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A Structural Equation Modeling Approach for Sustainable Institutional Decision Support

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ABSTRACT

The Sustainable Development Goals (SDGs) provide a global framework for advancing sustainability across social, economic, environmental, and institutional dimensions. Higher education institutions play a critical role in promoting sustainability through teaching, research, campus operations, and community engagement. This study assessed SDG awareness and sustainability integration among teaching and non-teaching personnel at Romblon State University and examined the relationships among teaching-learning application or office operations, engagement with SDG-related activities, campus environment integration, and research and development. Using a descriptive-quantitative design, data from 140 respondents were analyzed through descriptive statistics and Structural Equation Modeling (SEM). Results revealed that SDG awareness was generally high, with engagement in sustainability-related activities rated very high. SDG 4 (Quality Education) and SDG 5 (Gender Equality) were the most visible goals. However, key barriers included limited awareness, insufficient resources, weak collaboration, and policy implementation challenges. SEM findings indicated that research and development strongly influenced campus sustainability integration. The study highlights the need for stronger sustainability mainstreaming, enhanced research productivity, inclusive participation, and sustained institutional support to improve SDG implementation in higher education.

1. Introduction

The Sustainable Development Goals (SDGs) have become one of the most influential global frameworks for addressing urgent and interconnected problems related to poverty, inequality, education, health, environmental decline, and governance. Since their adoption in 2015, the 17 goals have guided institutions and governments toward a more inclusive and sustainable future by 2030 [1], [2]. Unlike earlier development models, the SDGs emphasize the interconnected nature of development challenges, recognizing that progress in one area often depends on progress in others [2]. This integrated perspective has made the SDGs particularly relevant to educational institutions,

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which are expected to contribute not only to knowledge creation but also to value formation, innovation, and social transformation [3], [15].

Education is central to the SDG agenda because it enables awareness, critical understanding, and behavioral change. Sustainability-oriented education equips individuals with the competencies needed to address local and global development issues and contributes to all 17 SDGs by raising consciousness, building analytical capacity, and encouraging action [1], [2]. This broader view of education underscores the importance of embedding sustainability principles across institutional systems, especially in higher education.

1.1 Higher education institutions and sustainability transformation

Higher education institutions (HEIs) hold a strategic role in advancing the SDGs because of their capacity to influence teaching, research, governance, community engagement, and innovation [3], [10], [24]. Universities are expected to move beyond traditional academic functions and serve as transformative institutions that model sustainability in their internal systems and external partnerships [5], [6], [24]. This expectation is consistent with the "whole-institution" perspective, which sees sustainability integration as an institutional rather than purely curricular concern [3], [6].

Evidence shows that many universities have begun embedding sustainability into strategic plans, curricula, research agendas, and stakeholder engagement mechanisms [5], [6], [7]. However, progress remains uneven. In many cases, SDGs are visible in institutional discourse yet only partially reflected in actual structures and practices [5], [25]. This creates a gap between symbolic commitment and operational transformation. Research further suggests that institutional support, internal motivation, research culture, and governance coherence are essential in moving from awareness to implementation [7], [9], [24].

1.2 SDG awareness in higher education settings

Awareness is a foundational requirement for effective SDG integration. Universities cannot mainstream sustainability if their personnel do not understand the goals, recognize their relevance, and connect them to daily academic and operational practices. Studies in higher education show that awareness of the SDGs is often present but varies in depth, consistency, and practical application [11], [16], [17]. In many cases, stakeholders are familiar with the existence of the goals but less confident about their meaning, interdependence, or implications for teaching, research, and institutional work [12], [16].

Research on teachers, students, and university personnel indicates that sustainability awareness is influenced by curriculum exposure, institutional culture, perceived relevance, and participation in SDG-related programs [4], [8], [11], [13], [21]. Awareness is also shaped by the kinds of goals most emphasized in the institution. For example, education, health, and gender equality often receive higher visibility than ecological and systems-oriented goals [11], [16], [22]. This selective visibility can limit holistic understanding and weaken the integrated spirit of the SDG framework.

