

Analysis of Environmental Literacy and Sustainable Development Goals (SDGs) Competence among Community Leaders: Bases for Technology-Assisted Module for Green Management Advocates

Juim T. Jimlan*, Evan Anthony Arias
Central Philippine University, Iloilo City, Philippines

*Corresponding Author Email: juim.jimlan@deped.gov.ph

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Abstract. Environmental sustainability is a growing concern globally, and in the Province of Aklan, the need for strong community leadership in addressing ecological challenges has become increasingly urgent. This study aimed to assess the environmental literacy and Sustainable Development Goals (SDG) competence of community leaders in Aklan and to evaluate the effectiveness of a technology-assisted green management module in enhancing these competencies. Utilizing an explanatory-sequential mixed methods design, the study first collected quantitative data from 210 community leaders through validated questionnaires and qualitative insights from focus group discussions and in-depth interviews. Colaizzi's phenomenological method and the Knowledge, Attitudes, and Practices (KAP) framework were used for thematic analysis. Key findings revealed a high level of environmental literacy and SDG competence across most demographic groups, with the LGBTQ+ and older participants scoring highest. A strong positive correlation ($r = 0.952$, $p < 0.001$) was found between environmental literacy and SDG competence. However, younger leaders exhibited lower engagement, and systemic barriers such as a lack of mentorship, decision-making power, and policy enforcement hindered broader participation in sustainability efforts. The green management module, delivered via Facebook, significantly improved participants' knowledge, attitudes, and behaviors, as evidenced by pre- and post-assessment results. The study concludes that targeted, inclusive, and technology-driven training can strengthen sustainability leadership at the community level. It recommends expanding youth involvement, integrating traditional ecological knowledge, and fostering multi-stakeholder collaboration to achieve long-term environmental resilience in Aklan.

Keywords: Environmental literacy; SDG competence; Community leadership; Sustainability education; Green management module; Youth empowerment.

1.0 Introduction

The Province of Aklan, renowned for its scenic landscapes and thriving tourism industry, faced environmental challenges threatening its ecological balance and socio-economic stability. Aklan's natural resources, such as its pristine beaches, lush forests, and marine ecosystems, were under considerable pressure from urbanization, overexploitation, and the adverse effects of climate change. For community leaders, safeguarding these resources while fostering economic growth required innovative approaches and informed decision-making processes. This

study explored the development of a technology-assisted green management module to enhance the capacity of community leaders to address these complex challenges.

Environmental issues such as coastal erosion, deforestation, biodiversity loss, and pollution have grown more prevalent in Aklan, posing risks not only to the environment but also to the livelihoods of its residents. Coastal areas experienced worsening erosion and marine degradation, directly impacting fishing communities and threatening the sustainability of the province's renowned tourism sector. Similarly, upland regions saw significant deforestation, leading to habitat destruction and increased vulnerability to landslides and flooding. According to Ceballos et al. (2018), despite ongoing conservation efforts, these environmental problems persisted, highlighting the limitations of existing frameworks and the need for a more integrated and technology-driven approach to environmental management.

As stewards of local governance and development, community leaders played a critical role in addressing these environmental challenges. They were tasked with implementing policies, raising awareness, and mobilizing resources to promote sustainable practices within their communities. However, many leaders faced significant gaps in knowledge, skills, and access to technological tools needed for effective environmental management. Ruffin (2017) emphasized that these gaps limited their ability to make data-driven decisions, respond to emerging threats, and engage their communities in sustainable development initiatives.

The lack of a cohesive framework that integrated advanced technology and environmental literacy further hindered community leaders' efforts. While policies and programs addressing environmental issues existed, their implementation was often inconsistent and fragmented due to limited technical capacity and resource constraints. Caranto (2020) noted that this situation underscored the necessity of providing community leaders with a structured and accessible module that effectively combined educational content and practical tools for managing environmental resources.

In an ideal setting, community leaders in Aklan would have the knowledge and resources to address environmental issues proactively. The technology-assisted green management module sought to fill critical gaps in environmental sustainability by equipping leaders with the knowledge, attitudes, and practices necessary for effective stewardship. To maximize accessibility and engagement, all resources, tools, and updates were made available through a dedicated Facebook page. Evans (2020) stressed that this platform was a hub for community leaders to access comprehensive learning materials, including tutorials, interactive modules, and best practice case studies. As one of the most widely used social media platforms in the Philippines, Facebook ensured that leaders, regardless of location or technological proficiency, could easily engage with the content. The initiative enhanced learning by integrating the module into a familiar and user-friendly digital space. It strengthened a sense of community among participants, enabling them to collaborate in addressing Aklan's environmental challenges effectively.

