Journal of Environmental Science and Management SI-1: 59-74 (2025) ISSN 0119-1144

Knowledge and Perception of Dormitory Students on Green Building Technologies in the Renovation and Retrofit of Dormitories

DOI: 10.47125/jesam/2025_sp1/06

Lavinia Marie M. Abucay[1*]
Decibel F. Eslava[2]
Richelle G. Zafra[3]

[1] Office of the Vice Chancellor for Research and Extension, University of the Philippines Los Baños, College, Laguna, Philippines 4031
[2] School of Environmental Science and Management (SESAM), University of the Philippines Los Baños, College, Laguna, Philippines 4031
[3] College of Engineering and Agro-Industrial Technology, University of the Philippines Los Baños, College, Laguna, Philippines 4031

*corresponding author: lamanaig@up.edu.ph

ABSTRACT

Green building aims to enhance resource efficiency and minimize environmental and health impacts throughout a building's life cycle. Old buildings are ideal for retrofitting with green technologies. The study used the BERDE for Retrofits and Renovations for Educational Institutions (BERDERR-EDU v.1.1.0 (2013) for the identification of the green building technologies. Using a systematic random sampling with a 10% margin of error and 90% confidence interval, a survey was conducted at the University of the Philippines Los Baños, involving 242 dormitory residents to assess their knowledge and perception of green building technologies. Descriptive statistics, Spearman correlation analysis, and Kendall's coefficient of concordance were used to analyze the collected data. Most respondents (89.04%) agreed that their dormitories require retrofitting; 97.80% supported integrating green technologies. While 55.13% were familiar with green features, only 10.64-16.67% recognized these in their dormitories. Respondents felt that green technologies improve social well-being (83.57%), resource allocation (83.79%), and enhance sense of responsibility (87.65%). The study recommends continuing the inventory and monitoring of green building initiatives to assess their effectiveness, track progress, and identify areas for improvement. Moreover, a follow-up study is also recommended to examine the implementation of green building technologies in new dormitories.

Keywords: *green building technologies, retrofit, renovation, dormitory, knowledge and perception*

INTRODUCTION

Globally, buildings have accompanying significant impacts on climate change, contributing to about 40% of energy usage and 33.33% greenhouse gas emissions (*Cappelletti et al. 2015*). In Canada, approximately 30% of the total secondary energy used by the residential and commercial or institutional buildings, which can be directly associated with almost 29% of CO_2 equivalent greenhouse gas emissions. Similarly, in the United States, around 39% of the total primary energy and 70% of the electricity consumption were from buildings. US building-related energy consumption alone can contribute almost 38% of CO_2, 52% of SO_2, and 20% of NO_X to the total greenhouse emission of its country (*Wang et al. 2005*). Moreover, the United States Environmental Protection Agency (US EPA) stated that buildings could affect land use, energy use, water consumption, materials usage, waste production, outdoor and indoor air quality, among others (*US EPA 2009*). According to the Philippine Green Building Council (PHILGBC), the buildings sector is considered as energy gluttons accounting for about 30-40% of the global energy usage and greenhouse gas emissions. However, when environmental sustainability measures are considered, positive impacts on the environment can be achieved (*PHILGBC, National Secretariat 2011*).

Existing buildings are generally responsible for significant energy consumption as it accounts for 30% of the total energy usage in developed countries (*Leung 2018*). However, the rate of new construction ranged from less than 1% - 3% and expected to lower in the coming years (M*a et al. 2012; Perino et al. 2017*). As the new build comes slowly to replace the old ones, proper retrofitting can lessen energy consumption and GHG emission (*Ma et al. 2012*). The study of *Leung* (*2018*) provides a systematic approach to greening existing buildings by assessing the need for greening, selecting and implementing appropriate measures, and monitoring to maintain the achieved green performance. Also, according to *Zuo and Zhao* (*2014*), the three approaches to achieve green buildings are: managerial, cultural and behavioral, and technical. These factors tend to affect each other and must be analyzed comprehensively. In terms of managerial approach, the commitments of the top management propel the success of green buildings. The success of green developments in the cultural and behavioral approach depends on the increased awareness of society towards green buildings and sustainability. In the technological sense, it is due to the integration and use of renewable energy and the management of construction and demolition wastes.

Awareness on green building principles is comparatively low among university students (*Novieto et al. 2023; Donkor-Hyiaman et al. 2023*). In the efforts of contributing to sustainable development goals, much effort was made in incorporating sustainability in the building sector (*Kim and Kim 2020*). However, awareness levels and satisfaction remain low. *Donkor-Hyiaman et al.* (*2023*) argued that to contribute to the Sustainable Development Goal 11 (Sustainable Cities and Communities), educating the youth on green buildings is necessary to alter their housing outcomes and preferences. They further suggest mainstreaming green building literacy programs across all levels of education regardless of the study field. This also supports the suggestion of *Novieto et al.* (*2023*) in promoting environmental sustainability through the inclusion of green building concepts in the curriculum. Integrating sustainability principles in the curriculum can also increase students' knowledge, awareness, and improve attitudes towards environmental sustainability.

The Paris Agreement and the Sustainable Development Goals (SDGs) are two global frameworks closely related to green buildings which aim to mitigate climate change and promote sustainable development (*Tolliver et al. 2019; Dzebo et al. 2023*). In particular, green buildings can contribute in achieving these objectives through reduction in energy consumption, promotion of sustainable practice, and lead to improving human health and well-being. Studies suggest that living in green buildings or dormitories can have positive impacts on the overall health and well-being of a student (*Seyis 2018; Golbazi et al. 2020; Novieto et al. 2023; Thorpert et al. 2023*). The conditions provided by green buildings, such as better daytime lighting, overall comfort such as air temperature and ventilation and better indoor air quality help promote well-being of occupants.

Around 40-60% total energy savings can be gained, which can eventually reduce the carbon intensity by 20%-30% (*Leung 2018*). However, *Perino et al.* (*2017*) stated that retrofitting an existing building is more complicated than constructing a new one, thus a key issue that needs attention. Retrofitting buildings faces both challenges and opportunities. The success of the project, which is directly related to the sound selection of appropriate technologies, is defined by uncertainties such as variations in climate, services, behavior of humans, and policy in the government (*Ma et al. 2012*). Structural and configuration of the building and compatibility are likewise issues that may negatively affect the adoption of new materials, systems, and technologies of which are essential components of the building retrofit (*Perino et al. 2017*). On the other hand, retrofitting a building provides a good set of opportunities. This includes better energy efficiency, higher staff productivity, lower maintenance costs, and better thermal comfort for its occupants. Overall, it can provide benefits to the economy, environment, and people (*Ma et al. 2012*). The results of the study in the Universiti Teknologi Malaysia (UTM) revealed that the campus had an urgent call to retrofit their existing campus buildings to green buildings for higher energy efficiency (*Zakaria et al. 2012*). The majority of the survey respondents- with involvement in UTM building development, including the academicians and students, identified solar technology as sustainable and essential criteria of green buildings. In the same study, the importance of renewable energy in Malaysia and the UTM campus was also highlighted.

A student dormitory is an excellent place for studying. Students living in the dormitories succeed academically (*Revington et al. 2020; Yii-Nii et al 2016*) due to the supportive environment with access to tutoring and student organizations (*de Araujo and Murray 2010*). Some researchers also argue that on-campus residency is critical to academic success and pushing forward for policies that eliminate off-campus living due to its negative effects. Proximity and location were identified as primary reasons for choosing a dormitory with consideration of access to public places such as markets and facilities (*Brilliantes et al. 2012*). Their study also found that while the cost of monthly rental contributes to the selection of dormitory, respondents were willing to pay a higher rate if there is a sense of safety and security. Moreover, this was attributed to the fact that learner-centered and quality-driven conditions were unsatisfactory, according to the respondents of their study.