1.3 Persistent barriers to SDG integration

Despite growing recognition of the importance of the SDGs, implementation in higher education continues to face multiple barriers. Common obstacles include insufficient funding, weak policy implementation, fragmented governance, lack of training, poor collaboration, and limited interdisciplinary structures [7], [18], [23]. Some institutions also struggle with low sustainability literacy and uneven stakeholder participation, which can reduce commitment to long-term implementation [9], [24].

These barriers are especially significant in institutions outside major metropolitan centers, where resource limitations, staffing constraints, and uneven access to training may affect sustainability efforts more strongly. For countryside universities, awareness-building and institutional mainstreaming are particularly important because such institutions often serve communities that directly experience development vulnerabilities and environmental pressures. This makes local evidence essential for understanding how sustainability awareness is formed and how university systems can better support SDG implementation.

1.4 Conceptual Framework of the Study

The conceptual framework of this study positions SDG awareness as a multidimensional construct shaped by institutional dynamics within a higher education setting. SDG awareness, treated as the dependent variable, encompasses key dimensions such as teaching-learning application or office operations, engagement with SDG-related activities, integration in the campus environment, and research and development. This structure reflects a whole-institution approach, where sustainability is embedded across academic, operational, and research functions rather than confined to classroom instruction alone. Such an approach aligns with the perspective that higher education institutions serve as integrated systems where teaching, governance, and knowledge production collectively contribute to sustainable development [3], [6], [25].

The framework identifies university role, specifically teaching and non-teaching personnel, as the independent variable influencing SDG awareness. This highlights that sustainability awareness is shaped not only by educators but also by administrative and operational staff who contribute to institutional practices and service delivery. In addition, the framework incorporates contextual factors that positively influence SDG awareness, including curriculum or office integration, institutional support and policies, SDG-related activities and engagement programs, and external partnerships. These factors function as enabling conditions that strengthen awareness and promote active participation in sustainability initiatives. Conversely, the framework also recognizes barriers that negatively affect SDG awareness, such as lack of understanding, insufficient resources, weak collaboration, ineffective policy implementation, and broader environmental and governance challenges. These barriers demonstrate that awareness is constrained by both internal institutional limitations and external systemic conditions [7], [8], [24].

Finally, the framework proposes that SDG awareness contributes to institutional sustainability outcomes, including stronger integration of SDGs in campus systems, improved research productivity, enhanced community engagement, and the adoption of sustainable practices. This relationship emphasizes that awareness serves as a critical foundation for action, where increased knowledge and engagement can lead to more effective and sustained implementation of sustainability initiatives. By illustrating the interactions among institutional roles, enabling factors, and barriers, the framework provides a systems-based perspective for understanding SDG integration in higher education. It also supports the use of Structural Equation Modeling to examine these relationships, allowing for a more comprehensive analysis of how awareness is developed and translated into institutional outcomes [1], [2], [15].