The integration of environmental literacy into the module was also essential. Environmental literacy empowered leaders to understand ecological systems, recognize their interdependence with human activities, and appreciate the importance of sustainable resource management. This understanding enabled them to identify the root causes of environmental challenges and implement solutions holistically addressing these issues. Additionally, by fostering a sense of environmental stewardship, the module encouraged leaders to advocate for sustainable practices within their communities, contributing to long-term ecological preservation. Quimpo (2015) emphasized the critical role of environmental literacy in promoting informed and responsible decision-making for sustainable development.

Furthermore, aligning the module with the Sustainable Development Goals (SDGs) ensured local actions were consistent with global sustainability frameworks. Goals such as Climate Action (SDG 13), Life Below Water (SDG 14), and Life on Land (SDG 15) provided a comprehensive framework for addressing Aklan's environmental challenges. By incorporating SDG-related principles and competencies into the module, community leaders were equipped to balance environmental, social, and economic considerations in their decision-making processes, ensuring that their initiatives promoted sustainable development across multiple dimensions. UNEP (2021)

highlighted the importance of integrating SDGs into local governance to achieve sustainable development outcomes.

The increasing frequency and severity of climate-induced disasters further compounded the urgency of Aklan's environmental issues. Typhoons, flooding, and rising sea levels threatened communities, requiring adaptive and resilient disaster risk reduction and recovery strategies. Climate Change Commission of the Philippines (2016) stressed that a technology-assisted green management module could provide community leaders with the tools and knowledge necessary to anticipate and respond to these challenges effectively. Leaders could develop and implement adaptive measures to safeguard their communities against future environmental risks by leveraging real-time data and predictive analytics.

This study sought to address the identified gaps by designing a technology-assisted green management module tailored to the needs of community leaders in Aklan. Miraflores (2017) emphasized that sustainable and technology-integrated approaches are essential to improving local governance and effectively addressing environmental challenges. The module combined cutting-edge technology, environmental education, and SDG-aligned frameworks to empower leaders with the capacity to drive sustainable development in their localities.

2.0 Methodology

2.1 Research Design

This study employed an Explanatory-Sequential research design, a two-phase mixed methods approach to integrate qualitative data to explain further quantitative findings (Creswell et al., 2003). The first phase involved collecting and analyzing quantitative data, followed by the second phase, which focused on gathering and analyzing qualitative data. The qualitative phase complements the quantitative findings, providing a deeper understanding and comprehensive insights. While the study primarily utilizes quantitative methods, mixed methods research integrates qualitative elements to enhance the overall understanding of the research problem (Johnson et al., 2007). In addition, the study utilized the ADDIE Model as its framework. ADDIE stands for Analysis, Design, Development, Implementation, and Evaluation. This framework ensures a systematic approach to instructional design, allowing for the systematic planning, creation, and assessment of interventions based on research findings. The study effectively structured its research processes through this model, ensuring alignment between qualitative and quantitative phases and facilitating a well-rounded exploration of the research objectives. For the qualitative phase, in-depth interviews and Focus Group Discussions (FGDs) were conducted. These methods allowed for a deeper exploration of participants' experiences and perspectives, facilitating a thorough understanding of the findings.

2.2 Research Locale

The research locale for this study is the Province of Aklan, a region in the Western Visayas of the Philippines. Aklan is known for its vibrant local communities, rich environmental resources, and diverse socio-economic landscapes. It is a suitable setting for research on environmental literacy and Sustainable Development Goals (SDG) competence among community leaders. The study was conducted across various municipalities in Aklan, ensuring representation from urban and rural areas to capture various perspectives on environmental management and sustainability initiatives. Given its ecological significance, Aklan provides an ideal setting to examine the role of community leadership in sustainable development, particularly in addressing environmental concerns that impact urbanized and rural regions.

2.3 Research Participants

The research participants in this study consisted of community leaders from the Province of Aklan, specifically individuals involved in management, research, innovation, or public service. These participants ranged in age from 25 to 56 years old. They represented a diverse group in terms of geographical location, covering both urban and rural areas, and gender identity, including male, female, and LGBTQ+ individuals. Their community governance and environmental advocacy backgrounds made them well-suited to provide insights into environmental literacy and Sustainable Development Goals (SDGs) competence.