The University of the Philippines Los Baños (UPLB) is expected to strictly implement the mitigating, enhancement, and rehabilitating measures on environmental management conditions set forth by the grant of Environmental Compliance Certificate (ECC). Under the general conditions of *DENR-egion IV CALABARZON* (*2016*), it was stated "that in compliance

(ECC). Under the general conditions of *DENR-egion IV CALABARZON* (*2016*), it was stated "that in compliance with the Kyoto Protocol Agreement and Republic Act 9367 (*Biofuels Act of 2006*) to deal with the reduction program on activities potential to contribute greenhouse gases or global warming, the proponent shall establish a carbon sink program or apply/use alternative fuel (i.e., biofuels liquefied petroleum gas, among others)". This condition is deemed relevant to pursue and implement specifically to the UPLB Buildings as buildings are known as significant contributors of greenhouse gas emissions. Specifically, the priority in the application of greening provisions is deemed necessary and has more significant impacts on the existing UPLB buildings. These buildings, which were built for more than 30 to 50 years, have the highest possibilities of low or even non-compliance with the recent green concept strategies.

Ultimately, the benefits of the adoption of green building technologies must reach its intended end-users. To date, UPLB has dormitories which are 50 years old already. As mentioned, these buildings can be assumed to have low if not zero compliance for having green building technology (GBT) features. The dormitory living situation of the students and their perception in GBTs must be fully understood, as this may be a good starting point in planning on which GBT should be prioritized for adoption.

This study aims to assess the knowledge and perception of dormitory students on green building technologies particularly in the context of retrofitting and renovation in selected dormitories of the University of the Philippines Los Baños. By providing better understanding of how GBTs can improve the dormitory living situation, the study will contribute valuable insights to the decision-making and policy development process towards the adoption of GBTs in the retrofit and renovation of dormitories. For context, this study adopted the definition that retrofit refers to the "work" required to upgrade an old or deteriorated building based on *Ma et al.* (*2012*).

MATERIALS AND METHOD

Location and Description of the Study Area

The study was conducted at the University of the Philippines Los Baños (UPLB) located in the Municipalities of Los Baños and Bay, province of Laguna in the Philippines. It is situated about 64 km southeast of Metro Manila (**Figure 1**). Six dormitories were included in the study (**Figure 1** and **Table 1**). The age of the dormitories can be categorized into two groups: old (above 30 years) and new (30 years and below) from the year of construction. Under the old dormitories group are the Women's Residence Hall (Women's Dormitory), Men's Residence Hall (Men's Dormitory), and New Forestry Residence Hall (New FOREHA) which were built in 1967, 1968 and 1983, respectively. The new dormitories include the New Dormitory (2001), Agricultural Training Institute-National Training Center (ATI-NTC) Residence Hall, and the Graduate Students' Dormitory (Female) formerly known as Upper Agricultural Credit and Cooperative Institute (ACCI) Residence Hall; both were constructed in 2010. The male dormitories are on the upper campus while the female dormitories are situated on the lower campus. The total building footprint floor area of each building ranges from 419.25 m^2 (Upper ACCI) up to 5,258.27 m^2 (MRH). All the dormitories are generally made of concrete with usable building physical condition.

Selection of Green Options

The study used the BERDE for Retrofits and Renovations for Educational Institutions (BERDE-RR-EDU v.1.1.0 (2013)) for the identification of the GBTs that may be present or not present in the UPLB dormitories. This version was used since it is tailor-fitted for the retrofit and renovation of educational institutions. Selection of the "green options" in this study was based on the top three impact categories as indicated in the BERDE rating scheme: Energy Efficiency and Conservation (16); Water Efficiency and Conservation (14); Waste Management (12). The list of the green building technology features considered in the retrofit and renovation of the dormitory includes energy-efficient light fittings, fixtures, and luminaires; automatic lighting controls (e.g., occupancy, daylight, or motion sensors); water-efficient fixtures (low-flow showerheads and faucets); rainwater harvesting system; materials recovery facility (MRF); and renewable energy technologies (e.g., solar panels, anaerobic digestion/biogas). However, the determination of the green building (GB) features through survey was not limited to the six pre-identified green building technology features. The green building features in this study considered only technologies and did not focus on the other green building features such as passive design, among others.

Primary Data Collection

Sampling design. Systematic Random Sampling (SRS) was used in the selection of respondents for the survey. The sample size was calculated based on a 10% margin of error and a 90% confidence interval using Sharon Lohr formula in a spreadsheet. The resulting total sample size for the six dormitories was 273 (**Table 2**).

Survey. The survey instrument was a structured questionnaire with open-ended questions. An “others” option was always included to capture the answers which were not anticipated to be included by the researcher. Throughout the survey preparation, the questionnaire was revised and improved in order to make it an effective instrument in gathering information on the perception and preferences of the UPLB dormitory residents on the need for retrofit and renovation and integration/ adoption of the GBTs in their respective dormitories. The questionnaire was composed of five parts. The first part explained the research objectives, presented contact details and instructions. The second part was designed to collect background information regarding the resident

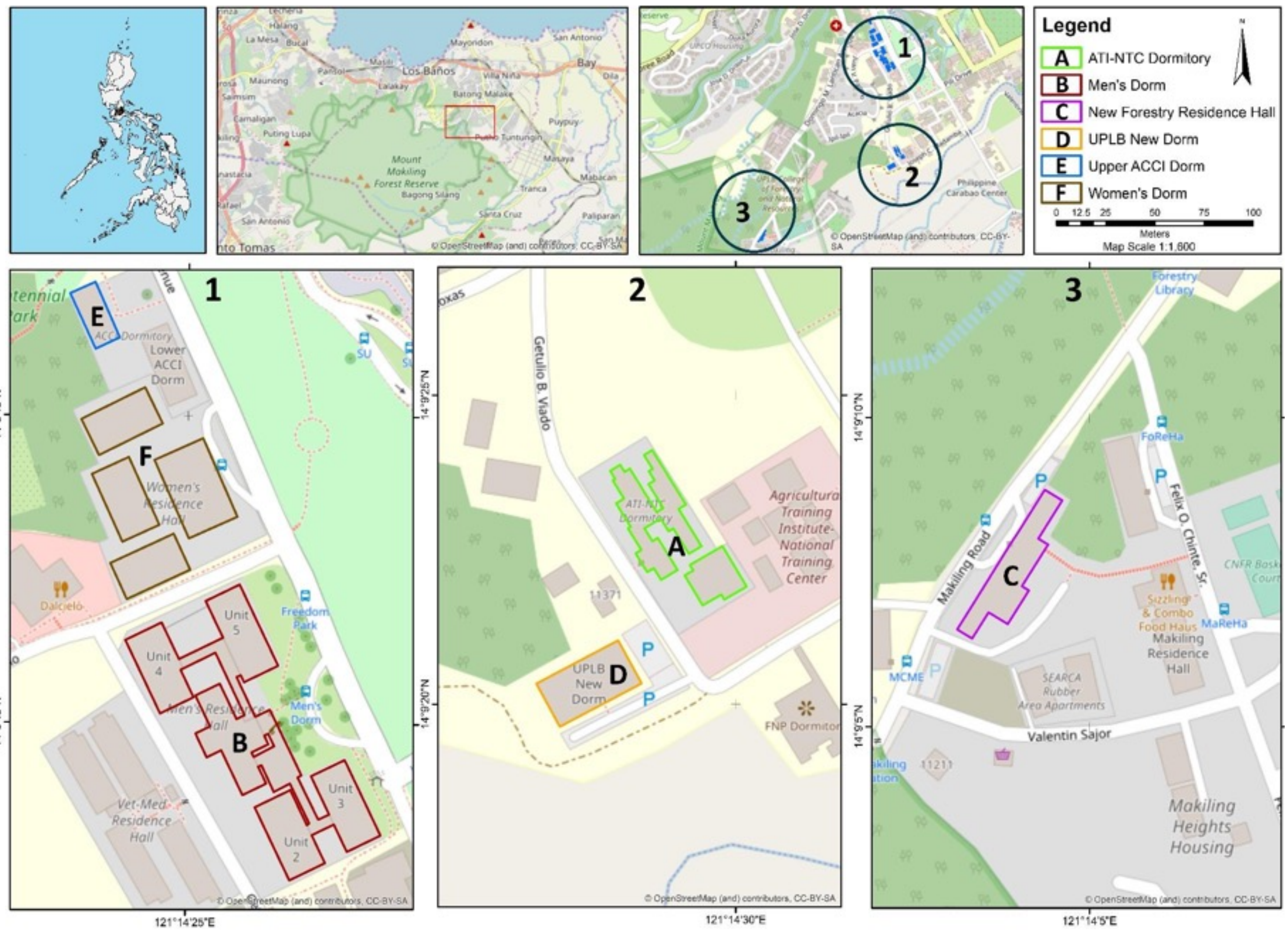

Figure 1. Location map of the study area showing the selected dormitories at the University of the Philippines Los Baño: Agricultural Training Institute-National Training Center [ATI-NTC] (A), Men’s Dorm (B), New Forestry Residence Hall (C), UPLB New Dorm (D), Upper Agricultural Credit and Cooperative Institute (ACCI) Dorm (E), and Women’s Dorm (F).

