Bridging Green Knowledge and Sustainable Tourism Operations: Evidence from Local Government Workspaces in Laguna, Philippines

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Abstract. This study explores the relationship between green knowledge, green strategies, and sustainable operations among local tourism offices in the Province of Laguna, Philippines. Anchored on the principles of sustainable development and environmental governance, the research utilized a quantitative approach through Partial Least Squares Structural Equation Modeling (PLS-SEM) to analyze data from tourism officers. Results revealed that while green knowledge significantly influences both the adoption of green strategies and sustainable operations, several green strategies demonstrated non-significant or even negative correlations with operational sustainability. Notably, regulatory and policy knowledge, and community engagement reflected moderate negative relationships with green strategies, suggesting potential gaps in implementation and alignment with policy frameworks. Mediation analysis further established that green knowledge serves as a crucial mediator between green strategies and multiple sustainability dimensions—including economic, social, and environmental aspects. The findings underscore the complexity of integrating green practices in local governance and the importance of capacity building to enhance environmental competence. This study contributes to the discourse on green public management by offering empirical insights into how knowledge-driven strategies can foster sustainability in tourism. Recommendations include institutionalizing sustainability training, aligning local strategies with national frameworks, and strengthening community participation to enhance the effectiveness of green initiatives.

1 Introduction

The accelerating impacts of climate change, resource depletion, and biodiversity loss have compelled industries worldwide to adopt environmentally sustainable practices. Among these, the tourism sector stands out both as a contributor to ecological strain and as a potential catalyst for environmental stewardship. As tourism develops, its ecological footprint including energy consumption, waste generation, and carbon emissions continues to increase,

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emphasizing the urgent need for sustainability-centered interventions [1]. One effective approach is the adoption of green strategies, which involve deliberate and structured actions designed to integrate environmental sustainability into tourism operations, management systems, and community relations [2]. This study investigates the relationship between green strategies, green knowledge, and sustainable operations within local tourism workspaces in Laguna Province, Philippines. Laguna represents an important context for examination because municipal and city tourism offices serve as frontline units responsible for implementing sustainability policies, environmental programs, and community-based tourism initiatives at the local level. These offices engage in activities such as energy efficiency improvements, solid waste management, sustainable procurement, and community-driven environmental education efforts that align with the broader goals of sustainable and responsible tourism development as emphasized by the Triple Bottom Line (TBL) framework [3]. Despite the presence of national sustainability directives such as RA 9003 on solid waste management and RA 9513 on renewable energy, many local government tourism offices encounter persistent challenges, including inconsistent regulatory compliance, limited training on environmental management, and weak institutional mechanisms needed to operationalize sustainability on the ground [4]. Capacity gaps in environmental planning and governance further impede progress, as many municipalities lack structured programs and technical knowledge to fully integrate sustainability into tourism operations [5]. A key motivation for this study rests on the limited scholarly attention given to public-sector tourism institutions. While numerous studies focus on green practices in private hotels, resorts, and tour operators, the sustainability performance of local government tourism offices remains underexplored [6]. This gap is significant because local government tourism units function as policymakers, program implementers, and coordinators of community engagement roles that directly shape local sustainability outcomes. This study introduces green knowledge as a mediating variable, offering a fresh perspective on how environmental awareness, regulatory understanding, and knowledge-sharing influence the effectiveness of green strategies. Organizations with higher levels of environmental knowledge demonstrate stronger sustainability performance because knowledgeable personnel are better positioned to apply policies, adopt innovations, and integrate environmental principles into daily operations [7]. Similarly, knowledge-oriented leadership has been shown to significantly enhance environmental performance in tourism departments [8]. Using Partial Least Squares–Structural Equation Modeling (PLS-SEM), this study examines the direct and indirect pathways linking green strategies, green knowledge, and sustainable operations across Laguna's tourism offices. PLS-SEM is particularly suited for this inquiry because it allows the assessment of latent variables and complex mediating relationships while remaining appropriate for emerging research frameworks and relatively small institutional samples [9]. Overall, this study contributes to sustainable tourism governance by illuminating how institutional knowledge, strategic implementation, and leadership commitment collectively enhance the environmental, economic, and social dimensions of sustainable operations. In the broader Southeast Asian context where tourism continues to expand these insights are crucial for strengthening policy frameworks, guiding capacity-building efforts, and promoting long-term sustainability in local tourism governance.

