INHENYERHIYA: A Proposed Integrative College of Engineering Building in Nueva Vizcaya State University Bayombong Campus

Paul Unseld A. Baltazar, Giancarlo Cenon C. Mendoza, RLA

ABSTRACT

In 2024, unprecedented heatwaves and climate extremes have dominated global patterns, with temperatures persistently surpassing 1.5°C above pre-industrial benchmarks for over a year. Regions worldwide have faced lethal heat stress, triggering ecological crises—including threats to vulnerable wildlife. Within this context, higher education institutions (HEIs) serve dual roles: as frontline responders to climate impacts and as critical hubs for innovative solutions. This study proposed "INHENYERHIYA," an integrative College of Engineering building for Nueva Vizcaya State University (NVSU) in Bayombong, rooted in the principles of green architecture and sustainable campus development. Prompted by the increasing environmental challenges and the urgent call for sustainable development in higher education institutions, the project aimed to design a future-ready academic facility that supports both environmental responsibility and academic excellence. The study incorporated the goals of the university's Land Use Development and Infrastructure Plan (LUDIP), optimizing space utilization for the Civil Engineering, Geodetic Engineering, and Agricultural and Biosystems Engineering programs. The research delved into global and local case studies of sustainable campus design, referencing standards from UI GreenMetric World University Rankings and integrating life cycle assessments to evaluate environmental impacts from construction to end-of-life. Smart campus principles, such as energy and water conservation, renewable technologies, ICT integration, and inclusive design, are emphasized. The result is a comprehensive design proposal that blends functionality, sustainability, and innovation to serve the diverse needs of students, faculty, and administrators. Ultimately, this thesis demonstrates how educational infrastructure can embody resilience, efficiency, and environmental stewardship in response to climate and societal demands.

Keywords: ecological, ui green metric world university, campus design, smart campus, water conservation, renewable technologies

INTRODUCTION

The global climate crisis is having a significant impact, particularly in East Asia and the Pacific. Young people worldwide are recognizing this urgent issue and demanding immediate action through protests such as school strikes. According to the latest scientific findings of United Nations Environment Programme (UNEP), to keep global warming below 2 degrees Celsius and 1.5 degrees Celsius, global greenhouse gas emissions in 2030 must be reduced by 28% and 42%, respectively, compared to the emissions projected under current policies, in order to mitigate the most severe consequences of climate change, including increased frequency and intensity of droughts, heatwaves, and rainfall (McLellan et al., 2024).

Universities worldwide are increasingly acknowledging their duty to prepare students and communities with the required skills to address and adapt to climate change. They also contribute to this global issue and often feel a responsibility to address their environmental impact by enforcing green initiatives on campus, according to Leal Filho et al. (2021). Universities are prioritizing becoming 'carbon-neutral' institutions by implementing low-carbon practices. This includes initiatives like renewable energy, recycling, campus greening, environmentally focused teaching methods, and nature-based outdoor education. Additionally, universities are developing educational programs to teach students the importance of carbon neutrality, climate change adaptation, and mitigation. Higher Education institutions (HEIs) can offer research-based solutions and educational resources to identify and address the most pressing climate challenges (Weissenberger, S. et al., 2023).

NVSU stakeholders engage in a wide array of activities based on the university's diverse land types, including brushlands, plantations, parks, farm reservations, agricultural areas, and the campus itself. With the growing number of stakeholders, the university's resources are becoming increasingly limited, necessitating changes in land use. To ensure efficient and sustainable resource allocation, NVSU has implemented a rationalization process. To guide this effort, the NVSU Land Use Development and Infrastructure Plan (LUDIP) was created. LUDIP aims to optimize land use, resource allocation, and productivity across NVSU campuses by minimizing environmental degradation and promoting socio-economic development.

NVSU has been recognized as a Center of Excellence in Forestry and a Center of Development in Agriculture. Beyond its contributions to agricultural advancement and food security in the region, the university plays a crucial role in advancing sustainable development by offering research-based solutions to the challenges facing the local agricultural industry. These influences led them to pursue a green campus initiative and participate in the UI GreenMetric World University Ranking.