Table1. Characteristics of the six dormitories at the University of the Philippines Los Baños in Laguna, Philippines under this study.

Name of Dormitory	Year Built	Classification	Campus Site	Total Floor Area (m^2)*	Make	Physical Condition
New Dormitory	2001	New	Upper Campus	1,109.97	Concrete	Usable
ATI-NTC	2010	New	Upper Campus	1,638.45	Concrete	Usable
New Forestry Residence Hall	1983	Old	Upper Campus	1,135.56	Concrete	Usable
Men’s Residence	1968	Old	Lower Campus	5,258.27	Concrete	Usable
Women’s Residence	1967	Old	Lower Campus	3,352.20	Concrete	Usable
Upper ACCI	2010	New	Lower Campus	419.35	Concrete	Usable

*Calculated geometry of the building footprint using Geographic Information System (GIS)

Table 2. Summary of sampling size, design and response rate of the survey.

Name of Dormitory	Capacity	2019 Population	No. of Samples	Response Rate (%)
New Dormitory	186	141	46	100.00
ATI-NTC	140	139	46	100.00
New Forestry Residence Hall	160	112	43	100.00
Men's Residence	536	382	58	70.69
Women's Residence	357	356	57	85.96
Upper ACCI	34	34	23	73.91
		TOTAL	273	88.64

*90% confidence & 10% margin of error

student's name (optional), age, sex, classification dormitory, and length of stay in the dormitory. The third part consisted of questions about the dormitory. The fourth part was related to the retrofit and renovation of the dormitory, and the last part dealt with green building technology features in the dormitory. A "yes or no" response for the majority of the questions was selected because it gave unambiguous results. The primary data collection was conducted during the 1st Semester of Academic Year 2019-2020 through surveys of the students.

Statistical Analyses

Collected and encoded data were cleaned by removing invalid responses (void) to ensure the accuracy of data for subsequent statistical analysis. Descriptive statistics were used to analyze the results of the student survey. Ranking, frequency count, measure of central tendency (mean), and standard deviation were used to describe and characterize the profile and the answers of the survey respondents. Selected variables were subjected to Spearman correlation analysis (*Daniel 1990*) as this was more appropriate for measurements taken from ordinal scales and Kendall's coefficient of concordance (W) analysis (*Kendall and Gibbons 1990*) to determine the level of agreement among the survey respondents. The formula for Spearman correlation is given by Spearman correlation (*Daniel 1990*):

$$R_s = \frac{(NW - 1)}{N - 1} \tag{1}$$

Where:
R_s = average spearman correlation
N = is the number of respondents
W = is the Kendall's coefficient of concordance

Whereas, the Kendall's coefficient of concordance is given by the formula Kendall's coefficient - (*Kendall and Gibbons 1990*):

$$W = \frac{C - D}{C + D} \tag{2}$$

Where:
W = is the Kendall's coefficient of concordance
C = is the number of concordant pairs
D = is the number of discordant pairs

RESULTS AND DISCUSSION

The study used the BERDE for Retrofits and Renovations for Educational Institutions (BERDERR-EDU v.1.1.0 (2013) for the identification of the green building technologies. The basis for the selection of the "green options" in this study is by choosing the top three impact categories with its corresponding points drawn from the BERDE rating scheme: Energy Efficiency and Conservation (16); Water Efficiency and Conservation (14); Waste Management (12). The list of the green building technology features to be considered in the retrofit and renovation of the dormitory includes energy efficient, light fittings, fixtures, and luminaires; automatic lighting controls (e.g., occupancy, daylight, or motion sensors); water-efficient fixtures (low-flow showerheads, and faucets); rainwater harvesting system; materials recovery facility (MRF); renewable energy technologies (e.g., solar panels, anaerobic digestion/biogas). However, the determination of the GB features through survey and interviews was not limited to the six pre-identified green building technology features.

Characteristics of the Survey Respondents

The respondents of the survey (N=242) demonstrated distinct demographic and residency patterns across six dormitory categories (**Table 3**). There were significant variations in age, with younger students predominantly located in ATI-NTC (18.20 years) and New Forestry Residences (18.56 years), whereas Upper ACCI accommodated the most senior group (28.69 years). A clear gender segregation was observed, with certain dormitories designated exclusively for males (New Dorm, ATI-NTC, New Forestry Residences) or females (Men's Residences, Women's Residences, Upper ACCI). The alignment of academic classification with housing

Table 3. Characteristics of the survey respondents of selected dormitories at the University of the Philippines Los Banos, College, Laguna, Philippines, 1st Semester 2019-2020 (N=242).

Characteristics		New Dorm (n=46)	ATI-NTC (n=46)	New Forestry Residences (n=43)	Men's Residences (n=41)	Women's Residences (n=49)	Upper ACCI (n=17)
Age (Years)	Mean	20.52	18.20	18.56	18.27	20.13	28.69
	Std. Deviation	1.95	0.54	0.81	0.63	1.57	6.49
Sex (%)	Male	100.00	100.00	100.00	0.00	0.00	0.00
	Female	0.00	0.00	0.00	100.00	100.00	100.00
Classification (%)	Freshmen	0.00	100.00	95.35	97.65	2.08	0.00
	Upper class men	100.00	0.00	4.65	2.44	97.92	0.00
	Graduate students	0.00	0.00	0.00	0.00	0.00	100.00
Length of stay (in months)	Mean	14.02	3.49	3.76	3.22	8.43	14.13
	Std. Deviation	15.93	2.47	3.09	1.87	9.41	13.09

assignments was evident, as freshmen overwhelmingly occupied ATI-NTC (100%), New Forestry Residences (95.35%), Men's Residences (97.65%), and Women's Residences (97.92%), while upperclassmen were exclusively accommodated in New Dorm (100%). Graduate students were strictly housed in Upper ACCI. The shortest residency durations are noted in freshman dormitories (~3–4 months), while the longest were in Upper ACCI (14.13 months) and New Dorm (14.02 months), suggesting enhanced housing stability for upperclassmen and graduate students. These observations underscored the structured nature of dormitory assignments dictated by academic level, gender, and residence duration.

Factors in Choosing a Dormitory

Respondents were asked to rank nine criteria as their considerations in choosing a dormitory: cost of the monthly rental, thermal comfort, natural lighting and contact with the outside environment, improved air quality, less noise, aesthetics, and architectural design, safety, amenities/facilities, and location (**Table 4**).

Overall, results of the concordance analysis showed that the cost of monthly rental was their main consideration for a dormitory with an average rank of about 2.16, followed by safety (3.16), location (3.69), amenities/facilities (4.58), thermal comfort (5.75), less noise (5.89), improved air quality (5.91), natural lighting and contact with the outside environment (6.28), and lastly, aesthetics and architectural design (7.59). Although the mean rank was highly significant, Kendall's coefficient of concordance for all dormitories was only 0.40, indicating relatively low agreement with all the survey respondents.

Table 4. Summary of the concordance analysis for the ranking of students' considerations in choosing a dormitory at the University of the Philippines Los Baños in Laguna, Philippines.

