IPS, Student, School of Architecture, IPS

Abstract- This study aimed to assess green building principles, sustainable construction attributes, industry practices, and barriers to sustainable construction implementation as a basis for developing a Sustainable Construction Framework for Nueva Vizcaya, Philippines. The study employed a descriptive mixed-methods research design using an explanatory sequential approach. The quantitative phase involved 20 construction professionals and stakeholders, while the qualitative phase involved 10 purposively selected key informants with relevant professional experience in construction, sustainability, and infrastructure development. Data were collected through a structured questionnaire and semi-structured interviews. Quantitative data were analyzed using frequency and percentage distributions, weighted mean, and standard deviation, while qualitative data were analyzed using thematic analysis. The findings revealed a generally favorable assessment of sustainable construction among the respondents. Green building principles were generally recognized and practiced, with construction waste management and recycling obtaining the highest weighted mean of 4.80. Sustainable construction attributes were also rated favorably, with promoting worker and community well-being receiving the highest weighted mean of 4.90. Among industry practices, worker training and regular monitoring of project performance for sustainability compliance obtained the highest weighted mean of 4.80. However, significant barriers to sustainable construction implementation were identified. The lack of government incentives, limited availability of sustainable materials, and weak enforcement of environmental policies each obtained the highest weighted mean of 5.00. High initial construction costs, resistance to organizational change, and limited technical knowledge were also identified as significant barriers. Overall, the findings indicate that construction stakeholders recognize the importance and benefits of sustainable construction but continue to encounter financial, technical, institutional, and organizational constraints. The study therefore recommends the development of a localized Sustainable Construction Framework for Nueva Vizcaya that incorporates stronger policy enforcement, capacity-building programs, financial incentives, improved access to sustainable materials and technologies, stakeholder collaboration, and sustainability monitoring mechanisms. Such a framework may contribute to environmentally responsible, economically viable, and socially responsive construction practices in the province.

Keywords- Sustainable construction, green building principles, sustainability attributes, industry practices, construction barriers, sustainable construction framework, Nueva Vizcaya.

I. INTRODUCTION

The construction industry is a major contributor to economic growth through infrastructure development, employment generation, and increased productivity. Despite these contributions, the sector is also one of the largest consumers of natural resources and a significant contributor to greenhouse gas emissions, energy consumption, and construction waste. These environmental impacts have increased global attention toward sustainable construction practices that seek to balance economic development with environmental protection and social well-being (Ofori, 2001).

Sustainable construction is rooted in the concept of sustainable development introduced by the World Commission on Environment and Development (WCED, 1987), which emphasizes meeting present needs without compromising the ability of future generations to meet their own needs. In the construction sector, this principle is applied through the integration of environmental stewardship, economic efficiency, and social responsibility throughout the building life cycle, including planning, design, construction, operation, maintenance, and demolition. Akadiri et al. (2012) identified resource conservation, life-cycle cost efficiency, and human-centered design as important components of sustainable construction, emphasizing the reduction of environmental impacts, improvement of economic performance, and creation of healthier built environments.

In the Philippines, sustainable construction has become increasingly important because of the country's vulnerability to climate-related hazards and natural disasters, including typhoons, flooding, earthquakes, and landslides. In response, the government has established policies and regulatory mechanisms that promote environmentally responsible and climate-resilient infrastructure. These include the Philippine Green Building Code, the Climate Change Act of 2009 (Republic Act No. 9729), the Ecological Solid Waste Management Act of 2000 (Republic Act No. 9003), and the Energy Efficiency and Conservation Act of 2019 (Republic Act No. 11285). Furthermore, the Philippine Development Plan (PDP) 2023–2028 identifies sustainable and resilient infrastructure development as a national priority and encourages stronger collaboration among government institutions and local stakeholders.