METHODOLOGY

This chapter discusses the research approaches used to conduct the study, including the data-collection process.

Data Gathering Procedure

The project site selection was finalized through discussions between the researchers and their adviser, Ar. Tomas B. Binbinon Jr., with Nueva Vizcaya State University Bayombong Campus, chosen based on a recommendation from a fellow student. An initial meeting with Engr. Andres M. Sabungan Jr. of PDIS led to the submission of a formal request letter to Dr. Wilfredo A. Dumale Jr., University President, to access essential data, including the NVSU Land Use Development and Infrastructure Plan (2023–2032).

To support the design phase, the researcher conducted case studies on green campuses and engineering buildings, focusing on sustainability and relevance to agricultural sciences. He compiled applicable codes and regulations, followed by a site visit with Ar. Justine Louie A. Labao for surveying and documentation. Additional data on campus infrastructure was acquired from Dr. Adornado Vergara, OIC Dean of COE. All gathered data were then assessed and organized for integration into the project design. Once the required data had been obtained, the researcher thoroughly examined and integrated the information into the project's development through the following processes:

Consultations

Consultations and interviews were conducted with various experts, including the University President, the College of Engineering Dean, and several local architects, to obtain relevant information for the project. They are the most knowledgeable in technical aspects and possess an intimate understanding of the local circumstances.

Site Visitation/Ocular Inspection

This was conducted to enable the researcher to gain a better grasp of the physical considerations and a firsthand experience of the environmental factors that cannot be fully assessed through documents or digital resources, including existing structures, accessibility, climatic context, site orientation, and other social conditions.

Architectural Manuals and Other References

A variety of resources, including books, manuscripts, manuals, design guides, building codes, regulations, e-books, and published research, were used to provide a thorough basis for the design complexities.

a. National Building Code of the Philippines (PD 1096)

b. Revised National Plumbing Code of the Philippines (RA 1378)

c. Batas Pambansa Blg. 344 (Accessibility Law)

d. Revised Fire Code of the Philippines of 2008 (RA 9514)

e. Commission on Higher Education Memorandum Order No. 89, 92, and 94 Series of 2017

f. Philippine Green Building Code (PD 1565)

Demand and Supply Analysis

Universities today are grappling with challenges such as learning disruptions caused by extreme weather, health risks intensified by climate change, and the need to adapt infrastructure and environments to shifting conditions, all consequences of global warming and the broader climate crisis. Urban regions, especially those with inadequately designed structures, play a major role in exacerbating this issue by driving up energy use, carbon emissions, and the urban heat island effect. Conventional construction methods heavily depend on non-renewable materials and outdated energy systems, worsening environmental decline.

Higher education institutions (HEIs) recognize their role in mitigating climate change by developing sustainable campuses that incorporate green building principles and modern technology. Continuous dedication to sustainability research, environmentally mindful campus development, and forward-thinking architectural solutions are crucial for building a climate-resilient future. These efforts ensure that universities lead by example in environmental stewardship and sustainability education.

Marketing Plan and Program

The School of Engineering serves as a pivotal academic hub, delivering equitable and adaptable educational programs for undergraduates and graduates to cultivate a versatile engineering workforce. The latest board exam results clearly demonstrate their steadfast dedication to training engineers for adaptable and internationally competitive careers. This encourages the department to adopt a more holistic and strategic marketing approach to increase the production of such professionals.

The following are several effective marketing strategies to promote the School of Engineering buildings:

a. **University Website** - The website provides comprehensive details on academics, research, training, campus life, organizational structure, and downloadable resources.

b. **Social Media** - NVSU can strengthen its brand, draw in more stakeholders, and elevate its standing in both academic and global circles.

c. **International Affairs Coordinators** - The International Affairs Coordinators unit fosters partnerships to strengthen NVSU's local and global collaborations.

d. **Collaboration with LGUs** - NVSU works closely with local government units in Nueva Vizcaya and neighboring regions to address community needs.

e. **Radio** – Radio remains a trusted medium, reaching offline audiences through diverse, multilingual broadcasts.

f. **Printed materials** - Printed materials like brochures, flyers, and posters offer an easy, tangible way for students, partners, and visitors to access and engage with information.