Participants were selected using Slovin's Formula, which determined the appropriate sample size from a total population of 420 community leaders with a 5% margin of error, yielding a required sample size of 205

participants. However, the researcher increased the sample size to 210 participants to enhance representation. Inclusion criteria guided the selection process to ensure diversity and relevance. Participants were required to hold recognized leadership positions within their communities, be actively engaged or interested in environmental issues and sustainable development, be familiar with sustainability initiatives, and be capable of providing relevant data or documentation regarding their environmental literacy and SDG competence. They also needed to be willing to participate in the study's quantitative and qualitative phases and represent a balanced distribution of age groups to ensure generational perspectives were considered.

Exclusion criteria were applied to maintain the study's focus and uphold ethical research standards. Individuals who did not meet the specified age group requirements, were not residents of Aklan, had conflicts of interest such as affiliations with the research team or sponsoring organizations, or could not provide informed consent were excluded. Additionally, those with physical, cognitive, or communicative impairments that prevented meaningful participation were not considered for the study.

2.4 Research Instrument

The quantitative data in this study were gathered using researcher-made questionnaires, namely the Environmental Literacy Questionnaire for Community Leaders (ELQCL) and the Sustainable Development Goals (SDG) Competence Questionnaire for Community Leaders (SDGCQCL). In contrast, qualitative data were collected through a Focus Group Discussion (FGD) guide. The ELQCL consisted of 20 items measuring environmental literacy, using a five-point Likert scale ranging from "Strongly Aware" to "Strongly Unaware." Similarly, the SDGCQCL was a 30-item questionnaire assessing perceptions of education for sustainable development, with responses ranging from "Very True of Me" to "Very Untrue of Me." These instruments evaluated participants' environmental awareness and competence in achieving sustainability goals.

To ensure the validity of the questionnaire, a panel of experts in environmental science, education, and sustainability reviewed the instrument for relevance, clarity, and alignment with the study's objectives. Their feedback led to refinements, ensuring accurate measurement of the intended constructs. Additionally, an FGD with community leaders was conducted to assess the questionnaire's clarity and applicability, ensuring that items were relevant to real-world experiences. For reliability, a pilot test was conducted with thirty community leaders from Capiz, and data was analyzed using Cronbach's Alpha in SPSS to measure internal consistency. A high Cronbach's Alpha value confirmed the questionnaire's reliability, ensuring the instrument provided stable and dependable results for the final study.

2.5 Data Gathering Procedure

Before data collection, ethical clearance and permission were secured from the Governor's Office and disseminated to all 17 municipalities in Aklan. Participation was voluntary, with assurances of confidentiality. Survey instruments were distributed personally to ensure clarity. A Focus Group Discussion (FGD) was conducted on October 28, 2024, at Bernwood Tower, Iloilo City, with five key stakeholders from various sectors contributing insights on sustainability challenges and strategies. Additionally, 11 in-depth interviews were conducted with distinguished community leaders, focusing on environmental literacy, SDG awareness, local programs, and leadership practices.

The study employed a mixed-methods approach, using both quantitative and qualitative data. Quantitative data from 210 participants were analyzed through frequency, percentage, mean, standard deviation, ANOVA, and Pearson r correlation (set at $\alpha = 0.05$), revealing strong correlations and patterns. Qualitative data, collected from FGDs and interviews, were examined using Colaizzi's Seven-Step Method and thematic analysis under the Knowledge, Attitude, and Practice (KAP) framework. Recurring themes included community engagement, policy gaps, and behavioral inconsistencies.

A Technology-Aided Green Management Module was designed to address identified gaps using the ADDIE model. It featured three dimensions: knowledge, attitude, and practice and was implemented over three days with 30 community leaders from Tangalan, Aklan. Pre- and post-assessments confirmed significant improvement in environmental literacy and SDG competence. Evaluation tools, including the Acceptability Level Questionnaire, highlighted strengths and areas for enhancement, such as delivery methods and leadership accountability.

2.6 Ethical Considerations

Prior to data collection, the study received ethical approval from the Research Ethics Review Board (RERB), and permission was secured from relevant institutions. The research posed minimal risk, with non-sensitive questions, and participants were informed of their right to decline or withdraw at any time without consequences. Participation was entirely voluntary, and anonymity was preserved through coded questionnaires. Data were securely stored and accessed only by authorized personnel. All materials were retained for five years and then securely disposed of to ensure ethical integrity. Participants received a modest token of appreciation, and the researcher declared no conflicts of interest. The study aimed to enhance community leaders' understanding of SDGs and environmental literacy, contributing to local governance, capacity building, and development planning.