Despite these initiatives, the adoption of sustainable construction practices remains uneven, particularly in provincial areas where financial limitations, technical capacity constraints, insufficient institutional support, and limited access to sustainable materials may affect implementation. Nueva Vizcaya, located in the Cagayan Valley Region of Northern Luzon, provides an important setting for examining these challenges. The province has experienced continuing infrastructure development associated with urbanization, public investment, and economic growth. At the same time, its forests, watersheds, agricultural areas, and other environmentally sensitive resources require careful consideration of sustainability in future development initiatives.

Although national policies provide a foundation for sustainable construction, existing studies in the Philippines have largely focused on highly urbanized areas. Limited empirical research has examined how sustainability principles are understood and implemented in provincial contexts with distinct environmental, economic, and institutional conditions. Consequently, there is a need for localized sustainability frameworks that consider the realities, resources, and capacities of provincial construction stakeholders.

This study addresses this research gap by assessing green building principles, sustainable construction attributes, industry practices, and barriers affecting sustainable construction implementation among construction stakeholders in Nueva Vizcaya. Specifically, it seeks to provide an empirical basis for developing a Sustainable Construction Framework that responds to the province's environmental conditions, industry capabilities, and institutional requirements.

II. LITERATURE REVIEW

Sustainable Construction

Sustainable construction represents the application of sustainable development principles within the construction industry by integrating environmental, economic, and social considerations throughout the building life cycle. Unlike conventional construction approaches that primarily emphasize project completion, sustainable construction focuses on long-term performance, resource efficiency, environmental responsibility, and social value creation.

According to Akadiri et al. (2012), sustainable construction involves minimizing environmental impacts, optimizing life-cycle costs, conserving resources, and creating healthier environments for building users. This approach recognizes that construction projects influence not only economic development but also ecological systems and community welfare.

Green Building Principles

Green building provides a practical framework for implementing sustainable construction principles during the planning, design, construction, and operation phases of buildings. Key green building principles include sustainable site development, energy efficiency, water conservation, sustainable material selection, indoor environmental quality, waste management, and climate-responsive design.

These principles are incorporated into internationally recognized sustainability assessment systems, including Leadership in Energy and Environmental Design (LEED), the Building Research Establishment Environmental Assessment Method (BREEAM), Green Star, and the Philippine Building for Ecologically Responsive Design Excellence (BERDE) rating system. These frameworks provide guidelines for evaluating and improving building sustainability performance.

Sustainable Construction in the Philippine Context

The Philippine construction sector continues to expand due to urbanization, population growth, and government infrastructure programs. However, this growth has increased demand for natural resources and contributed to environmental pressures associated with construction activities.

Government policies, including the Philippine Green Building Code, Republic Act No. 9003, Republic Act No. 9729, Republic Act No. 11285, and the BERDE Green Building Rating System, provide institutional support for sustainable construction implementation. Nevertheless, adoption remains inconsistent, particularly outside major urban centers where organizations may experience limitations in financial resources, technical expertise, sustainable materials, and regulatory support.

Sustainable Construction Attributes

Sustainable construction performance is commonly evaluated through the Triple Bottom Line framework, which incorporates environmental, economic, and social dimensions. Environmental attributes include resource conservation, energy efficiency, waste reduction, and environmental protection. Economic attributes focus on life-cycle cost savings, operational efficiency, productivity, and long-term financial benefits. Social attributes emphasize worker safety, occupant health, accessibility, and community welfare.

The integration of these dimensions provides a comprehensive approach to evaluating construction sustainability because it recognizes that successful sustainable development requires a balance among ecological protection, economic viability, and social responsibility.

Barriers and Drivers of Sustainable Construction Adoption

Previous studies have identified several challenges that limit sustainable construction implementation, including high initial costs, inadequate technical knowledge, limited stakeholder awareness, weak regulatory enforcement, and restricted access to sustainable materials. These barriers may be particularly significant in developing regions where organizations often prioritize short-term project costs over long-term sustainability benefits.

Conversely, government incentives, technological advancement, professional training, organizational commitment, and stakeholder collaboration serve as important drivers of sustainable construction adoption. Strengthening these enabling factors is essential for developing effective sustainability strategies at the local level.