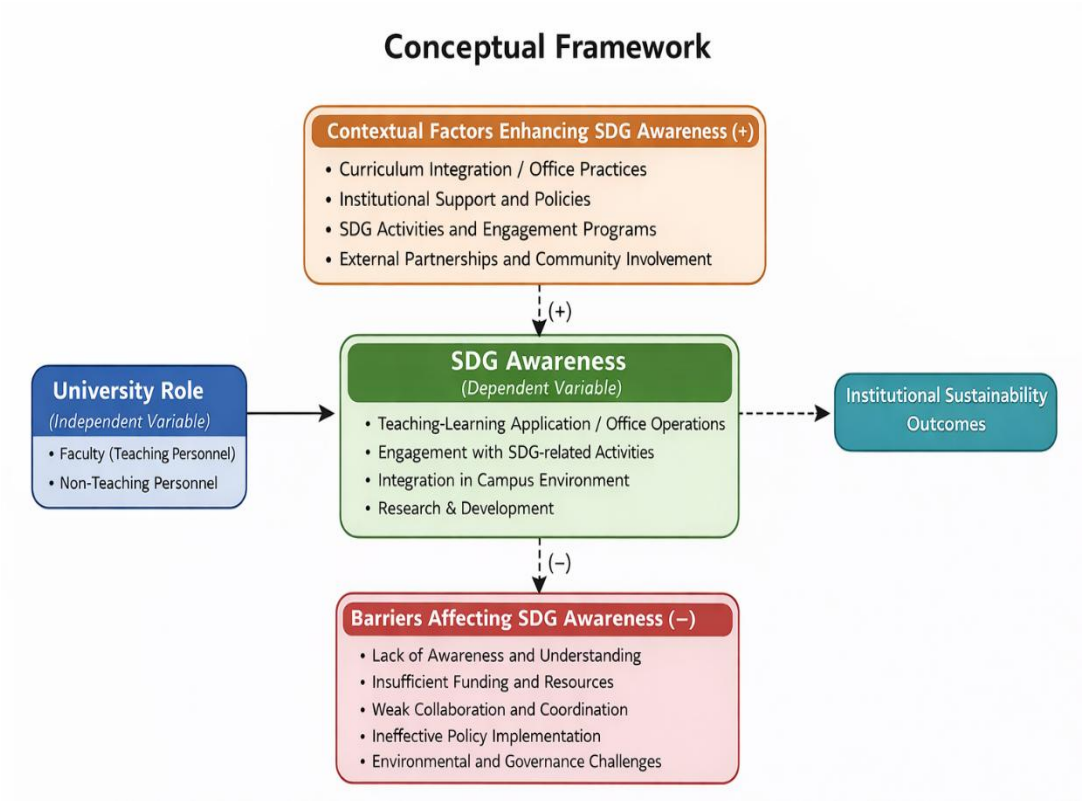

Fig. 1. Conceptual Framework of the study.

1.5 Research Gap and Significance

Although previous studies have examined SDG awareness in higher education, there is limited research exploring how SDG awareness varies across different institutional roles, particularly between teaching and non-teaching personnel within a single university setting. Most existing studies focus on students or educators alone and often emphasize descriptive assessments of awareness, with limited attention to how different dimensions of SDG integration interact within an institution [4], [11], [16], [17]. In addition, only a few studies have employed structural modeling approaches, such as Structural Equation Modeling (SEM), to examine the relationships among teaching-learning practices, engagement, research, and campus integration [8], [9].

This study addresses these gaps by providing empirical evidence on SDG awareness among both teaching and non-teaching personnel at Romblon State University and examining the interrelationships among key institutional dimensions of sustainability integration. The findings contribute to the growing body of literature on sustainability education and SDG localization in higher education, particularly in developing-country and countryside university contexts. By identifying strengths, gaps, and barriers in awareness and implementation, the study offers practical insights for strengthening SDG integration, enhancing research and engagement, and improving institutional sustainability practices.

1.6 Objectives of the Study

This study aimed to:

1. Assess the perceived level of SDG awareness among the university community in terms of:
    - teaching-learning application (faculty) / office operations (non-teaching);
    - engagement with SDG-related activities;
    - integration in campus environment and physical facilities; and
    - research and development.
2. Identify the SDGs that are most visible and commonly addressed within the university community.
3. Determine the barriers encountered by the university community in promoting and sustaining SDG awareness and integration.
4. Examine the interrelationships among the dimensions of SDG awareness, specifically:
    - teaching-learning application (faculty) / office operations (non-teaching);
    - engagement with SDG-related activities;
    - integration in campus environment and physical facilities; and
    - research and development.

2. Methodology

2.1 Research Design

This study used a descriptive-quantitative research design. The descriptive approach was appropriate because the study sought to determine the level of SDG awareness and the visibility of sustainability-related practices within the institution. The quantitative approach allowed for the use of measurable indicators and statistical analysis to examine patterns, differences, and relationships among variables. This design is widely used in sustainability and education studies that investigate awareness, integration, and institutional conditions [1], [8], [11].

To further understand the institutional dynamics of SDG awareness, Structural Equation Modeling (SEM) was applied. SEM was selected because it allows simultaneous examination of relationships among multiple constructs and helps identify both direct and indirect effects. In this study, SEM was used to examine how the major dimensions of SDG awareness and integration interact institutionally.

2.2 Research locale and participants

The study was conducted at Romblon State University, a public higher education institution in the Philippines. As a countryside university, the institution serves an important academic and developmental role in a provincial and island setting, making it an appropriate context for examining local SDG awareness and integration.

A total of 218 responses were initially gathered. After screening for completeness and usability, 140 responses were retained for analysis. These respondents included 150 teaching and 68 non-teaching personnel in the initial pool, with 140 usable responses ultimately forming the analytical dataset. The inclusion of both teaching and non-teaching personnel was important because SDG integration in higher education is not limited to instruction; it also includes operations, services, administration, and institutional practices.