Reason for Choosing Dormitory	All Dormitory	New Dorm	ATI-NTC	New Forestry Residence	Men's Residence	Women's Residence	Upper ACCI
Cost of monthly rental	2.16	2.14	2.01	1.77	2.85	1.78	3.2
Thermal comfort (not feeling too hot or too cold)	5.75	5.57	6.05	5.14	5.83	5.96	6.2
Natural lighting and contact with the outside environment	6.28	6.05	6.4	6.23	5.9	6.9	5.73
Improved air quality	5.91	5.30	6.35	5.45	6.41	5.99	6
Less noise (distraction)	5.89	6.20	5.88	5.92	6.21	5.52	5.33
Aesthetics and architectural design	7.59	7.25	7.13	6.93	8.21	8.36	7.73
Safety (intrusion accidents)	3.16	3.70	3.16	4.23	2.36	2.65	2.33
Amenities/Facilities	4.58	4.42	4.05	4.97	4.6	4.82	4.6
Location (e.g., proximity to your college, distance from amenities)	3.69	4.37	3.99	4.36	2.64	3.03	3.87
N	232	42	44	43	39	49	15
Kendall's, W[a]	0.40	0.31	0.41	0.30	0.54	0.62	0.37
Average Spearman correlation, R_s	0.40	0.30	0.40	0.28	0.53	0.61	0.33
Asymp. Sig.	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Note: values for each criterion in respective dormitory are mean rank
[a]Kendall's Coefficient of Concordance

Higher concordance values were observed for Men's Residence and Women's Residence with 0.62 and 0.54, respectively. The top three considerations in each dormitory were the cost of the monthly rental, safety, and location. However, for residents of Men's Residence and Upper ACCI, safety was the primary consideration.

When choosing a dormitory, cost of the monthly rental, less noise (distraction), safety (intrusion accidents), location (distance from amenities), and amenities were on the students' top list. The remaining choices which were not selected included thermal comfort, natural lighting and contact with the outside environment, improved air quality, fewer problems with building physics, operational comfort, aesthetics and architectural design, and useful building areas. An "Others" option was also included to allow the opinions of the respondents that can be added to the list of considerations.

Proximity and location were identified as primary reasons for choosing a dormitory with consideration of access to public places, such as markets and facilities based on the study of *Brilliantes et al.* (*2012*). They also found that while the cost of monthly rental contributes to the selection of dormitory, respondents were willing to pay a higher rate as long as there is a sense of safety and security. Safety and security ranked 2nd across dormitories as one of the considerations in choosing dormitories in this study.

Building Satisfaction

Overall, 74.36% of respondents expressed satisfaction, whereas 25.64% reported dissatisfaction, indicating a generally favorable perception of dormitory facilities. Satisfaction levels differ among dormitories (**Table 5**). ATI-NTC residents exhibited the highest satisfaction rate (88.89%), followed by New Forestry Residences (81.40%) and Men's Residences (78.05%). Women's Residences (74.47%) and Upper ACCI (73.33%) displayed slightly lower yet still positive satisfaction levels. Notably, New Dorm demonstrated the lowest satisfaction at 50.00%, reflecting a different perception among residents. The findings suggests that newer or well-maintained dormitories such as ATI-NTC and New Forestry Residences, tend to exhibit higher satisfaction rates, potentially due to better infrastructure or facilities. Conversely, the varied response in New Dorm may suggest inconsistencies in facility conditions or varying resident expectations. These findings shows the need for enhancements in dormitory infrastructure to improve the student living experience.

Table 5. Survey respondents' satisfaction with current building features of their dormitories at the University of the Philippines Los Baños in Laguna, Philippines (N=242).

Dormitory	Yes (%)	No (%)
New Dorm (n=46)	50.00	50.00
ATI-NTC (n=46)	88.89	11.11
New Forestry Residences (n=43)	81.40	18.60
Men's Residences (n=41)	78.05	21.95
Women's Residences (n=49)	74.47	25.53
Upper ACCI (n=17)	73.33	26.67
Average	74.36	25.64

A study by *Navarez* (*2017*) about student residential satisfaction for on-campus housing facilities in the Philippines revealed that living conditions do not meet the current needs and demands of the dormitory residents. This was attributed to the fact that learner-centered and quality-driven conditions were unsatisfactory, according to the respondents of the study. The study also found that residential life programs were absent such as sports development, which were not evident, thus the unsatisfactory rating of current dormitory residents. On the contrary, student housing services were perceived to be highly implemented and with high satisfaction among the stakeholders in a study that assessed the implementation and level of student's satisfaction of student services programs at Don Mariano Marcos Memorial State University, Philippines (*Eisma 2015*). The study by *Najib et al*. (*2011*) on the measurement of satisfaction with student housing facilities in Malaysia showed that student dormitory residents are satisfied in most facilities of their dormitories. However, respondents were dissatisfied in terms of Wi-Fi in a study bedroom. Connectivity as part of their lifestyle was also mentioned in the study of *La Roche et al.* (*2010*) as one of the expectations of millennial students at Longwood University, USA. Satisfaction with university dormitories plays a significant role in the framework for sustainability in higher education (*Ning and Chen 2016*). The level of satisfaction can be an indicator in assessing the living quality of the dormitories or residential buildings (*Adriaanse 2007; Jansen 2014; Nabilou and Khani 2015*).

Need for Retrofit and Renovation

The study shows that a high demand for dormitory improvements is needed indicated by an average of 89.04% of respondents agreeing with the need for renovations (**Table 6**). The most pronounced demand for renovations was in Men's Residences (100%), followed by Women's Residences (95.74%), Upper ACCI (94.12%),

Table 6. Perception of the survey respondents on the need to retrofit and renovate the dormitories at the University of the Philippines Los Baños in Laguna, Philippines (N=242).

Dormitory	Yes (%)	No (%)
New Dorm (n=46)	91.11	8.89
ATI-NTC (n=46)	69.57	30.43
New Forestry Residences (n=43)	83.72	16.28
Men's Residences (n=41)	100.00	0.00
Women's Residences (n=49)	95.74	4.26
Upper ACCI (n=17)	94.12	5.88
Average	89.04	10.96

and New Dorm (91.11%), suggesting recognition of ageing infrastructure or inadequate facilities within these dormitories. The New Forestry Residences also showed considerable need for renovations (83.72%), while ATI-NTC demonstrated the lowest perceived need (69.57%), consistent with previously high satisfaction ratings. These results indicate the urgent need for dormitory upgrades, particularly within older residences, to improve habitability and student well-being. The disparities between dormitories highlight differences in facility conditions.

Moving towards green building initiatives will likely promote better living conditions in dormitories, and contribute to sustainable development, particularly in energy consumption. Energy-efficiency can be achieved through building retrofit planning to arrive at optimal results in conjunction with high investments involved depending on the choice or combination of GBT-based retrofitting approaches (*Fan and Xia 2018; Lee et al. 2019*). The choice of appropriate retrofit strategies will likely affect the success of building retrofitting towards energy efficiency and reduced environmental impacts of existing buildings (*Javid et al. 2019; Zhao et al. 2019*). In Korea, *Lee et al.* (*2019*) found that green remodeling of existing buildings was effective in the reduction of heating energy demands. Moreover, retrofitting such installation of insulation and high-efficiency windows can significantly improve the overall indoor air quality and temperatures in dormitories.

Implementation of Measures for Retrofit and Renovation

The result indicates strong support for sustainability and enhanced quality of life in all the dormitories (**Table 7**). Almost 98.64% of the respondents accept resource-saving technologies and conservation efforts, and 97.04% accept activities to minimize pollution and waste. Additionally, 99.23% accept measures focused on enhancing residents' quality of life. The highest percent agreement was with Men's Residences (100%) across all categories, reflective of a huge need for wholesale renovations. Similarly, New Dorm, Women's Residences, and Upper ACCI residents across the board call for quality-of-life improvements unanimously (100%), reflecting the centrality of a better living experience. ATI-NTC and the New Forestry Residences also showed very high concurrency on all measures, with slight difference in favor of pollution reduction (95.35% in both dormitories). These findings identify a clear student preference for the inclusion of sustainability-oriented and well-being-centered developments in dormitory upgrades. Purposeful application of these measures will be critical to further environmental efficiency and residential comfort in university dormitories.

Greening university campus buildings can substantially reduce energy consumption and emissions based on the study of *Chalfoun* (*2014*). It showed that using various tools, energy consumption, and emissions can be estimated for a particular building. In a green building analysis for Taiwan's first zero-carbon green building, Magic School of Green Technology in National Cheng Kung University, simulation of energy usage using analytical software was comparable to the actual usage of the building reaching an efficiency of about 65% (*Wang and Lin 2011*).