2 Literature review

2.1 Green strategies in tourism workspaces

Green strategies in tourism refer to coordinated organizational efforts designed to reduce environmental harm while simultaneously enhancing social and economic outcomes [2]. These strategies typically involve waste reduction programs, energy conservation initiatives, sustainable procurement practices, and environmental education campaigns all of which are particularly important in tourism, where activities directly affect natural and cultural resources. In the Southeast Asian context, local tourism offices have begun adopting these strategies with varying levels of institutional readiness and resource support. Municipal tourism departments that have implemented structured green policies have reported improved stakeholder engagement and operational efficiency [6]. Likewise, aligning green initiatives with regulatory frameworks has been shown to enhance the effectiveness of local tourism governance, particularly when compliance mechanisms and environmental planning tools are clearly integrated [4]. Despite these benefits, many local government units continue to struggle with fragmented implementation, limited budgets, and inadequate monitoring systems. The absence of consistent evaluation mechanisms and persistent capacity gaps at the municipal level often hinder the long-term success of sustainability efforts, resulting in uneven adoption of green strategies across local tourism offices [5].

2.2 Green knowledge as an enabler of sustainability

Green knowledge refers to the awareness, understanding, and practical competence required to apply environmental principles within organizational settings. It encompasses regulatory literacy, familiarity with sustainability innovations, and the ability to implement environmentally responsible practices in day-to-day operations [7]. Within the tourism sector, green knowledge is essential for both leaders and frontline personnel because it enables informed decision-making and strengthens the execution of sustainability initiatives. Tourism departments whose employees possess strong environmental knowledge have been shown to demonstrate higher efficiency in resource management and waste reduction efforts [8]. In the Philippine context, many local tourism offices continue to struggle with limited access to updated sustainability training, environmental monitoring tools, and technical guidance needed for effective program implementation [4]. Local capacity gaps can be addressed through community-based training programs and partnerships with environmental organizations, which help enhance environmental literacy and stakeholder participation [5]. Despite these efforts, green knowledge remains unevenly distributed across tourism workspaces particularly between well-resourced urban municipalities and smaller, rural localities resulting in inconsistencies in sustainability implementation.

2.3 Sustainable operations in local tourism

Sustainable operations are those that balance environmental integrity, economic viability, and social responsibility in day-to-day organizational functions. In the tourism sector, this includes practices such as energy efficiency, low-emission transportation options, waste minimization, eco-certification compliance, and socially responsible employment systems [1]. In the Philippine context, tourism destinations that adopt sustainability-centered operational models such as eco-friendly waste systems and resource-efficient infrastructure have been shown to experience lower operating costs and improved visitor satisfaction [10]. Similarly, when tourism offices integrate sustainability into administrative routines and management practices, they tend to enhance service quality and operational efficiency [6]. However, many local government tourism offices continue to encounter structural barriers, including outdated administrative systems, inadequate infrastructure, and limited regulatory

enforcement capacity. Many municipalities also lack systematic frameworks to assess whether their operational practices align with national sustainability goals, resulting in fragmented implementation and uneven progress across localities [5].