2.3 Sampling technique

Convenience sampling was used in the study. Respondents who expressed willingness to participate and were accessible during the data collection period were included. This approach is often used in institutional studies where participation depends on administrative access and voluntary response patterns. While convenience sampling limits statistical generalizability, it is acceptable in exploratory and institution-based research where the goal is to produce contextual evidence that can inform local planning and policy.

2.4 Research instrument

The study used a structured questionnaire designed to assess SDG awareness in four institutional dimensions:

1. teaching-learning application (faculty) / office operations (non-teaching);
2. engagement with SDG-related activities;
3. integration in campus environment and physical facilities; and
4. research and development.

The questionnaire also included sections on SDG visibility and perceived barriers to SDG awareness and integration. Responses to awareness items were measured using a five-point Likert scale. The study used the following interpretation: 4.50–5.00 = Very High, 3.50–4.49 = High, 2.50–3.49 = Moderate, 1.50–2.49 = Low, and 0.00–1.49 = Very Low.

The multidimensional design of the instrument reflected the whole-institution view of sustainability in higher education. Instead of limiting SDG awareness to teaching alone, the instrument recognized that sustainability awareness in universities is shaped by engagement, research, operations, and environmental practices.

2.5 Data gathering procedure

Descriptive statistics, including mean, standard deviation, frequency, and percentage, were used to analyze the data. Mean scores and standard deviations were used to determine the level of SDG awareness across dimensions. Frequency and percentage distributions were used to identify the visibility of specific SDGs and the barriers perceived by respondents.

Structural Equation Modeling was then used to examine the interrelationships among the four awareness dimensions. The structural model analyzed how teaching-learning application or office operations, engagement, research and development, and campus environment integration influenced one another

2.6 Ethical Consideration

This study adhered to ethical research standards. Participation was voluntary, and respondents provided informed consent prior to answering the survey. No personal identifiers were collected, and all data were securely stored and used exclusively for research purposes. The study ensured confidentiality, anonymity, and responsible data handling throughout the research process.

3. Results

3.1 Level of SDG Awareness

The results showed that SDG awareness in the university was generally high across the four dimensions assessed. Teaching-learning application (faculty) / office operations (non-teaching) obtained an overall mean of 3.94, interpreted as High. This indicates that respondents generally perceived sustainability to be present in classroom practice, work routines, and institutional functions. Among the items in this dimension, the highest ratings were observed in course integration of SDGs and opportunities for non-teaching staff to contribute to SDG-related efforts, both of which were interpreted as Very High. In contrast, university-provided teacher training related to SDGs received only a Moderate rating, indicating a capacity-building gap.

Engagement with SDG-related activities had the highest overall score, with a mean of 4.52, interpreted as Very High. This suggests strong institutional engagement in sustainability-related policies, university participation in SDG initiatives, community partnerships, and collaboration with external organizations. The consistently high scores in this dimension reflect visible institutional action and outreach related to the SDGs.

Integration in campus environment yielded an overall mean of 4.42, interpreted as High.

Respondents perceived that the university encourages SDG integration in projects and practices, promotes innovation, supports sustainability-oriented financial practices, and attempts to reduce environmental impacts. The strongest item in this dimension was the availability of opportunities for innovative SDG-related projects, which was rated Very High. Communication of SDG-related initiatives to stakeholders, while still high, had a comparatively lower mean, suggesting room for stronger dissemination and visibility.

Research and development recorded the lowest overall mean among the four dimensions, at 3.57, though still interpreted as High. This dimension showed a mixed pattern. Funding and resource support for SDG-related research was rated High, but actual conduct of SDG-related research projects was only Moderate. This suggests a gap between institutional support and realized research productivity.