Table 7. Survey respondents' agreement on the adoption measures in the retrofit and renovation of the University of the Philippines Los Baños dormitories in Laguna, Philippines (N=242).

Dormitory	Resource-efficient Technologies and Conservation Measures (%)	Pollution and Waste Reduction Measures (%)	Measures that Improve the Quality of Life of its Occupants(%)
New Dorm (n=46)	100.00	97.78	100.00
ATI-NTC (n=46)	97.78	95.35	100.00
New Forestry Residences (n=43)	95.35	95.35	95.35
Men's Residences (n=41)	100.00	100.00	100.00
Women's Residences (n=49)	100.00	93.75	100.00
Upper ACCI (n=17)	98.73	100.00	100.00
Average	98.64	97.04	99.23

Familiarity and Awareness on Green Building Technologies (GBTs)

The findings indicate that 55.13% of the respondents are aware of the features of green buildings, while 44.87% are unaware, showing a moderate level of awareness of green building practices among students (**Table 8**). Familiarity rates vary between dormitories. Students living in Upper ACCI had the highest rate of awareness (75.00%), which could be due to higher exposure to sustainability efforts or previous experience with green infrastructure. In contrast, Women's Residences posted the lowest rate of familiarity (43.75%), indicating that more information dissemination or education regarding the features of green buildings needs to be made in this dormitory. New Dorm (56.82%) and Men's Residences (58.54%) were relatively more familiar compared to ATI-NTC (47.83%) and New Forestry Residences (48.84%), which both registered less than 50% awareness. These results emphasize the need for focused educational programs or campaigns that seek to enhance student understanding of green building technology. Enhancing awareness could make students more supportive of sustainability programs and lead to more judicious use of dorm resources.

The results of this study conform with the study of *Novieto et al.* (*2023*) and *Donkor-Hyiaman et al.* (*2023*) on student perceptions of green building concepts. Students' awareness of green building principles was also comparatively low in a technical university in Ghana (*Novieto et al. 2023*). *Donkor-Hyiaman et al.* (*2023*) found that the low level of green building literacy is attributed to age, gender, level of education, level of study, employment status, income level, and a condition if the individual has lived in a house with green features. These suggest that there is a need to increase awareness and knowledge of green building principles and technologies particularly among students, dormitory residents and occupants of other buildings. This can help promote the future adoption of sustainable building practices and improve the environmental performance of buildings in the university.

Knowledge and Perception on GBTs

Only about 13.78% of respondents in all dormitories were aware of existing green building elements, while 86.22% reported being unaware, indicating a substantial lack of visibility or understanding of sustainability features in student dormitories (**Table 9**). Across all dormitories, awareness levels remained consistently low, with the highest recognition reported in Upper ACCI (16.67%) and ATI-NTC (15.22%). On the other hand, Women's Residences had the lowest awareness (10.64%), followed by Men's Residences (12.20%) and New Dorm (13.64%).

Table 8. Familiarity of the survey respondents with the features of green building technologies at the University of the Philippines Los Baños in Laguna, Philippines (N=242).

Dormitory	Yes (%)	No (%)
New Dorm (n=46)	56.82	843.18
ATI-NTC (n=46)	47.83	52.17
New Forestry Residences (n=43)	48.84	51.16
Men's Residences (n=41)	58.54	41.46
Women's Residences (n=49)	43.75	56.25
Upper ACCI (n=17)	75.00	25.00
Average	55.13	44.87

Table 9. Respondents' knowledge on the presence of green building technology features in the dormitories (N=242).

Dormitory	Yes (%)	No (%)
New Dorm (n=46)	13.64	86.36
ATI-NTC (n=46)	15.22	84.78
New Forestry Residences (n=43)	14.29	85.71
Men's Residences (n=41)	12.20	87.80
Women's Residences (n=49)	10.64	89.36
Upper ACCI (n=17)	16.67	83.33
Average	13.78	86.22

Among the listed knowledge and perception regarding green building technology features, survey respondents across dormitories selected sustainable (86.47%), low carbon emission (81.28%), and good indoor environment quality (73.23%) (**Table 10**). On the contrary, respondents perceived that green building technologies require a certain amount of investment and are difficult to operate.

This widespread lack of awareness underscores the need for more proactive communication and educational initiatives to inform residents about sustainable features in their living spaces. Strategies such as information campaigns, dormitory orientations, and interactive sustainability programs could help bridge this knowledge gap. By increasing awareness, students may be more inclined to adopt sustainable behaviors and support future green building initiatives, ultimately fostering a more environmentally conscious dormitory culture. Articulation of knowledge and views regarding sustainability were easier for students (*Hayles 2007*). It can be inferred based on the results of the survey that the respondents were knowledgeable to a certain extent, particularly in the perception of green building technologies as sustainable practice with an average of about 86.47% across dormitories (**Table 10**).

Sources of Information on GBTs

Respondents for all dormitories who answered "Yes" were asked where they got the information about features of green building technologies. About half (54.06%) of the total respondents selected media as their primary source of information (**Table 11**). This trend can also be observed for each dormitory ranging from 46.51 to 63.41%. Scientific meetings (19%), conferences (15%), policy papers, laws, and ordinances (12%), and consultations with experts in the field (4.32) are generally the source of information regarding GB technologies and strategies. Scientific meetings, conferences, consultations with experts in the field, policy papers, laws, and ordinances are generally the sources of information regarding GB technologies and strategies.

Perception on the Need for GBTs in Dormitories

Almost all the respondents (97.80%) who answered "Yes" were in agreement to equip their respective dormitories with green building technology features (**Table 12**). Features with only a small percentage (2.38-5.26%), saying that there is no need to have such building features.

Dormitory residents' knowledge about GBTs and its importance will likely influence how they perceive the adoption in dormitories. In general, individuals with higher knowledge about GBTs will likely propose adoption (*Liu et al. 2018*). Decisions on GBT adoption can also be affected by social trust and environmental attitude. Social trust plays an essential role in forming attitudes of residents, while environmental attitude translates to environmental perspectives in terms of protection (*Liu et al. 2018; Rajaee et al. 2019*).

Respondents who answered "Yes" were asked if they agree on identified green building technology features to be installed in their dormitories. Results showed that energy-efficient light fittings, fixtures, and luminaries (82.73%), and renewable energy technologies (80.78%) should be present as green building technology features for their dormitories (**Table 13**). Automatic light control features, however, received the lowest response across and within the dormitories with an average of 46.06%.

Table 10. Survey respondents' knowledge and perception about 'green building technology' at the University of the Philippines Los Baños in Laguna, Philippines (N=242, %).

Knowledge and Perception	New Dorm (n=46)	ATI-NTC (n=46)	New Forestry Residences (n=43)	Men's Residences (n=41)	Women's Residences (n=49)	Upper ACCI (n=17)	Average
Sustainable	81.82	89.13	86.05	95.12	85.42	81.25	86.47
Low carbon emission	84.44	78.26	83.72	82.93	70.83	87.50	81.28
Low investment	8.89	21.74	13.95	14.63	12.50	12.50	14.04
High investment	26.67	23.91	27.91	41.46	60.42	18.75	33.19
Advanced technology	44.44	52.17	48.84	63.41	52.08	43.75	50.78
Hard to operate and high maintenance	13.33	6.52	13.95	21.95	39.58	6.25	16.93
Easy to operate and low maintenance	26.67	47.83	39.53	24.39	22.92	18.75	30.02
Good indoor environment quality	68.89	67.39	60.47	78.05	83.33	81.25	73.23
New	35.56	47.83	25.58	36.59	35.42	12.50	32.25

Table 11. Information sources on features of green building technologies of the survey respondents at the University of the Philippines Los Baños in Laguna, Philippines (N=242, %).

Dormitory	Media	Policy Papers, Laws and Ordinances	Scientific Meetings, Conferences, and etc	Scientific Papers	Consultation with Experts in the Field
New Dorm (n=46)	60.00	13.33	17.78	24.44	8.89
ATI-NTC (n=46)	56.52	13.04	4.35	15.22	2.17
New Forestry Residences (n=43)	46.51	13.95	11.63	13.95	2.33
Men's Residences (n=41)	63.41	4.88	12.20	17.07	0.00
Women's Residences (n=49)	54.17	8.33	8.33	14.58	0.00
Upper ACCI (n=17)	43.75	18.75	37.50	31.25	12.50
Average	54.06	12.05	15.30	19.42	4.32

Table 12. Respondents' perception on the need for green building technologies in the dormitories at the University of the Philippines Los Baños in Laguna, Philippines (N=242).