2.4 Theoretical framework

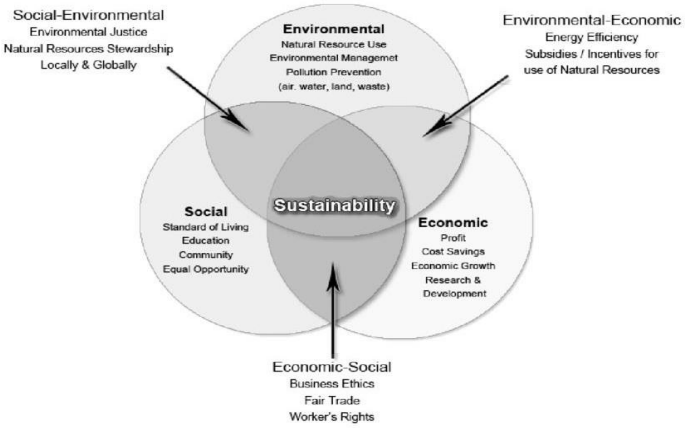

Fig. 1. Sustainable and Triple Bottom Line (TBL) Model

Figure 1. theoretical foundation of this study is anchored on the Triple Bottom Line (TBL) framework originally introduced by Elkington [3] and further operationalized by later scholars [11], as illustrated in Figure 1. The TBL framework identifies three essential pillars of sustainability people, planet, and profit and posits that organizations should evaluate their performance not only in terms of financial outcomes but also with respect to social and environmental impacts. Rather than focusing solely on economic gain, the framework emphasizes a balanced approach in which ecological protection and social well-being are prioritized alongside profitability. Subsequent extensions of the TBL model expanded sustainability into six interrelated dimensions, namely operations, technology, engineering, social, environmental, and economic aspects [11]. This expanded interpretation highlights the need to examine sustainability initiatives holistically, recognizing overlaps and constraints across different functional areas of an organization. Such a perspective reinforces the idea that sustainability is not an isolated activity but a system of integrated practices that collectively influence organizational performance. In the context of tourism workspaces, the TBL framework provides a valuable lens for assessing how green strategies contribute to sustainable operations. It underscores the need for tourism offices to implement practices that reduce environmental harm, foster community welfare, and support long-term economic viability. This perspective aligns with the role of local government tourism offices, which are tasked with balancing visitor management, environmental conservation, and local economic development. Anchoring the present study in the TBL framework enables a structured evaluation of how green strategies and green knowledge influence sustainable operations in Laguna's tourism offices. By examining these factors through the TBL dimensions, the study seeks to determine whether existing practices meaningfully contribute to environmental responsibility, social engagement, and economic resilience. Ultimately, applying this theoretical lens provides a sound basis for recommending improvements and regulatory measures that strengthen sustainability integration in local tourism governance.

2.4.1 Conceptual Framework

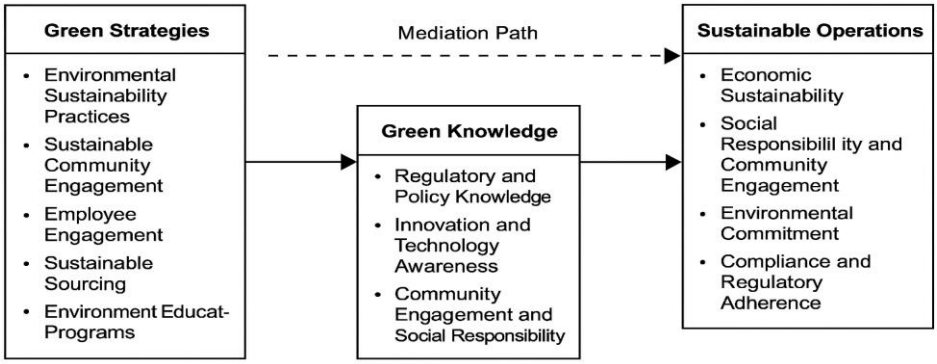

Fig. 2. Conceptual Framework of the study

Figure 2. study is grounded in the Triple Bottom Line (TBL) framework introduced by Elkington [3], which emphasizes that true sustainability must balance three core dimensions: economic viability, social responsibility, and environmental protection. Empirical evidence further demonstrates that sustainability outcomes improve when organizations integrate environmental knowledge with strategic actions within their operational systems [7], as illustrated in Figure 2. In the context of local tourism governance, this implies that municipal and city tourism offices must adopt green strategies that not only protect natural resources but also enhance community well-being and support long-term economic benefits.

3 Methodology

3.1 Research design

This study employed a quantitative descriptive-correlational research design to assess the relationship among green strategies, green knowledge, and sustainable operations in selected local tourism offices across Laguna Province, Philippines. The study further investigated the mediating role of green knowledge using Partial Least Squares–Structural Equation Modeling (PLS-SEM). This analytical approach enables the examination of complex causal relationships between latent constructs and is particularly appropriate for developing and testing theoretical models in sustainability research [9].