Table 1
The Level of Sustainable Development Goals' Awareness of Romblon State University Students

Teaching-Learning Application (Faculty)/Office Operations (Non-Teaching)	**Mean**	***SD***	**DI**
1. Teaching-learning experience or the course integrates any of the SDGs.	4.68	1.06	VH
2. SDGS are discussed and presented inside the classroom.	3.58	0.73	H
3. SDGS are incorporated in assignments or tasks.	3.93	1.29	H
4. The university provides resources to integrate SDGs in teaching.	4.16	1.61	H
5. The university provides teacher trainings related to SDGs.	2.79	1.74	M
6. There are opportunities for non-teaching staff to contribute to SDG-related efforts at the university.	4.75	0.95	VH
7. Daily activities in work support SDGs.	3.73	0.73	H
Total	**3.94**	**1.15**	**H**
Engagement with SDG Related Activities	**Mean**	***SD***	**DI**
1. The university has policies and initiatives related to SDGs.	4.42	1.08	H
2. RSU community participates in SDG related initiatives or programs.	4.47	1.01	H
3. Community and university partnership to promote SDGs is evident.	4.48	1.08	H
4. There is a collaboration between the university and external organizations / NGOs in terms of SDG initiative	4.70	0.79	H
Total	**4.52**	**0.99**	**VH**
Integration in Campus Environment	**Mean**	***SD***	**DI**
1. The college/campus encourages integrating SDGs into practices and projects.	4.46	0.53	H
2. There are opportunities for innovative projects related to the SDGs within your college/campus.	4.95	0.30	VH
3. The college/unit incorporates sustainability in terms of financial practices and programs.	4.82	0.70	VH
4. The university has efforts to reduce environmental impacts.	4.20	0.48	H
5. The university's infrastructures (buildings, facilities, etc.) align with SDG principles.	4.22	0.50	H
6. The university communicates the SDG related initiatives among its stakeholders	3.85	0.57	H
Total	**4.42**	**0.51**	**H**
Research and Development	**Mean**	***SD***	**DI**
1. The university conducts SDG related research projects.	3.06	1.12	M
2. The university provides sufficient funding and resources for SDG-related research.	4.15	0.38	H
3. RSU faculty and staff collaborate on research project related to SDG.	3.49	1.04	H
Total	**3.57**	**0.85**	**H**

Legend: 4.5-5.0= Very High (VH),
3.5-4.49= High (H)
2.5- 3.49=Moderate (M)
1.5-2.49=Low (L)
0-1.49=Very Low (VL)

3.2 Visibility of SDGs in the University

The visibility analysis showed that SDG 4 (Quality Education) and SDG 5 (Gender Equality) were the most visible goals within the university community. Among teaching personnel, SDG 4

registered the highest frequency, followed by SDG 5 and SDG 3 (Good Health and Well-being). Among non-teaching personnel, SDG 5 and SDG 3 were the most visible. These findings indicate that the institution is strongest in areas closely aligned with its core educational mission, inclusivity efforts, and welfare-related functions.

By contrast, goals such as SDG 14 (Life Below Water), SDG 15 (Life on Land), SDG 1 (No Poverty), and SDG 10 (Reduced Inequalities) were less visible. This suggests an uneven pattern of SDG representation, where some goals are strongly embedded in institutional awareness and others are not.

Table 2
Visibility of Sustainable Development Goals (SDGs) in the RSU Community

Sustainable Development Goals (SDGs)	Teaching Personnel (*f*)	Non-Teaching Personnel (*f*)
SDG 1: No Poverty	21	3
SDG 2: Zero Hunger	15	5
SDG 3: Good Health and Well-being	48	27
SDG 4: Quality Education	75	17
SDG 5: Gender Equality	60	32
SDG 6: Clean Water and Sanitation	31	16
SDG 7: Affordable and Clean Energy	19	7
SDG 8: Decent Work and Economic Growth	27	13
SDG 9: Industry, Innovation, and Infrastructure	27	7
SDG 10: Reduced Inequalities	21	3
SDG 11: Sustainable Cities and Communities	13	3
SDG 12: Responsible Consumption and Production	11	11
SDG 13: Climate Action	21	4
SDG 14: Life Below Water	9	2
SDG 15: Life on Land	12	2
SDG 16: Peace and Justice Strong Institutions	23	6
SDG 17: Partnerships for the Goals	31	13
Total	**464**	**171**

3.3 Barriers to SDG Awareness

The most frequently reported barrier was lack of awareness and understanding about the SDGs, accounting for 22.66% of all responses. This was followed by insufficient funding and resources, lack of collaboration and cooperation, and lack of effective policies and implementation.