Research Gap

Although sustainable construction has gained international recognition, there is no universal framework that fully addresses the diverse environmental, economic, and institutional conditions of different regions. International sustainability models may require adaptation to suit local contexts, particularly in developing countries and provincial communities.

In the Philippines, existing research has primarily focused on metropolitan areas, resulting in limited understanding of sustainable construction implementation in provinces such as Nueva Vizcaya. This study contributes to addressing this gap by examining current sustainability practices among local construction stakeholders and providing an empirical foundation for a localized Sustainable Construction Framework.

III. METHODOLOGY

Research Design

This study employed a descriptive mixed-methods research design using an explanatory sequential approach. The quantitative phase was conducted first to assess the implementation of sustainable construction practices in Nueva Vizcaya, focusing on green building principles, sustainable construction attributes, industry practices, and barriers affecting adoption. The qualitative phase followed to provide deeper explanations and contextual understanding of the quantitative findings through interviews with selected key informants.

The quantitative component determined the respondents' assessment of sustainable construction practices, while the

qualitative component provided additional insights into implementation challenges, enabling factors, and strategies for developing a localized Sustainable Construction Framework. The integration of quantitative and qualitative findings provided the basis for developing a framework suited to the conditions of Nueva Vizcaya.

Research Setting

The study was conducted in Nueva Vizcaya, a province located in Region II (Cagayan Valley), Philippines. The province was selected as the research setting because of its continuing infrastructure development, significant natural resource base, and environmentally sensitive landscapes that require sustainable development strategies.

Although national policies and sustainability initiatives have been established in the Philippines, limited empirical studies have investigated sustainable construction practices in provincial contexts. Nueva Vizcaya therefore provides an appropriate setting for examining how construction stakeholders perceive, implement, and experience sustainable construction practices within a developing provincial environment.

Research Participants

The quantitative participants consisted of 20 construction professionals and stakeholders involved in the planning, design, management, regulation, and implementation of construction projects in Nueva Vizcaya. The respondents included consultants, developers, contractors, clients, architects, engineers, project managers, environmental planners, building officials, and representatives of relevant government agencies.

For the qualitative phase, 10 key informants were selected through purposive sampling. These individuals possessed relevant knowledge and professional experience in sustainable construction, green building implementation, construction management, and infrastructure governance. Their perspectives were used to provide contextual explanations of the survey findings and identify strategies for developing the proposed Sustainable Construction Framework.

Sampling Procedure

A combination of sampling techniques was employed. For the quantitative phase, respondents were selected based on their professional involvement and experience in the construction industry. For the qualitative phase, purposive sampling was used to identify key informants with relevant expertise and practical experience in sustainable construction and infrastructure development.

Research Instrument

The primary data collection instrument was a structured questionnaire developed from existing literature on sustainable construction, green building principles, sustainability indicators, and construction industry practices.

The questionnaire consisted of five major sections:

1. Respondents' demographic and professional characteristics;
2. Green building principles;
3. Sustainable construction attributes;
4. Sustainable construction industry practices; and
5. Barriers affecting sustainable construction implementation.

A five-point Likert scale was used to measure respondents' perceptions of the identified sustainability indicators.

A semi-structured interview guide was also developed for the qualitative phase. The interview questions focused on current sustainability practices, implementation challenges, opportunities, and recommendations for establishing a localized Sustainable Construction Framework.

Data Collection Procedure

Prior to data collection, the necessary permissions were obtained from relevant authorities and participants. Respondents were informed about the purpose of the study, participation requirements, and confidentiality measures.

Survey questionnaires were distributed to the selected construction professionals and stakeholders in Nueva Vizcaya. After completion of the quantitative survey, semi-structured interviews were conducted with selected key informants to further explore the findings, identify implementation challenges, and gather recommendations for strengthening sustainable construction practices.

Data Analysis

Quantitative data were analyzed using descriptive statistical techniques. Frequency and percentage distributions were used to describe the respondents' demographic and professional characteristics. Weighted mean and standard deviation were

used to determine the respondents' assessment of the sustainability indicators.