TECHNICAL STUDY

Project Location: The proposed building site is within the College of Engineering compound of Nueva Vizcaya State University's Main Campus in Bayombong. It is surrounded by engineering and agricultural facilities, including the College of Engineering Building 1, Food Processing Center (CA), Outdoor Engineering Laboratory, and Engineering Laboratory Buildings 1 and 2, the four-story engineering building in the rear, southeast portion, and the COE Pavilion, exactly at the center of the compound. Additionally, the area is characterized by lush greenery and numerous trees, with an immediate view of Bangan Hill.

Region: Region II (Cagayan Valley)

Climate: Type III, Tropical Rainforest Climate

Conceptual Framework

Design Philosophy

- **"To create architecture is to put in order"** - Le Corbusier

At its core, architecture transforms disorder into balanced, functional beauty. It systematically arranges spatial relationships, natural illumination, building materials, and human necessities. Effective architectural solutions bring clarity and purpose to the intertwined challenges of practical use, environmental context, and social interaction.

- **"Form follows function"** - Louis H. Sullivan.

A building's form should emerge from its practical requirements, not mere aesthetics. Every aspect of its design, from structure to spatial organization, must serve a clear purpose. Just as a well-crafted tool is shaped by its use, effective architecture prioritizes utility over arbitrary decoration, allowing the function to guide its visual expression naturally.

Design Concept

Green Architecture Concept

The study incorporated the Philippine Green Building Code by enhancing energy performance, implementing water-saving strategies, using eco-friendly materials, and improving indoor air quality in its design. Adhering to sustainable benchmarks minimizes ecological harm while boosting user well-being, reflecting the project's commitment to environmentally responsible building methods.

Figure 1
Exterior Perspective

Planning Concept

Form Concept

The concept of the engineering building is rectangular, with a single-loaded corridor, a typical feature of institutional building layouts. The utility core of the engineering building sits at the center, and void spaces are prominent throughout its floors to break the monotony and encourage airflow. The multi-purpose building is also rectangular. It has a void deck on the ground floor that can transform from an enclosed to an open space with the aid of sliding panels and pivot doors. These structures draw from enduring principles of symmetry, balance, and proportion.

Structural Concept

The building's structural system employs a reinforced concrete slab-and-beam framework selected for its superior load-bearing capacity and long-term resilience. This design combines concrete slabs with composite steel decking, supported by heavy-duty beams, to form a rigid load-distributing system capable of resisting substantial dynamic and static forces, ensuring optimal stability and service life. Upper levels feature cantilevered beam extensions and strategically placed planted columns. These elements transfer loads to primary square columns, which decrease in size as the floors increase.

Allied Engineering Services Concept

Electrical Concept

The building incorporates multiple energy-saving measures to minimize electricity demand, such as harnessing solar energy through photovoltaic arrays, deploying high-efficiency equipment, and integrating intelligent lighting controls with automated building management systems.

Mechanical Concept

For vertical transportation, elevators are utilized in both buildings to compensate for the absence of a multi-level ramp. Water pumps are used to move water from the overhead tanks and rainwater tanks located on the roof deck.

Design Considerations

This section outlines the sustainable design strategies incorporated into the proposed Science Laboratory Facility, in accordance with the Philippine Green Building Code, the UI GreenMetric Ranking criteria, and relevant institutional design guidelines.