Dormitory	Yes (%)	No (%)
New Dorm (n=46)	94.74	5.26
ATI-NTC (n=46)	100.00	0.00
New Forestry Residences (n=43)	94.44	5.26
Men's Residences (n=41)	100.00	0.00
Women's Residences (n=49)	97.62	2.38
Upper ACCI (n=17)	100.00	0.00
Average	97.80	2.15

Green Building Features

A high level of agreement regarding the listed features of green building technologies was shown by the respondents across dormitories (**Table 14**). Among the listed features, respondents agreed on efficiency in the use of energy, water, and other sources (94.57%); adopts pollution and waste reduction measures, promotes reuse and recycling of materials (87.38%), and uses all forms of renewable energy (83.94%).

Mansour and Radford (*2014*) identified four major factors in the perception of green buildings: degree of belief in sustainability; degree of green certification;congruity of design with the existing schema of similar conventional buildings; and users' personal experience in the building. As in the case of this study, respondents agreed with the concept of sustainability in trying to understand green building technologies. Their perception would also likely depend on their personal experience. Experiences can be categorized as task performance, social territories, wayfinding, cultural expression, as well as visual and non-visual aesthetics (*Doxtater 2005*). On the other hand, environmental and experiential factors might contribute to the level of individual judgments in terms of confidence about green buildings (*Mansour and Radford 2014*).

Table 13. Respondents' perceived agreement on having green building technologies features in the dormitories at the University of the Philippines Los Baños in Laguna, Philippines (N=242, values in percent).

Green Building Technology Feature	New Dorm (n=46)	ATI-NTC (n=46)	New Forestry Residences (n=43)	Men's Residences (n=41)	Women's Residences (n=49)	Upper ACCI (n=17)	Average
Energy-efficient light fittings, fixtures, and luminaries	76.32	89.74	77.78	94.44	88.10	70.00	82.73
Automatic lighting controls	44.74	66.67	30.56	47.22	57.14	30.00	46.06
Water-efficient fixtures	60.53	74.63	52.78	75.00	69.05	70.00	67.00
Rainwater harvesting system	63.16	64.10	55.56	63.89	66.67	40.00	58.90
Materials Recovery Facility (MRF)	55.26	64.10	33.33	69.44	50.00	70.00	57.02
Renewable energy technologies	84.21	87.18	75.00	77.78	90.48	70.00	80.78

Table 14. Survey respondents' agreement on the features of a green building technology at the University of the Philippines Los Baños in Laguna, Philippines (N=242, values in percent).

Features of a Green building Technology	New Dorm (n=46)	ATI-NTC (n=46)	New Forestry Residences (n=43)	Men's Residences (n=41)	Women's Residences (n=49)	Upper ACCI (n=17)	Average
Uses all forms of renewable energy such as solar	77.78	80.43	86.05	92.68	91.67	75.00	83.94
Efficiently uses energy, water and other resources	93.33	95.65	93.02	100.00	91.67	93.75	94.57
Provide good indoor and environmental air quality	80.00	91.30	83.72	82.93	85.42	81.25	84.10
Uses materials which are sustainable, ethical and non-toxic	77.78	89.13	83.72	92.68	72.92	81.25	82.91
Adopts pollution and waste reduction measures, promotes reuse and recycling of materials	82.22	93.48	93.02	95.12	85.42	75.00	87.38
Employs a design that adapts in a changing environment	60.00	76.09	65.12	75.61	62.50	67.78	67.85
Considers environment-friendly design, construction and operation	77.78	86.96	86.05	92.68	70.83	75.00	81.55

While adopting GBTs could contribute to energy savings, it must be noted that their direct impact on power outages and availability of electricity and water sources may be limited (*Chen et al. 2021*). GBTs primarily focuses on reducing resource consumption and improving efficiency within buildings. However, they can indirectly contribute towards a more reliable and sustainable energy and water supply in the long run. For example, energy-efficient lighting systems and automatic lighting controls can reduce the overall energy demand of a dormitory. To some extent, electricity load can be alleviated due to less energy usage (*Chen et al. 2021*). Heating, ventilation, and air conditioning (HVAC) can significantly impact how "green" a building is (*Khabiri and Ghavami 2015*). However, the improvement in the current technologies HVAC system such as eco-friendliness suggest a contribution to creating sustainable energy-efficient buildings. The consideration of Green HVAC technologies which typically include heat pumps that are more sustainable, comfortable, and cost saving are vital when designing and constructing green buildings. On the other hand, the presence of water-efficient fixtures and rainwater harvesting systems tend to promote sustainable water use (*Ali and Sang, 2023; Lima et al. 2021*). Reducing water consumption and the use of alternative water sources such as rainwater canlead to better water resource conservation in dormitories. As such, GBTs play only a part in reducing water demand and promoting responsible water use.

GBT Features in UPLB dormitories

Through the survey, the perceived and identified GBT present in each dormitory was determined (**Table 15**). Across all the dorms, waste management practices, such as waste segregation (even though not sure if strictly implemented) and the use of trash bins are highly noticeable to the dorm residents. Having natural ventilation and good air quality (3 out of 6) were also evident. light-emitting diode (LED) lights were also mentioned.

Waste management in dormitories through waste segregation and the use of trash bins can have significant impacts on public health, environment, and resource conservation (*Ifyalem and Jakada 2023*). For instance, waste recycling helps reduce waste transported to landfills (*Abubakar et al. 2022*). Proper waste management also reduces cost associated with waste collection (*Pongpunpurt et al. 2022*).

On the other hand, natural ventilation promotes better air circulation resulting in a comfortable indoor temperature. A study by *Bamdad et al.* (*2022*) found

Table 15. Survey respondent's perceived and identified green building technologies (GBT) present in the dormitories at the University of the Philippines Los Baños in Laguna, Philippines.

Dormitory	Perceived GBTs
New Dorm Residence Hall	- Insulated roof - Huge windows for natural light - Fluorescent lights - LED Lights - Natural lighting - Waste management (waste segregation and trash bins) - Natural ventilation (utilization of natural ventilation through structural features of the dorm)
ATI-NTC	- Air quality (good indoor/environment air quality) - Waste management (trash bins, waste reduction measures, segregation, recycling) - Good ventilation - Natural Ventilation - Trees
New Forestry Residences	- Plants (trees, plants inside the dorm) - Waste management (proper waste segregation, segregated trash cans) - Properly ventilated rooms - Use of wood - Less usage of electricity
Men's Residences	- Air quality (good air quality) - Contact w/ outside environment - Waste management (trash bins, waste segregation)
Women's Residences	- Waste management (recycling, waste reduction measures/methods, water bottle collection) - Water dispenser
Upper ACCI	- LED lights - Waste management (waste reduction measures)

that natural ventilation can reduce building energy consumption by up to 59.8%, improve indoor air quality and promote sustainability. The provision of energy-efficient LED lighting fixtures also contributes to cost and energy savings (*Petersen et al. 2007*). LED lighting fixtures are designed to provide adequate illumination while minimizing energy waste. An implementation of an energy-efficient lighting system could translate to substantial energy savings and potential reduction in carbon emissions (*Hong and Rahmat 2022*).

Perceived Effects of GBTs

The majority of the respondents across the dormitories agreed that living in a dormitory with green building technology features will improve their sense of responsibility (87.65%), enhanced resource utilization (83.79%), and greater social well-being (83.57%). Between the three parameters measured, the sense of responsibility got the largest general agreement with the maximum response in Men's Residences (97.65%) and Women's Residences (93.75%), implying that students perceive eco-friendly dorms can influence more responsible conduct in terms of environmental and shared living habits. Perceived increases in resource efficiency were especially high in ATI-NTC (91.30%) and New Forestry Residences (88.37%), which indicated that there was a belief that green building technologies would increase efficiency in the use of energy and water. Women's Residences (77.08%) and Men's Residences (78.05%) were slightly lower, which indicates that there are still some residents who might not yet understand the resource management advantages of sustainable dormitory attributes. Social well-being also widely experienced impact, as noted by Upper ACCI (93.75%) and Women's Residences (87.50%), who expressed the most agreement (**Table 16**). This can indicate that sustainable dormitories are viewed as such environments where positive social interaction, comfort, and overall satisfaction can be developed in terms of residing there.