The five-point Likert scale was interpreted using the following ranges:

Weighted Mean	Verbal Interpretation
4.21–5.00	Strongly Agree
3.41–4.20	Agree
2.61–3.40	Neutral
1.81–2.60	Disagree
1.00–1.80	Strongly Disagree

Qualitative data obtained from interviews were analyzed using thematic analysis. Responses were coded, categorized, and organized into themes related to sustainable construction implementation, barriers, enabling factors, and recommended strategies. The integration of quantitative and qualitative findings served as the basis for developing the proposed Sustainable Construction Framework.

Ethical Considerations

The study adhered to ethical research principles throughout the research process. Participation was voluntary, and respondents were provided with information regarding the purpose and scope of the study before participation. Confidentiality and anonymity were maintained, and collected data were used exclusively for academic and research purposes.

IV. RESULTS AND DISCUSSION

Respondent Profile

A total of 20 respondents participated in the quantitative phase of the study. The respondents represented different groups involved in the construction industry. Their professional backgrounds and industry experience provided relevant perspectives on sustainable construction practices in Nueva Vizcaya.

The respondents' professional experience suggests that they possessed practical knowledge and exposure to construction activities, enabling them to provide informed assessments of sustainable construction practices, benefits, implementation factors, and barriers.

Green Building Principles

Table 1. Green Building Principles

No.	Indicators	Weighted Mean	Standard Deviation	Verbal Interpretation
1	Sustainable site planning is practiced in construction projects.	4.05	1.05	Agree
2	Energy-efficient building systems are incorporated in project designs.	4.05	0.89	Agree
3	Water conservation measures are implemented during construction.	4.00	0.65	Agree
4	Sustainable and environmentally friendly materials are utilized.	3.55	0.89	Agree
5	Construction waste is properly managed and recycled.	4.80	0.41	Strongly Agree
6	Indoor environmental quality is considered during building design.	4.05	0.89	Agree

This shows that the respondents' assessment of green building principles. The results show that all indicators were rated either Agree or Strongly Agree, indicating a generally positive assessment of green building practices. The highest weighted mean was recorded for construction waste management and recycling (WM = 4.80, SD = 0.41), interpreted as Strongly Agree. Meanwhile, sustainable site planning, energy-efficient building systems, and indoor environmental quality each obtained a weighted mean of 4.05, interpreted as Agree. Overall, the findings suggest that green building principles are generally recognized and practiced, particularly in the area of construction waste management and recycling.

Sustainable Construction Attributes

Table 2. Sustainable Construction Attributes

No.	Indicators	Weighted Mean	Standard Deviation	Verbal Interpretation
7	Sustainable construction reduces environmental impacts.	3.50	0.89	Agree
8	Sustainable construction improves long-term economic benefits.	4.70	0.47	Strongly Agree
9	Sustainable construction promotes worker and community well-being.	4.90	0.31	Strongly Agree
10	Sustainable construction improves building durability and resilience.	4.75	0.44	Strongly Agree
11	Sustainability principles are integrated throughout the project life cycle.	4.35	0.67	Strongly Agree
12	Sustainable construction contributes to climate change adaptation.	3.45	0.89	Agree

The assessment of sustainable construction attributes showed that promoting worker and community well-being obtained the highest rating (4.90). This indicates that respondents consider social responsibility a fundamental component of sustainable construction.

Building durability and resilience ranked second (4.75), followed by the Long-term economic benefits (4.70). The integration of sustainability principles throughout the project life cycle (4.35), reduced environmental impacts (3.50), and climate change adaptation (3.45) were also recognized as important sustainability attributes.

The findings demonstrate that stakeholders perceive sustainable construction as a multidimensional concept involving social, economic, and environmental considerations rather than solely focusing on ecological performance.