Other barriers included corruption and unethical practices, political conflicts and instability, environmental degradation and climate change, and inequality and injustice.

These findings show that barriers are both internal and external. Some arise from organizational processes, such as weak collaboration and ineffective implementation, while others are systemic and contextual.

Table 3
Barriers Encountered by Students in Addressing SDG Awareness

	Barriers encountered	Frequency (*f*)	Percentage (*%*)
1.	Lack of awareness and understanding about the SDGs	121	22.66
2.	Insufficient funding and resources	87	16.29
3.	Political conflicts and instability	50	9.36
4.	Inequality and injustice	30	5.62
5.	Lack of collaboration and cooperation	75	14.04
6.	Environmental degradation and climate change	49	9.18
7.	Corruption and unethical practices	52	9.74
8.	Lack of effective policies and implementation	70	13.11
Total		**534**	**100%**

3.4 Structural equation modeling results

The structural equation model showed several important relationships among the SDG awareness dimensions. Teaching-learning application had a strong positive effect on research and development. Engagement with SDG-related activities also positively influenced research and development. Research and development, in turn, had a very strong positive effect on integration in campus environment. This indicates that research functions as a major institutional pathway through which sustainability awareness can be translated into campus-level integration.

A small positive relationship was also observed between teaching-learning application and engagement with SDG-related activities, although this path was not statistically significant. Overall, the SEM findings suggest that SDG awareness is not composed of isolated dimensions; instead, the dimensions are interconnected and collectively shape sustainability mainstreaming within the university.

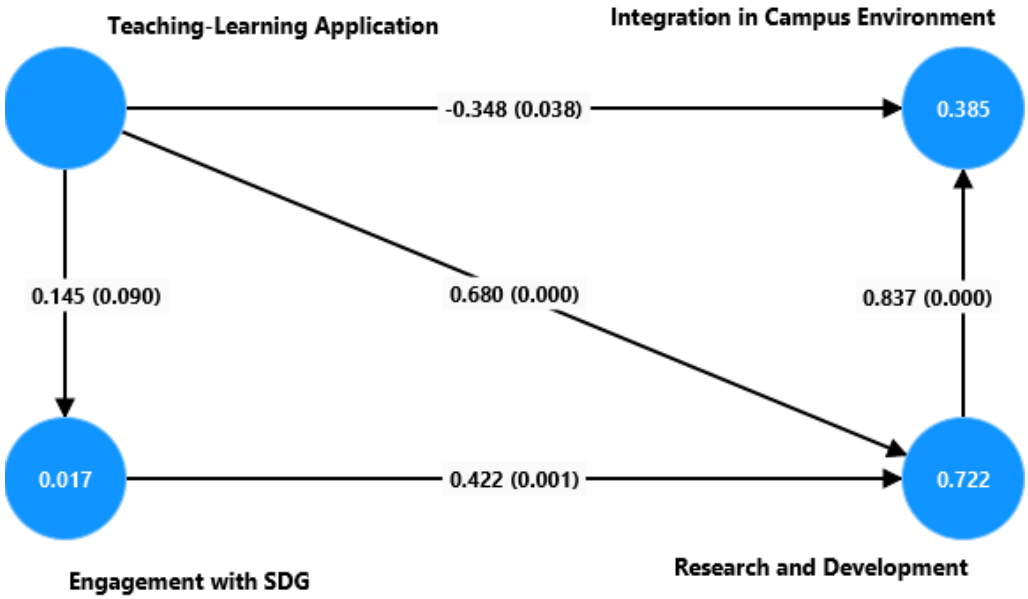

Fig. 2. Structural Equation Modelling of the Interrelationships between SDG awareness dimensions

4. Discussion

The findings indicate that the university demonstrates a strong foundation of SDG awareness across academic, operational, and engagement-related functions. The high level of awareness supports the view that higher education institutions serve as key spaces for sustainability learning and institutional transformation [1], [2], [15]. Sustainability is already evident in teaching-learning practices, office operations, and especially in engagement activities, which were rated very high. However, the moderate result in SDG-related training suggests that awareness does not necessarily translate into adequate institutional capacity. This implies the need for more structured faculty and staff development to strengthen sustainability integration. Furthermore, the strong performance in engagement highlights the importance of institutional policies, partnerships, and community involvement in reinforcing SDG awareness beyond classroom settings [3], [6], [24].