Table 16. Respondents' perception of the possible effects of living in a dormitory with green building technology features (N=242, values in percent).

Dormitory	Improved Social Well-being	Better Allocation of Resources	Sense of Responsibility
New Dorm (n=46)	77.78	86.67	86.67
ATI-NTC (n=46)	82.61	91.30	89.13
New Forestry Residences (n=43)	74.42	88.37	83.72
Men's Residences (n=41)	85.37	78.05	97.65
Women's Residences (n=49)	87.50	77.08	93.75
Upper ACCI (n=17)	93.75	81.25	75.00
Average	83.57	83.79	87.65

In general, these results highlight the capability of green building technologies to make a positive contribution to sustainability as well as good behavioral and social changes for dormitories. As students are aware of such benefits, future design and renovation for dormitories should incorporate sustainable elements in addition to enhancing awareness of their contribution to community health and the environment. Dormitory residents' health and comfort may be improved in green buildings through the reduction or removal of toxic substances as well as improvement in retention and learning ability (*Nalewaik and Venters 2009*). Living quality of occupants was also highlighted in the study of *Mesthrige and Kwong* (*2018*), relating the impacts of green features on overall health and productivity dependent on design quality. The design quality is also related to improvements in air quality, temperature, and daylighting. Criteria about green features for built environment performance, such as indoor environmental quality, occupants' satisfaction, occupants' health, and occupants' productivity all have a positive impact on health and comfort (*Nalewaik and Venters 2009*).

CONCLUSION AND RECOMMENDATIONS

The knowledge and perception of dormitory students on Green Building Technologies (GBTs) in the retrofit and renovation of dormitories at the University of the Philippines Los Baños (UPLB) were assessed. Retrofitting and renovation of the dormitories is needed, with the majority of respondents agreeing on the importance of integrating GBTs in these efforts. Despite a relatively low level of familiarity with GBT features, the students recognized the positive impacts of living in a dormitory with GBTs, including improved social well-being, better resource allocation, and a sense of responsibility.

The schedule of retrofit and renovation of UPLB dormitories can be prioritized based on the oldest to the newest building with a focus on addressing the concerns identified by the respondents of this study. This will ensure that the highest needs for improvement are given priority. The GBT features already identified in the dormitories should be continued and further improved to enhance their functionality and ensure their effectiveness in achieving sustainability goals. Continuous monitoring and evaluation of the impacts of GBTs in dormitories should be conducted to assess their effectiveness to allow identification of areas for improvement. This will provide valuable insights for future retrofitting and renovation projects. Considering this, promotional materials can be created to raise awareness among decision-makers, implementers of GBTS, dormitory managers and staff, and dormitory residents about the advantages of GBTs. These materials should be written in simple language and accessible through various media channels. Finally, a follow-up study is recommended to assess the effectiveness of implemented GBTs in new dormitories. This will provide valuable insights for future retrofitting and renovation projects and contribute to the knowledge on sustainable building practices.

REFERENCES

Abubakar, I.R., Maniruzzaman, K.M., Dano, U.L., AlShihri, F.S., AlShammari, M.S., Ahmed, S.M.S., Al-Gehlani, W.A.G, and Alrawaf, T.I. 2022. "Environmental Sustainability Impacts of Solid Waste Management Practices in the Global South". *International Journal of Environmental Research and Public Health* 2022 19:12717, https://doi.org/10.3390/ijerph191912717

Adriaanse, C.C.M. 2007. "Measuring Residential Satisfaction: a Residential En3vironmental Satisfaction Scale (RESS)". *Journal of Housing and the Built Environment* 22: 287–304.

Ali, S. and Sang, Y. 2023. "Implementing Rainwater Harvesting Systems as a Novel Approach for Saving Water andEnergy in Flat Urban Areas". *Sustainable Cities and Society* 89: 2023, 104304, ISSN 2210-6707. https://doi.org/10.1016/j.scs.2022.104304

Bamdad, K., Matour, S., Izadyar, N., and Omrani, S. 2022. "Impact of Climate Change on Energy Saving Potentials of Natural Ventilation and Ceiling Fans in Mixed-mode Buildings". *Building and Environment* 2022(209):108662, ISSN 0360-1323. https://doi.org/10.1016/j.buildenv.2021.108662

Biofuels Act of 2006, Rep. Act No. 9367, (July 24, 2006). https://web.senate.gov.ph/republic_acts/ra%209367.pdf

Brilliantes, R.A., Aga, N.B., Tipace, F.C., Adegue, C.A., Perez, M.P., and Sagarino, E.V. 2012. "The Living Conditions of University Students in Boarding Houses and Dormitories in Davao City, Philippines". *International Journal of Social Science* 1: 66-85.

Cappelletti, F., Mora, T.D., Peron, F., Romagnoni, P., and Ruggeri, P. 2015. "Building Renovation: Which Kind of Guidelines Could be Proposed for Policy Makers and Professional Owners?" *Energy Procedia* 78: 2366–2371.

Chalfoun, N. 2014. "Greening University Campus Buildings to Reduce Consumption and Emission while Fostering Hands-on Inquiry-based Education". *Procedia Environmental Sciences* 20: 288–297.

Chen, L., Gao, X., Hua, C., Gong, S., and Yue, A. 2021. "Evolutionary Process of Promoting Green Building Technologies Adoption in China: A Perspective of Government". *Journal of Cleaner Production* 279:2021, 123607 ISSN 0959-6526.

Daniel, W.W. 1990. "Spearman Rank Correlation Coefficient." In: Applied Nonparametric Statistics (2nd ed.). Boston: PWS-Kent. pp. 358–365. ISBN 978-0-534-91976-4.

De Araujo, P., and Murray, J. 2010. Estimating the effects of dormitory living on student performance. SSRN Electronic Journal. https://doi.org/10.2139/ssrn.1555892

Department of Environment and Natural Resources-Region IV CALABARZON. 2016 . Environmental Compliance Certificate. University Complex Phase 1 Project UPLB.

Doxtater, D. 2005. "Living in La Paz: An Ethnographic Evaluation of Categories of Experience in a "New Urban" Residence Hall". *Journal of Architectural and Planning Research* 22: 30–50.

Donkor-Hyiaman, K.A., Gyamfi-Yeboah, F., Tudzi, E.P. and Bugri, J.T. 2023. "Green Building Literacy and University Students' Housing Choice in Ghana". PREPRINT (Version 1) Research Square. https://doi.org/10.21203/rs.3.rs-2713342/v1

Dzebo, A., Iacobuţă, G.I. and Beaussart, R. 2023. The Paris Agreement and the Sustainable Development Goals: Evolving Connections. SEI Policy Brief. Stockholm Environment Institute, Stockholm. https://doi.org/10.51414/sei2023.036

Eisma, D.V. 2015. "Extent of Implementation and Level of Students' Satisfaction on Student Services Programs of DMMMSU". Proceedings of ISER 12th International Conference, Pattaya, Thailand, 22nd November 2015, ISBN: 978-93-85832-53-6

Fan, Y. and Xia, X. 2018. "Energy-efficiency Building Retrofit Planning for Green Building Compliance". *Building and Environment* 136: 312–321.

Golbazi, M., Danaf, A.E., and Aktas, C.B. 2020. "Willingness to Pay for Green Buildings: A Survey on Students' Perception in Higher Education". *Energy and Buildings*

216:2020 109956 ISSN 0378-7788. https://doi.org/10.1016/j.enbuild.2020.109956

Hayles, D.C. 2007. "A Study of Student Perceptions and Awareness of Sustainability". Built Environment Education Conference.

Hong, W., and Rahmat, B.N.N.N. 2022. "Energy Consumption, CO_2 Emissions and Electricity Costs of Lighting for Commercial Buildings in Southeast Asia". *Scientific Report* 12:13805. https://doi.org/10.1038/s41598-022-18003-3

Ifyalem, K.J. and Jakada, Z.A. 2023. "The Influence of Housing and Waste Management Facilities on Public Health. *Journal of Materials and Environmental Science* 14(1): 62-81.