3.2 Participants and sampling

A total of 224 respondents from 28 local tourism offices (municipal and city-level) were selected using purposive random sampling. The inclusion criteria required participants to be active employees of tourism offices with direct or indirect involvement in planning, implementing, or reporting sustainability initiatives. The sample included administrative

staff, field personnel, technical officers, and managerial staff, ensuring cross-functional perspectives.

3.3 Research instrument

A structured survey questionnaire served as the primary data collection instrument. The items were adapted from previously validated measurement scales and modified to reflect the context of local tourism governance. Indicators for Green Strategies were developed based on established sustainability dimensions such as environmental education, sustainable sourcing, employee participation, and community engagement areas emphasized in recent sustainability and knowledge-management literature [7][8]. Items measuring Green Knowledge captured regulatory awareness, understanding of conservation practices, and familiarity with sustainability-related innovation, reflecting constructs highlighted in contemporary studies on environmental knowledge and performance [7]. The measurement of Sustainable Operations was adapted from prior work on sustainability assessment and green operational practices, incorporating indicators related to regulatory compliance, economic viability, environmental stewardship, and community engagement [12]. All items were assessed using a 5-point Likert scale (1 = Strongly Disagree to 5 = Strongly Agree). To ensure content validity, the instrument underwent expert evaluation by specialists in tourism management and sustainability. A pilot test (n = 30) was conducted to assess reliability and refine item wording. Cronbach's alpha values ranged from 0.56 to 0.87, indicating medium to high internal consistency across constructs. Items or subscales that produced low reliability scores particularly within sections of the green knowledge domain were removed from the final model to maintain statistical rigor and measurement validity, consistent with recommended methodological standards [14].

Table 1. Validity Measures using Cronbach's alpha coefficients (Cronbach, 1951)

Cronbach's alpha coefficients					
Latent Constructs	**Variables**	Item-indicators	Cronbach's alpha coefficients	Validity Value	Consistency Value
	Environmental Sustainability Practices	(1 to 5 Item-indicators)	.590	*Medium Validity*	*Acceptable Consistency*
	Sustainable Community Engagement	(1 to 5 Item-indicators)	.662	*Medium Validity*	*Acceptable Consistency*
	Employee Engagement	(1 to 5 Item-indicators)	*.578*	*Medium Validity*	*Acceptable Consistency*
Green Strategies					
	Sustainable Sourcing	(1 to 5 Item-indicators)	*.847*	*High Validity*	*Good Consistency*
	Environmental Education Programs	(1 to 5 Item-indicators)	*.803*	*High Validity*	*Good Consistency*
	Environmental Management and Conservation	**(1 to 5 Item-indicators)**	***.299***	***Low Validity***	***Questionable Consistency***
Green Knowledge					
	Sustainable Tourism Practices	**(1 to 5 Item-indicators)**	***.265***	***Low Validity***	***Questionable Consistency***
	Regulatory and Policy Knowledge	(1 to 5 Item-indicators)	*.734*	*High Validity*	*Good Consistency*
	Community Engagement and Social	(1 to 5 Item-indicators)	*.778*	*High Validity*	*Good Consistency*

	Responsibility				
	Innovation and Technology in Sustainability	(1 to 5 Item-indicators)	*.709*	*High Validity*	*Good Consistency*
	Economic and Financial Aspects of Sustainability	(1 to 5 Item-indicators)	*.560*	*Medium Validity*	*Acceptable Consistency*
	Economic Sustainability	(1 to 5 Item-indicators)	*.623*	*Medium Validity*	*Acceptable Consistency*
	Social Responsibility and Community Engagement	(1 to 5 Item-indicators)	*.584*	*Medium Validity*	*Acceptable Consistency*
Sustainable Operation					
	Environmental Commitment	(1 to 5 Item-indicators)	*.876*	*High Validity*	*Good Consistency*
	Compliance and Regulatory Adherence	(1 to 5 Item-indicators)	*.765*	*High Validity*	*Good Consistency*

Table 1 presents the validity measures of various latent constructs associated with green strategies, green knowledge, and sustainable operations, evaluated through Cronbach's alpha coefficients. This table serves as a crucial tool in understanding the reliability and consistency of the indicators used to measure these constructs, as the values indicate the extent to which the items within each category correlate with one another. Cronbach's alpha coefficients typically range from 0 to 1, with higher values indicating better internal consistency and reliability.