3.0 Results and Discussion

3.1 Level of Environmental Literacy

The data presented in Table 1 reveal that participants consistently demonstrated a high level of environmental literacy across four dimensions, with an overall mean score of 3.55 (SD = 0.843). Among these, the highest-rated was Action and Engagement in Environmental Citizenship (Mean = 3.64, SD = 0.887), indicating strong involvement in sustainability efforts. Critical thinking was also evident in the Examination and Evaluation of Community Environmental Issues and Solutions (Mean = 3.54, SD = 0.873). The other two dimensions – Foundation of Community-Based Ecological Practices (Mean = 3.51, SD = 0.865) and Awareness of Issues and Values in Community Context (Mean = 3.48, SD = 0.853) – reflected a solid grasp of local ecological values and practices. These findings align with contemporary frameworks such as Chen's (2022) Revised Environmental Literacy Framework and Rickmann's (2022) Contextual Influences Model, which underscore the importance of both knowledge and engagement in cultivating environmental literacy.

Table 1. *Level of Environmental Literacy*

Level of Environmental Literacy	Mean	SD	Description
Level 1. Foundation of Community-Based Ecological Practices	3.51	0.86	High
Level 2. Awareness of Issues and Values in Community Context	3.48	0.85	High
Level 3. Examination and Evaluation of Community Environmental Issues and Solutions	3.54	0.87	High
Level 4. Action and Engagement in Environmental Citizenship	3.64	0.88	High
Overall	3.55	0.84	High

Scale: 4.21- 5.00 Extremely High; 3.41-4.20 High; 2.61-3.40 Moderate; 1.81-2.60 Low; 1.00-1.80 Extremely Low

This robust environmental awareness was vividly illustrated in the interview. As Discussant 2 shared, *“Environmental conservation was not just a slogan – it became a regular part of our collective lives.”* Within local government units (LGUs), nature-centered initiatives like tree planting, coastal clean-ups, and recycling drives were implemented in collaboration with community groups, schools, and volunteers. Branded under the key responsibility area of *Makakalikasan*, these programs reflected strategic planning and genuine grassroots participation. This community-driven model supports Kim's (2020) Sustainability-Linked Environmental Literacy Framework, which emphasizes transforming knowledge into empowered, sustainable action. The shared responsibility between LGUs and citizens exemplifies how environmental literacy, when deeply rooted in local values and community engagement, can lead to meaningful and lasting ecological stewardship.

3.2 Level of Sustainable Development Goals Competence

Table 2 revealed that respondents demonstrated high levels of competence across all dimensions of the Sustainable Development Goals (SDGs), with the strongest performance in Environmental SDGs (Mean = 3.57, SD = 0.857), followed closely by Social (Mean = 3.46, SD = 0.830) and Economic (Mean = 3.42, SD = 0.860) dimensions. The aggregate score of 3.48 (SD = 0.832) affirms a well-rounded understanding of sustainable development. This echoes the findings of Sarbassova and Smagulova (2021), who emphasized the importance of environmental literacy, and aligns with UNESCO's (2023) focus on SDG 10 – Reducing Inequalities – as well as Ramirez's (2022) and Chen's (2022) work on inclusive economic policy. Such competence reflects knowledge and readiness to implement these principles, addressing pressing global challenges through education, equity, and environmental stewardship.

Table 2. *Level of Sustainable Development Goals Competence*

Sustainable Development Goals Competence	Mean	SD	Description
Economic Sustainable Development Goals	3.42	0.86	High
Social Sustainable Development Goals	3.46	0.83	High
Environment Sustainable Development Goals	3.57	0.85	High
Over All	3.48	0.83	High

This readiness is more than theoretical, as shown in the responses. As Discussant 2 underscored the importance of internalizing the goals. *“Living by the SDGs means weaving their values into your daily decisions,”* they shared, emphasizing that authentic leadership involves modeling sustainable behavior in both personal and public life. In communities like Aklan, where leaders are equipped with this level of competence, there is a powerful opportunity to translate understanding into action – crafting inclusive programs, influencing policy, and fostering collective responsibility. This positions them not just as administrators, but as change agents capable of driving holistic development that resonates with both global targets and local needs.