Sustainable Construction Industry Practices

Table 3. Sustainable Construction Industry Practices

No.	Indicators	Weighted Mean	Standard Deviation	Verbal Interpretation
13	Sustainability is considered during project planning.	3.65	1.18	Agree
14	Environmental regulations are consistently followed.	4.05	0.83	Agree
15	Green procurement practices are implemented.	4.15	0.81	Agree
16	Workers receive training on sustainable construction practices.	4.80	0.41	Strongly Agree
17	Sustainable construction technologies are utilized.	4.55	0.61	Strongly Agree
18	Project performance is regularly monitored for sustainability compliance.	4.80	0.41	Strongly Agree

Results showed that regular monitoring of project performance for sustainability compliance and Worker training obtained the highest ratings among industry practices (4.80). This highlights the importance of continuous assessment and evaluation in ensuring that sustainability objectives are achieved throughout project implementation.

The utilization of sustainable construction technologies ranked second (4.55), while green procurement practices ranked third (4.15). Compliance with environmental regulations and

sustainability consideration during project planning were also identified as relevant practices.

These results suggest that effective sustainable construction implementation requires not only technological adoption but also improved management systems, regulatory compliance, workforce development, and sustainability-oriented decision-making.

Barriers to Sustainable Construction Implementation

These items were specifically measuring the respondents' level of agreement regarding factors that hinder or limit the implementation of sustainable construction practices.

The table shows an overall weighted mean of 4.88 and a standard deviation of 0.39, interpreted as Strongly Agree. This indicates that the respondents strongly recognize the identified factors as significant challenges to sustainable construction implementation.

Table 4. Barriers to Sustainable Construction

No.	Indicators	Weighted Mean	Standard Deviation	Verbal Interpretation
19	High initial construction costs hinder sustainable construction.	4.95	0.22	Strongly Agree
20	Limited technical knowledge affects implementation.	4.50	0.76	Strongly Agree
21	Lack of government incentives discourages green construction.	5.00	0.00	Strongly Agree
22	Limited availability of sustainable materials is a challenge.	5.00	0.00	Strongly Agree
23	Weak enforcement of environmental policies affects implementation.	5.00	0.00	Strongly Agree
24	Resistance to organizational change limits adoption of sustainable practices.	4.85	0.37	Strongly Agree

Among the identified barriers, lack of government incentives, limited availability of sustainable materials, and weak enforcement of environmental policies obtained the highest weighted mean of 5.00, indicating unanimous agreement among the respondents. High initial construction costs ranked next, with a weighted mean of 4.95, followed by resistance to organizational change (WM = 4.85) and limited technical knowledge (WM = 4.50).

The findings indicate that improving sustainable construction adoption requires stronger policy enforcement, increased technical capacity, improved access to sustainable resources and materials, financial support, and organizational readiness for sustainability-oriented practices.

Summary of Respondents' Assessment of Sustainable Construction

This summarizes the respondents' assessment of sustainable construction practices, perceived benefits, supporting factors, and challenges in Nueva Vizcaya. The overall weighted mean of 4.39, with a standard deviation of 0.83, indicates that the respondents Strongly Agree with the statements presented. This demonstrates a generally favorable assessment of sustainable construction and its importance in the local construction industry.

Table 5. Summary of Respondents' Assessment of Sustainable Construction in Nueva Vizcaya

Category	Indicators	Weighted Mean	Standard Deviation	Verbal Interpretation
Sustainable Construction Practices	Items 1–6	4.08	0.89	Agree
Perceived Benefits of Sustainable Construction	Items 7–12	4.28	0.87	Strongly Agree
Supporting Factors and Implementation	Items 13–18	4.33	0.85	Strongly Agree
Challenges/Barriers to Sustainable Construction	Items 19–24	4.88	0.39	Strongly Agree
Overall Assessment	Items 1–24	4.39	0.83	Strongly Agree

Among the four categories, Challenges/Barriers to Sustainable Construction obtained the highest weighted mean of 4.88 (SD = 0.39), interpreted as Strongly Agree. This indicates that respondents strongly recognize the factors that hinder sustainable construction implementation. The low standard deviation further suggests a high degree of consistency in the respondents' perceptions.