Sustainability

This highlights the integration of a university's physical infrastructure with its environmental objectives. It further encourages the development of sustainable landscapes, the adoption of environmentally responsible building materials, inclusive accessibility features, enhanced safety measures, and strategic spatial design:

- Energy Efficiency. To enhance energy efficiency and lower operational expenses, the facility’s design prioritized sustainable strategies that balance indoor comfort with minimal environmental impact. Key approaches included implementing energy-saving technologies and materials, integrating renewable energy systems, and maximizing passive design features such as natural ventilation and daylighting.
- Water Efficiency. Sustainable water management for the building’s operations includes water-saving measures such as low-flow plumbing fixtures, rainwater collection systems, and other conservation-focused strategies to minimize consumption and promote reuse.
- Material Sustainability. This focuses on ethically sourcing and managing building and production resources to reduce ecological harm while optimizing performance and lifespan. Key practices included selecting environmentally preferable materials (e.g., recycled, bio-based, or carbon-neutral alternatives), implementing circular-economy principles to minimize waste, and prioritizing resilient designs that extend product lifecycles.
- Solid Waste Management. This encompasses the organized management of everyday campus waste, including paper products, food waste, packaging materials, and electronic refuse generated in academic buildings, dining areas, and other facilities. It highlighted the implementation of recycling and composting initiatives, the reduction of waste output, and the establishment of proper waste-disposal systems.
- Site Sustainability. This evaluates how the project harmonized constructed and natural environments to mitigate ecological damage while fostering sustainability. It prioritizes environmentally conscious site selection and development, emphasizing open space preservation, reduced land disturbance, adaptive reuse of existing structures, and integration of vegetated areas.
- Indoor Environmental Quality. This involves the health and comfort conditions in academic spaces such as classrooms, labs, and offices, including air quality, thermal regulation, lighting, acoustics, and ergonomics. Optimal IEQ enhances cognitive performance while supporting energy efficiency and green building standards such as LEED and WELL through smart system design and HVAC systems.

Accessibility

Inclusive design creates barrier-free spaces for people of all ages and abilities, incorporating step-free access, adaptive elevators, wide pathways, tactile guides, and visual alerts to enable seamless indoor/outdoor navigation.

User's Safety and Comfort

Human-centered design merges safety and comfort in buildings by incorporating fire protection, clear exits, slip-resistant floors, and good lighting, while climate control, noise reduction, and ergonomic layouts ensure comfort, all meeting industry standards.

Interactive Building

This design approach prioritizes creating functional, efficient spaces that enhance usability for both educators and learners across the university's College of Engineering, including agricultural and biosystems engineering, geodetic engineering, and civil engineering departments. It balances spatial optimization, operational efficiency, and human-centered experiences in the built environment.

- Building Efficiency. This is fundamental to developing interactive university spaces, as it strategically optimizes physical resources, spatial layouts, and smart systems to promote collaborative learning, flexible use, and environmental stewardship. Advanced systems such as IoT-enabled climate control and adaptive lighting not only reduce energy costs but also transform building operations into live educational interfaces, enabling students to engage directly with real-time sustainability data and smart infrastructure analytics.
- Spatial Optimization. Thoughtful spatial organization is essential for crafting dynamic university environments, as it deliberately structures floor plans to foster seamless connectivity, adaptive functionality, and cross-disciplinary collaboration. Strategic placement of circulation routes and communal zones fosters organic engagement among students and educators from diverse fields, including technology, humanities, and applied sciences.
- User-Driven Design Features. This is achieved through curated spatial interventions that foster knowledge sharing and participatory experiences. Augmented reality guidance apps, blending engineering students' technical development with creative visuals from art majors, revolutionize campus orientation. Transformable learning areas featuring reconfigurable partitions and multi-purpose furnishings enable instant adaptation for varied needs, supporting everything from software engineering to surveying.

Site Analysis

The site of the proposed buildings is located within the College of Engineering compound, with the four-story building on the left side of the Engineering Annex Building and along the road and the three-story building on the vacant lot right at the center of the compound. They are both in the western part of the campus.