3.3 Relationship between Environmental Literacy and Demographic Profile

Table 3 indicates a consistent level of environmental literacy across age groups, geographical locations, and sex, revealing no significant differences among these demographic categories. Specifically, ANOVA results for age groups [$F(209) = 0.607$, $p = 0.658$] and sex [$F(209) = 1.685$, $p = 0.188$] demonstrate that respondents’ environmental awareness is uniform, irrespective of age or gender identity. Furthermore, the t-test results for geographical location [$t(208) = 0.307$, $p = 0.759$] affirm that both rural and urban respondents exhibit comparable levels of environmental literacy. This consistency reflects a shared understanding of environmental concerns across diverse groups, suggesting that demographic variables do not limit foundational environmental knowledge.

Table 3. *Difference in the Level of Environmental Literacy when Classified into Demographic Profile*

Demographic Profile	Mean	t/ F value	df	p	Decision
Age					
younger 25 years old	3.08				
26-35 years old	3.54				
36-45 years old	3.64	0.60	209	.658	Accept Ho
45-55 years old	3.54				
56 years old and older	3.41				
Geographical Location					
Rural	3.57	0.30	208	.759	Accept Ho
Urban	3.53				
Gender					
Male	3.51				
Female	3.53	1.68	209	.188	Accept Ho
LGBTQIA+	4.02				

* p 0.05% level of significance

3.4 Relationship between SDG Competence and Demographic Profile

Table 4 revealed no significant differences in Sustainable Development Goals (SDG) competence based on age, geographical location, or sex, indicating a consistent understanding of these competencies among various demographic groups. Specifically, the ANOVA results showed that age does not significantly affect SDG competence [$F(209) = 0.800$, $p = 0.526$], while a t-test demonstrated no notable difference between rural and urban respondents [$t(208) = 0.295$, $p = 0.768$]. Additionally, the ANOVA results confirmed that males, females, and LGBTQ individuals exhibit similar levels of SDG competence [$F(209) = 1.884$, $p = 0.155$]. These findings suggest a shared foundation across diverse sectors for promoting awareness and participation in sustainability efforts. This uniformity can empower community leaders, particularly in Aklan, to design inclusive programs that transcend demographic divisions and foster collective action toward the 2030 Agenda.

This consistency in competence was mirrored in the field, where stories of local engagement demonstrated that people from all walks of life embraced sustainable development. In Iloilo, high school students presented vibrant infographics on climate action and quality education, while elderly women from a rural cooperative organized clean-up drives supporting clean water and sanitation, which were examples that illustrated how shared passion for the SDGs cut across age and geography. In a coastal barangay, fisherfolk independently adopted eco-friendly

practices aligned with Life Below Water, proving that awareness often precedes policy. However, one discussant noted that awareness alone is insufficient—sustainability requires systems, monitoring, and commitment. These real-world accounts echoed the study’s findings: while understanding may be widespread, turning that knowledge into lasting impact requires participation and perseverance.

Table 4. *Difference in the Level of Sustainable Development Goals Competence When Classified into Demographic Profile*

Demographic Profile	Mean	t/ F value	df	p	decision
Age					
younger 25 years old	2.90				
26-35 years old	3.58				
36-45 years old	3.59	0.80	209	.526	Accept Ho
45-55 years old	3.45				
56 years old and older	3.36				
Geographical Location					
Rural	3.50	0.29	208	.768	Accept Ho
Urban	3.47				
Gender					
Male	3.44				
Female	3.48	1.88	209	.155	Accept Ho
LGBTQIA+	3.97				

*p 0.05% level of significance

3.5 Relationship between Environmental Literacy and SDG Competence

Table 5 revealed a strong, significant positive relationship between the Level of Environmental Literacy and Sustainable Development Goals (SDG) Competence ($r = 0.952$, $p < 0.001$), indicating an almost perfect correlation. This suggests that as environmental literacy increases, so does SDG competence, with the extremely low p-value confirming the result's high statistical significance. In practical terms, individuals with higher environmental literacy are more likely to understand and engage meaningfully with sustainability initiatives. This underscores environmental education's critical role in shaping competent leaders who can navigate and address complex global issues through informed, interconnected approaches. Discussants echoed this by highlighting how environmental literacy bridges knowledge gaps, enabling even the most remote communities to align local actions with global goals, demonstrating that education is not just informative but transformative.