Supporting Factors and Implementation obtained a weighted mean of 4.33 (SD = 0.85), while Perceived Benefits of Sustainable Construction obtained 4.28 (SD = 0.87). Both categories were interpreted as Strongly Agree, indicating that respondents recognize the importance of institutional support, workforce training, technology, monitoring, and the environmental, economic, and social benefits of sustainable construction.

Meanwhile, Sustainable Construction Practices obtained the lowest category weighted mean of 4.08 (SD = 0.89), interpreted as Agree. Although this represents a favorable assessment, the comparatively lower rating may indicate that actual implementation of some sustainable practices remains less consistent than respondents' recognition of their benefits and importance.

Overall, the findings reveal a strong recognition of sustainable construction among the respondents. However, the particularly high rating for the challenges category indicates that recognition of sustainability does not necessarily mean that implementation is free from obstacles. The findings point to the need for stronger government support, financial incentives, improved access to sustainable materials and technologies, enhanced technical training, effective environmental policy enforcement, and stronger collaboration among construction stakeholders.

V. CONCLUSION

This study assessed sustainable construction implementation in Nueva Vizcaya, Philippines, through the evaluation of green building principles, sustainable construction attributes, industry practices, and barriers affecting adoption. The findings demonstrate that construction stakeholders generally recognize the importance of sustainable construction and its environmental, economic, and social benefits.

The results show that green building principles are generally recognized and practiced, particularly in construction waste management and recycling. Respondents also strongly recognized the social, economic, structural, and resilience-related benefits of sustainable construction. In terms of industry practices, worker training, sustainable construction technologies, and sustainability monitoring received favorable assessments.

However, the findings also demonstrate that significant barriers continue to affect sustainable construction implementation. The most prominent barriers include the lack of government incentives, limited availability of sustainable materials, weak enforcement of environmental policies, high initial construction costs, resistance to organizational change, and limited technical knowledge.

The findings highlight the importance of developing a localized Sustainable Construction Framework for Nueva Vizcaya that considers the province's environmental conditions, construction industry capacity, available resources, and institutional context. Such a framework can provide stakeholders with practical strategies for promoting environmentally responsible, economically viable, and socially responsive construction practices.

Recommendations

Based on the findings of the study, the following recommendations are proposed:

- Strengthen environmental policy implementation and enforcement. Government agencies and local authorities should strengthen the implementation and enforcement of environmental policies and sustainable construction requirements to ensure consistent compliance among construction stakeholders.
- Expand capacity-building and professional training. Training programs, professional development activities, and sustainability education should be expanded to improve the technical knowledge and awareness of construction professionals, project managers, and workers.
- Improve access to sustainable materials and technologies. Industry stakeholders should be encouraged to adopt environmentally responsible materials and sustainable construction technologies by improving their availability, affordability, and accessibility within the province.
- Provide financial incentives for sustainable construction. Government agencies and relevant institutions should

consider developing financial incentives, tax-related benefits, recognition programs, and other mechanisms that can encourage construction organizations to adopt green building practices.

- Strengthen stakeholder collaboration. Government agencies, contractors, developers, consultants, professionals, communities, and other stakeholders should establish stronger partnerships to integrate sustainability principles throughout the project life cycle.
- Enhance sustainability monitoring and evaluation. Construction projects should adopt systematic monitoring and evaluation mechanisms to ensure that environmental, economic, and social sustainability objectives are incorporated and maintained throughout project implementation.
- Develop a localized Sustainable Construction Framework. A framework specifically designed for Nueva Vizcaya should be developed to integrate green building principles, sustainable construction practices, capacity-building strategies, financial mechanisms, policy support, stakeholder collaboration, sustainable material access, and monitoring systems. The framework should reflect the province's environmental conditions, construction industry capabilities, and institutional requirements.
- Conduct further research. Future studies may involve a larger sample of construction stakeholders and examine differences in sustainable construction practices across municipalities, professional groups, project types, and public and private construction projects. Further research may also evaluate the effectiveness of the proposed Sustainable Construction Framework after its implementation.

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