Despite these strengths, important gaps remain. Research and development, although rated high, showed lower actual research engagement, indicating that sustainability research is not yet fully maximized. SEM results revealed that research plays a critical role in strengthening campus integration, emphasizing its importance as a bridge between awareness and implementation. The uneven visibility of SDGs also suggests that institutional focus remains concentrated on selected goals, limiting a more holistic sustainability perspective [1], [19]. In addition, key barriers such as lack of awareness, limited resources, weak collaboration, and policy challenges continue to constrain effective implementation. These findings highlight that SDG awareness is shaped by both enabling factors and institutional constraints, and that a more integrated, research-driven, and well-supported approach is necessary to achieve deeper sustainability mainstreaming in higher education [7], [9], [23], [25].

Furthermore, the results emphasize the interconnected nature of SDG awareness dimensions within the institution. Teaching-learning application and engagement contribute to the development of research capacity, while research and development significantly influence campus-level sustainability integration. This indicates that sustainability in higher education is not a linear process but a systems-driven approach where academic, operational, and research functions reinforce one another. Strengthening these linkages is essential for transitioning from awareness to sustained institutional practice. For countryside universities, this integrated approach is particularly important, as it enables institutions to align global sustainability goals with local development needs and community realities.

Moreover, the findings highlight the need for a more balanced and inclusive approach to SDG integration across all 17 goals. While education, health, and gender-related goals were more visible, other areas such as environmental sustainability and social equity received less attention. This imbalance may limit the institution's ability to fully embrace the interconnected nature of sustainable development. Addressing this requires deliberate institutional strategies that promote interdisciplinary collaboration, expand SDG coverage across programs and initiatives, and strengthen communication of sustainability efforts. By doing so, the university can move toward a more comprehensive and transformative sustainability framework that aligns with both global priorities and local community needs.

5. Conclusions

This study assessed SDG awareness among teaching and non-teaching personnel in a Philippine countryside university and examined the institutional relationships among teaching-learning application or office operations, engagement with SDG-related activities, research and development, and campus environment integration. The results showed that SDG awareness was generally high across the institution. Engagement with SDG-related activities emerged as the strongest area, while teaching-learning application or office operations, campus environment integration, and research and development were all rated high.

The study also found that SDG 4 and SDG 5 were the most visible goals in the university community, reflecting strong institutional emphasis on education and gender equality. However, the lower visibility of several other goals indicates that SDG integration remains uneven. Key barriers included lack of awareness and understanding, insufficient resources, weak collaboration, and ineffective policy implementation.

One of the most important findings was the strong positive effect of research and development on campus integration. This indicates that research is a central institutional mechanism through which sustainability awareness can be translated into visible and operational campus practices. The findings therefore suggest that strengthening SDG-oriented research productivity may significantly improve broader institutional sustainability integration.

The study concludes that while the university demonstrates a strong commitment to sustainability, deeper mainstreaming is still needed. This includes stronger faculty and staff development, more inclusive participation across institutional units, greater balance in SDG visibility, improved communication to stakeholders, and more coherent policy implementation. A whole-institution approach remains essential if the university is to move from high awareness toward more transformative and sustained SDG integration.

Author Contributions

Conceptualization, D.D.L., G.E.M.L., and J.R.C.M.; methodology, D.D.L. and J.R.C.M.; software, G.V.V.B.; validation, D.D.L., G.E.M.L., and G.V.V.B.; formal analysis, D.D.L., J.R.C.M., and G.V.V.B.; investigation, D.D.L. and J.R.C.M.; resources, G.V.V.B.; data curation, D.D.L., J.R.C.M., and G.V.V.B.; writing—original draft preparation, D.D.L., J.R.C.M., and G.V.V.B.; writing—review and editing, D.D.L., G.E.M.L., and G.V.V.B.; visualization, D.D.L., J.R.C.M., and G.V.V.B.; supervision, G.E.M.L.; project administration, D.D.L. All authors have read and agreed to the published version of the manuscript.

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Data Availability Statement

The data that support the findings of this study are available from the corresponding author upon reasonable request.

Conflicts of Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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