Table 5. *Relationship between the Level of Environmental Literacy and Sustainable Development Goals Competence*

Variables	r value	p value*	Decision
Level of Environmental Literacy			
Sustainable Development Goals Competence	0.952	0.000	Reject Ho

*p 0.05% level of significance

One vivid example comes from a coastal village where the mayor, once skeptical of environmental efforts, began personally leading recycling and clean-up drives. Rather than issuing directives, she joined residents on the shoreline, picking up trash and modeling eco-conscious behavior. Discussant 1 noted how her actions sparked a cultural shift—villagers began adopting sustainable habits, from waste segregation to regular coastal clean-ups. This vignette exemplifies how environmentally literate leadership inspires collective responsibility and long-term ecological commitment. For leaders in Aklan and similar communities, this affirms the value of integrating environmental literacy into leadership development. By empowering leaders with knowledge and modeling sustainable practices, communities can foster resilient systems that address present environmental challenges and build a future rooted in shared stewardship and sustainable progress.

Sustainability is a growing global concern, with young leaders at the forefront of advocacy. However, despite their strong awareness, many face institutional and systemic barriers that hinder the implementation of sustainability initiatives. Using Colaizzi’s phenomenological method within the Knowledge, Attitude, and Practice (KAP) framework, this study explores the lived experiences of youth-led sustainability leadership. Findings reveal key challenges, such as knowledge gaps, lack of mentorship, limited decision-making power, and resistance from older leaders, all of which contribute to the gap between awareness and meaningful action. While some grassroots efforts like urban gardening and climate education have succeeded, broader structural issues such as token youth representation and limited funding persist. Literature supports these findings, with scholars like Alvarez (2021) emphasizing the need for practical skills, inclusion of Traditional Ecological Knowledge (TEK), and recognition

of indigenous contributions. The study also highlights intergenerational tensions, where older leaders prioritize short-term economic goals over long-term sustainability, creating friction in governance. The research underscores the importance of reimagining leadership through inclusive policymaking, mentorship, and intergenerational collaboration. Theoretical frameworks such as Transformational Leadership, Intergenerational Governance, and the Theory of Planned Behavior all support the idea that while young leaders are capable, institutional reforms are needed to unlock their full potential. Recommendations include bridging knowledge gaps through mentorship, increasing youth roles in governance, integrating TEK, scaling successful grassroots projects, and fostering structured dialogues between generations.

4.0 Conclusion

Based on the study's findings, several conclusions were drawn regarding community leaders' environmental literacy and sustainability competence. First, although community leaders generally demonstrated good environmental literacy, younger and marginalized leaders showed lower engagement and leadership capacity in sustainability efforts. This highlights the existence of environmental literacy disparities across demographic groups. While participants generally understood the Sustainable Development Goals (SDGs), their practical application remained limited, particularly in aligning SDG frameworks with local policies and initiatives. Moreover, demographic factors such as age, leadership experience, and geographical location significantly influenced both environmental literacy and SDG competence, signaling the need for targeted educational and policy interventions.

A key finding was the strong positive correlation between environmental literacy and SDG competence, suggesting that enhancing environmental education directly improves leaders' ability to implement sustainability goals effectively. The study also emphasized the importance of leadership advocacy and capacity-building, particularly in collaborative environmental stewardship and community resilience. However, several barriers to sustainability action were identified, including a lack of awareness, limited leadership experience, and poor policy integration. To address these issues, there is a pressing need for inclusive, youth-centered training programs, especially tailored for younger leaders and marginalized groups such as the LGBTQ community, to enhance participation and leadership in environmental efforts.

The study further concluded that the Technology-Assisted Green Management Module improved participants' environmental knowledge, attitudes, and practices. Pre-test and post-test results confirmed significant behavioral and knowledge gains, demonstrating the intervention's success in fostering proactive sustainability actions. However, to maximize its impact, particularly among younger users, there is a need for continuous improvement through enhanced emotional engagement, greater social media interactivity, and platform optimization. Lastly, the research underscored the crucial role of multi-stakeholder collaboration. Strengthening partnerships among government agencies, educational institutions, NGOs, and community leaders is essential to achieving long-term environmental resilience and integrating sustainability into policy and practice.

5.0 Contributions of Authors

Dr. Juim Jimlan contributed to the overall paper, while Dr. Evan Anthony Arias advised on quality assurance.

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7.0 Conflict of Interests

The authors declare that no conflicts of interest are associated with this research.

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