S.W.O.T. Analysis

Table 1
Proposed Building Site SWOT Analysis

Factors	Strengths	Weaknesses	Opportunities	Threats
Natural Environment	The site is populated with numerous trees that provide natural shade, helping to protect the building from direct sunlight.	There is a lack of programs or initiatives focused on the sustainable use of the area.	Encourages a more environmentally responsible strategy through Green building principles.	Flood-prone area of the site elevation
Accessibility	Catwalks and walkways are present along the compound.	Lack of designated parking areas and catwalks.	Proposal for designated parking areas and catwalks.	Very far and long walking distance from the entrance/exit gates.
Adjacent Facilities	The buildings are in close proximity to other College of Engineering buildings.	The lack of study and recreational areas for groups.	Collaborative spaces can be developed to improve the connectivity among engineering courses.	Existing classrooms are used as laboratories, negatively affecting functionality, safety, and learning quality

Building Space Description

The proposed engineering building is designed to accommodate a variety of functional spaces, thoughtfully planned to align with both the capabilities of existing infrastructure and the evolving requirements of the academic program. The following are the several types:

Classrooms

University classrooms are purpose-built academic spaces designed to support various teaching methods and class sizes while fostering student engagement, well-being, and overall learning experience.

Lecture Halls

Optimized for group learning, tiered academic venues employ elevated seating arrangements and integrated presentation tools to ensure unobstructed viewing and effective knowledge dissemination for cohorts of 30 to 200+ learners.

Computer Laboratory

A computer lab, also known as a computer laboratory, houses numerous computers and associated technology to facilitate teaching, learning, research, and hands-on training in computing disciplines.

Faculty Rooms

The Faculty Room is a shared workspace equipped with tables and chairs, serving as a working area for faculty members and department heads outside of lecture times. It also functions as a hub for collaboration, allowing teachers to interact and hold meetings.

Utility and Operation Spaces

Utility and operation spaces are dedicated building areas that house essential infrastructure and support services. These zones typically contain mechanical rooms, electrical closets, custodial storage, plumbing systems, and service access pathways to maintain efficient facility operations.

Collaboration Spaces

These purposefully designed areas encourage group collaboration, interactive education, and teamwork between students and teachers. They facilitate creative brainstorming, hands-on projects, and student-led discussions.

SOCIO-ECONOMIC STUDY

Social Benefits

An integrative educational engineering building generates significant societal value by facilitating cross-departmental synergy and knowledge exchange among students from Agricultural and Biosystems Engineering, Geodetic Engineering, and Civil Engineering through shared-space events.

Cultural Benefits

This fosters a welcoming environment where learners and residents can meaningfully interact with diverse cultural traditions, deepening mutual understanding.

Educational Benefits

Academic facilities are purpose-built to support learning, research, and intellectual growth.

Health Benefits

Thoughtfully designed learning spaces actively promote holistic wellness by optimizing environmental conditions for physical health, cognitive performance, and social connectivity.

Economic Benefits

The development generates employment opportunities across multiple sectors, from infrastructure development and facility operations to sustainable food production and environmental solutions, stimulating regional economic growth.

Environmental Benefits

Adopting green building methodologies reduces long-term operational expenditures while enhancing fiscal efficiency.

FINANCIAL STUDY

Table 2
Project Rough Cost Estimate of Engineering Building

Building Facility/Spaces	Area (SQ.M)	Rate (Per SQ.M)	Building Facility/Space Cost
Faculty Rooms	116.31	35000	4,070,850
Dean's Office	26.07	35000	912,450
Pantry	9.80	35000	343,000
Lecture Halls	163.29	40000	6,531,600
Monitor Room	24.626	35000	861,910
Conference Room	39.57	35000	1,384,950
Mini Library	33.37	35000	1,167,950
Computer Laboratory	137.48	35000	4,811,800
Classroom	159.6	35000	5,586,000
Laboratory Assistant Office	18.74	35000	655,900
Storage	48.471	35000	1,696,485
Restrooms	93.934	35000	3,287,690
Utility	25.727	35000	900,445
Roof Deck	777.37	20000	15,547,400
Lounge/Hallway/Circulation Areas	631	20000	12,620,000
	TOTAL		**60,378,430**