3.4 Data analysis

The following analytic strategies were used, Descriptive Statistics: Frequency counts and percentages summarized demographic variables. Correlational Analysis: Assessed relationships between the main constructs. PLS-SEM: Conducted using SmartPLS 4.0 to examine: Path coefficients (direct and indirect effects), Construct reliability (using Composite Reliability and Cronbach's α), Convergent and discriminant validity (via AVE and Fornell–Larcker criterion), Bootstrapping (5000 subsamples) to test mediation significance

4 Result and discussion

The study was presented, focusing on the interrelationships among green strategies, green knowledge, and sustainable operations. This investigation aimed to understand how these constructs influenced one another and contributed to enhancing sustainability within organizations. The findings were organized around the validity measures of the indicators employed, as well as the statistical analyses conducted to evaluate their reliability and effectiveness. By exploring the nuances of green strategies ranging from environmental sustainability practices to sustainable sourcing and examining the critical aspects of green knowledge, such as regulatory awareness and community engagement, the researchers aimed to shed light on the multifaceted nature of sustainability efforts. Furthermore, the discussion addressed the implications of these findings for organizations striving to implement sustainable operations, including the importance of environmental commitment and

compliance with regulatory frameworks. This chapter served as a foundation for understanding how effective green strategies and robust green knowledge could drive sustainable practices, fostering a more environmentally responsible and economically viable future.

Table 2. Demographic Profile of the Respondents

Indicator	Frequency	Percentage	Rank
Age Category			
18 to 27 Years Old (Generation Z)	48	21.4	3
28 to 43 Years Old (Millennials)	107	47.8	1
44 to 59 Years Old (Generation X)	66	29.5	2
60 years old and above (Baby Boomers)	3	1.3	4
Gender Category			
Male	37	16.5	3
Female	50	22.3	2
Prefer not to say	137	61.2	1
Type of Local Tourism Office			
Municipal Tourism Office	270	79.9%	1
City Tourism Office	92	20.1%	2
District of Laguna			
District 1 (Biñan, Sta. Rosa, San Pedro)	30	13.4	4
District 2 (Cabuyao, Calamba, Bay, Los Baños)	32	14.3	3
District 3 (San Pablo, Alaminos, Calauan, District 4 (Liliw, Nagcarlan, Rizal, Victoria)	51 111	22.8 49.6	2 1
Role in Tourism Office			
Head/Manager	5	2.2	5
Administrative Staff	163	72.8	1
Field Officer	28	12.5	2
Technical Officer	21	9.4	3
Others	7	3.1	4
Years of Operation			
Less than 1 year	14	6.3	4
1-3 years	69	30.8	2
4-6 years	124	55.4	1
7-10 years	15	6.7	3
More than 10 years	2	.9	5

Table 2 the demographic profile of the respondents is presented. The results indicate that Millennials (28–43 years old) comprise the largest age group at 47.8%, followed by Generation X (44–59 years) at 29.5%, and Generation Z (18–27 years) at 21.4%. The minimal representation of Baby Boomers (60 years old and above) at only 1.3% suggests a clear generational shift within local tourism offices. The strong presence of Millennials who are often associated with greater openness to sustainability initiatives and technological adaptation implies that tourism operations are increasingly shaped by a workforce inclined toward environmentally responsible and innovation-driven practices [6]. In terms of gender, a majority of respondents (61.2%) opted not to disclose their gender, while 22.3% identified

as female and 16.5% as male. Most participants were employed in Municipal Tourism Offices (79.9%), with the remainder coming from City Tourism Offices. Additionally, most respondents reported 4–6 years of work experience (55.4%), indicating a relatively young yet experienced workforce that is likely familiar with current trends in tourism management. Overall, the generational distribution reflects broader patterns observed in sustainability-oriented sectors, where younger cohorts tend to demonstrate stronger engagement with environmental initiatives and greater adaptability to emerging technologies. Conversely, the low participation of Baby Boomers may be associated with differences in digital familiarity and work orientation, which can limit involvement in sustainability-focused operational models.