Jansen, S.J.T. 2014. "The Impact of the Have–Want Discrepancy on Residential Satisfaction". *Journal of Environmental Psychology* 40: 26–38.

Javid, A.S., Aramoun, F., Bararzadeh, M., and Avami, A. 2019. "Multi Objective Planning for Sustainable Retrofit of Educational Buildings". *Journal of Building Engineering* 24: 100759.

Kendall, M. G. and Gibbons, J.D. 1990. Rank Correlation Methods. New York, NY: Oxford University Press.

Khabiri, O., and Ghavami, M. 2015. "Efficient HVAC System in Green Building Design". *Journal of Nature Science and Sustainable Technology* 9(3):559-566. Retrieved from https://www.proquest.com/scholarly-journals/efficient-hvac-system-green-building-design/docview/1770075776/se-2

Kim, H.H. and Kim, S.S. 2020. "Occupants' Awareness of and Satisfaction with Green Building Technologies in a Certified Office Building". *Sustainability* 2020, 12, 2109; https://doi:10.3390/su12052109

La Roche, C.R., Flanigan, M.A., and Copeland Jr., P.K. 2010. "Student Housing: Trends, Preferences and Needs". *Contemporary Issues in Education Research* 3(10): 45-50.

Lee, J., Shepley, M.M., and Choi, J. 2019. "Exploring the Effects of a Building Retrofit to Improve Energy Performance and Sustainability: A Case Study of Korean Public Buildings". *Journal of Building Engineering* 25:100822.

Leung, B.C.M. 2018. "Greening Existing Buildings [GEB] Strategies". *Energy Reports* 4: 159–206.

Lima, C.A.S. de Souza, R.S., Almeida, A.K. and de Almeida, I.K. 2021. "Economic Feasibility of a Rainwater Harvesting System in a Residential Condominium in the Brazilian Midwest". *International Journal of Sustainable Engineering* 14:6:1950-1961 http://doi.org/10.1080/19397038.2021.1961910

Liu, Y., Hong, Z., Zhu, J., Yan, J., Qi, J., and Liu, P. 2018. "Promoting Green Residential Buildings: Residents' Environmental Attitude, Subjective Knowledge, and Social Trust Matter". *Energy Policy* 112: 152–161.

Ma, Z., Cooper, P., Daly, D., and Ledo, L. 2012. "Existing Building Retrofits: Methodology and State-of-the-Art". *Energy and Buildings* 55: 889–902.

Mansour, O.E. and Radford, S.K. 2014. "Green Building Perception Matrix, a Theoretical Framework", In: Proceedings of the 6th Annual Architectural Research Symposium in Finland: Designing and Planning the Built Environment for Human Well-Being. Presented at the 6th Annual Architectural Research Symposium, Finland, p. 13.

Mesthrige, J.W. and Kwong, H.Y. 2018. "Criteria and Barriers for the Application of Green Building Features in Hong Kong". *Smart and Sustainable Built Environment* 7: 251–276.

Nabilou, B. and Khani, M. 2015. "Quality of Dormitory Services in Urmia University of Medical Science: Female Student's Perceptions". *Journal of Educational and Management Studies* 5(4): 233-239.

Najib, N.U.M., Yusof, N.A., and Osman, Z. 2011. "Measuring Satisfaction with Student Housing Facilities". *American Journal of Engineering and Applied Sciences* 4:52–60.

Nalewaik, A. and Venters, V. 2009. "Cost Benefits of Building Green". *Cost Engineering* 51:1 (28-34).

Navarez, J.C. 2017. "Student Residential Satisfaction in an On-campus Housing Facility". DLSU Research Congress 2017, De La Salle University, Manila, Philippines, 20-22 June 2017.

Ning, Y. and Chen, J. 2016. "Improving Residential Satisfaction of University Dormitories through Post-occupancy Evaluation in China: A Socio-technical System Approach". *Sustainability* 8:1050.

Novieto, D.T., Kulor, F., Apprey, M.W. and Ayeke, E. 2023, "Appraisal of Students' Perceptions on Green Building Concepts in a Technical University". *Frontiers in Engineering and Built Environment* 3(2):22-136. https://doi.org/10.1108/FEBE-08-2022-0034

Perino, M., Quenard, D., and Wakili, K.G. 2017. "Building Retrofit: Energy Conservation, Comfort and Sustainability". *Energy and Buildings* 152: 40.

Petersen, J.E., Shunturov, V., Janda, K., Platt, G. and Weinberger, K. 2007. "Dormitory Residents Reduce Electricity Consumption when Exposed to Real-time Visual Feedback and Incentives". *International Journal of Sustainability in Higher Education* 8(1):16-33. https://doi.org/10.1108/14676370710717562

Philippine Green Building Council, National Secretariat. 2011. http://www.philgbc.org/newsroom/mediareleases/2-green-convergencebuildings-information-technologies

Pongpunpurt, P., Muensitthiroj, P., Pinitjitsamut, P., Chuenchum, P., Painmanakul, P., Chawaloesphonsiya, N., and Poyai, T. 2022. "Studying Waste Separation Behaviors and Environmental Impacts toward Sustainable Solid Waste Management: A Case Study of Bang Chalong Housing, Samut Prakan, Thailand". *Sustainability*. 14(9):5040. https://doi.org/10.3390/su14095040

Rajaee, M., Hoseini, S.M., and Malekmohammadi, I. 2019. "Proposing a Socio-psychological Model for Adopting Green Building Technologies: A Case Study from Iran". *Sustainable Cities and Society* 45: 657–668.

Revington, N., Moos, M., Henry, J. and Haider, R. 2020. "The Urban Dormitory: Planning, Studentification, and the Construction of an Off-campus Student Housing Market". *International Planning Studies* 25:2, 189-205. https://doi.org/10.1080/13563475.2018.1552565

Seyis, S. 2018. "Sustainable Retrofits for Student Dormitories". Conference Paper at the 42nd IAHS World Congress: 10-13 April 2018 Naples, Italy.

Thorpert, P., Englund, J.E. and Sang, A.O. 2023. "Shades ofGreen for Living Walls – Experiences of Color Contrast and its Implication for Aesthetic and Psychological Benefits". *Nature-Based Solutions* 3 100067, ISSN 2772-4115. https://doi.org/10.1016/j.nbsj.2023.100067

Tolliver, C., Keeley, A.R., and Managi, S. 2019. "Green Bonds for the Paris Agreement and Sustainable Development Goals". *Environmental Research Letters* 14 (2019):064009. https://doi.org/10.1088/1748-9326/ab1118

United States Environmental Protection Agency. 2009. Buildings and their impact on the environment: A Statistical Summary. Revised 22 April 2009, [www. epa. gov/green building/pubs/gbstats.pdf].

Wang, W., Zmeureanu, R., and Rivard, H. 2005. "Applying Multi-objective Genetic Algorithms in Green Building Design Optimization". *Building and Environment* 40(11):1512–1525.

Wang, Y.C. and Lin, H.T. 2011. "Energy-saving Techniques of Full-scale Green Building Analysis Research - Taiwan's First Zero-Carbon Green Building". *Applied Mechanics and Materials* 121–126: 3058–3066.

Yii-Nii, L., Pi-hui, L., Chiu, Y., Hsieh., H., and Chen., Y. 2016. "Experience of Dormitory Peer Mentors: A Journey of Self Learning and Development". *Education* 3-13:136(4):437-450.

Zakaria, R. B., Foo, K.S., Zin, R.M., Yang, J., and Zolfagharian, S. 2012. "Potential Retrofitting of Existing Campus Buildings to Green Buildings". *Applied Mechanics and Materials* 178–181: 42–45.

Zhao, X., Tan, Y. Shen, L., Zhang, G., and Wang, J. 2019. "Case-based Reasoning Approach for Supporting Building Green Retrofit Decisions". *Building and Environment* 160:106210.

Zuo, J., and Zhao, Z. 2014. Green building research–current status and future agenda: A review. Renewable and Sustainable Energy Reviews, 30, 271-281. https://doi.org/10.1016/j.rser.2013.10.021