Table 3
Project Rough Cost Estimate of Multi-purpose Building

Building Facility/Spaces	Area (SQ.M)	Rate(Per SQ.M)	Building Facility/Space Cost
Pavilion Hall	196.70	35000	6,884,500
Multi-purpose Hall w/stage	194.83	40000	7,793,200
Lecture Hall 3 w/stage	194.83	40000	7,793,200
Storage	49.58	35000	1,735,300
Control Room	9.02	35000	315,700
Dressing Room	16.66	35000	583,100
Monitor Room	16.66	35000	583,100
Restrooms	49.6	35000	1,736,000
Utility	62.45	35000	2,185,750
Roof Deck	358.27	20000	7,165,400
Hallway/Circulation Areas	112.28	20000	2,245,600
	TOTAL		**39,020,850**

MANAGEMENT STUDY

Management Scheme

The university's governance structure follows a defined hierarchy illustrated in its organizational chart. The CHED Chairperson is the Board of Regents' top position, and Marita Rana-Canapi, CHED Commissioner, represents him. To guarantee the alignment of the university with CHED guidelines and policies for HEIs, the Chairperson works with the University President, who is supported by the Board and University Secretary; he is in charge of overseeing the major offices like Academic Affairs, Research, Extension and Training, Administration and Finance, and Planning, Development, and Information System, each of which is run by a vice president. These administrative units are further organized into colleges/schools led by deans, who supervise department heads responsible for specific academic programs.

Phases of Implementation

The pre-design phase involved the researcher's comprehensive data gathering and analysis of the proponent's spatial needs, functional requirements, organizational flow, environmental conditions, community context, and relevant regulations, alongside detailed site studies of the surroundings, climate, and legal constraints. The schematic design phase converted these requirements into a conceptual framework, defining spatial relationships and architectural intent. Design development refined these concepts by finalizing facade treatments, interior layouts, precise dimensions, and material specifications, with input from specialist consultants as needed. The construction phase completed technical documentation and transformed architectural concepts into a built reality.

Environmental Study

This section presents the institutional framework of Nueva Vizcaya State University, as depicted in Figure 99. The university's administrative body will maintain operational governance of these facilities.

CONCLUSION AND RECOMMENDATIONS

CONCLUSION

To address the study's design goals and investigative inquiries outlined in Chapter 1, the analysis yielded the following key determinations:

- The study presented a sustainable campus development framework for Nueva Vizcaya State University, designed in alignment with UI GreenMetric's benchmark criteria and performance metrics.
- To optimize spatial efficiency and foster interdisciplinary collaboration, the proposed vertical structure consolidated essential laboratory facilities for the BS Agricultural and Biosystems Engineering, BS Geodetic Engineering, and BS Civil Engineering programs, ensuring equitable access and functional synergy.
- The design strategically harnessed natural light and passive airflow systems to cultivate an optimal learning atmosphere while simultaneously addressing the functional requirements and technical challenges inherent in the lecture facility.
- The study proposed acoustic mitigation measures to address reverberation distortion and ambient noise issues resulting from constrained spatial configurations and dense building proximities.
- The architectural scheme embedded interactive design principles via shared innovation hubs, optimized spatial programming, smart building systems, space-saving workstations, and eco-conscious features systematically implemented across all levels.

RECOMMENDATION

The initiatives of this study align with Nueva Vizcaya State University's strategic vision for ecological stewardship and campus modernization. Their implementation would simultaneously advance institutional prestige while creating tangible quality-of-life improvements for students, faculty, and staff. The research findings suggest multiple actionable pathways forward, including:

- This research initiative positions Nueva Vizcaya State University for transformative growth into a globally benchmarked sustainable institution. Beyond elevating the university's prestige, these proposed developments would significantly enhance the holistic campus experience for NVSU students, faculty, and stakeholders.
- Incorporate additional engineering laboratory case studies to facilitate comprehensive comparative analysis and deeper insights within the research.
- Offer a comprehensive analysis of the UI GreenMetric World University Ranking framework, including its evaluation methodology, key performance indicators, and institutional benchmarking processes.
- Should the project proponents utilize this research as a basis for execution, the study advises collaborative review with specialized engineering consultants to assess the technical schematics, particularly the mechanical, electrical, plumbing, fire protection, and sanitation (MEPFS) plans, which fall beyond standard architectural documentation.

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