Table 3. Relationship Between Green Knowledge and Green Strategies

Predictors (Green Knowledge)	**Criterion Variables (Green Strategies)**	**R-value/ Interpretation**	**p-value**	**Decision on Ho1**
	Environmental Sustainability Practices	-.046/ Very Weak Negative Relationship	.495	Not Significant/ Accept Ho1
	Sustainable Community Engagement	-.075/ Very Weak Negative Relationship	.262	Not Significant/ Accept Ho1
	Employee Engagement	-.0185*/ Very Weak Negative Relationship	.006	Significant/ Reject Ho1
Green Knowledge				
	Sustainable Sourcing	-.129/ Weak Negative Relationship	.053	Not Significant/ Accept Ho1
	Environmental Educational Programs	.073/ Very Weak Negative Relationship	.274	Not Significant/ Accept Ho1
	Overall Green Strategies	-.099/ Very Weak Negative Relationship	.140	Not Significant/ Accept Ho1

Table 3 the relationship between green knowledge and the different dimensions of green strategies is presented in Table 3. The analysis of correlation coefficients (R-values) and p-values reveals an overall pattern of weak or very weak negative relationships. Among the predictors, only employee engagement exhibits a statistically significant correlation with green knowledge, demonstrating a very weak negative relationship ($R = -0.185$, $p = 0.006$). This result leads to the rejection of the null hypothesis (Ho1), suggesting that higher levels of green knowledge are associated with slightly lower employee engagement in sustainability initiatives. Other components including sustainable community engagement ($R = -0.075$, $p = 0.262$), environmental sustainability practices ($R = -0.046$, $p = 0.495$), and sustainable sourcing ($R = -0.129$, $p = 0.053$) show non-significant negative correlations. Environmental education programs ($R = 0.073$, $p = 0.274$) and the aggregate green strategies construct ($R = -0.099$, $p = 0.140$) likewise indicate negligible associations with green knowledge. These

findings highlight a notable paradox within local tourism offices: while personnel may possess environmental awareness, such knowledge does not consistently translate into the practical application of green strategies. The significant but negative association with employee engagement suggests the presence of organizational barriers, including limited empowerment, insufficient training mechanisms, unclear task roles, or operational cultures that do not actively support sustainability practices. Previous studies emphasize that environmental knowledge must be reinforced by structured organizational systems to manifest as consistent sustainable behavior [7]. Similarly, the absence of institutional mechanisms such as leadership support, operational guidance, and incentive structures can hinder employees' ability to integrate sustainability into daily routines [6]. Capacity gaps within local government units further constrain the effective implementation of sustainability initiatives despite personnel awareness [5].

Table 4. Relationship Between Green Knowledge and Sustainable Operation

Predictors (Green Knowledge)	**Criterion Variables (Sustainable Operation)**	**R-value/ Interpretation**	**p-value**	**Decision on Ho2**
Green Knowledge	Regulatory and Policy Knowledge	.733/ Moderate Relationship	.000	Significant/ Reject Ho2
	Community Engagement and Social Responsibility	.469/ Moderate Relationship	.000	Significant/ Reject Ho2
	Innovation and Technology Sustainability	.670/ Moderate Relationship	.000	Significant/ Reject Ho2
	Economic and Financial Aspects of Sustainability	.625/ Moderate Relationship	.000	Significant/ Reject Ho2
	Overall Sustainable Operation	.487/ Moderate Relationship	.000	Significant/ Reject Ho2

Table 4 the relationship between green knowledge and the different dimensions of sustainable operations is presented. The analysis reveals that green knowledge has a statistically significant and moderate positive relationship with all dimensions of sustainable operations, as indicated by correlation coefficients ranging from 0.487 to 0.733 (all $p < 0.001$). These results support the rejection of the null hypothesis (Ho2) and confirm that green knowledge plays a central role in shaping effective sustainability practices within local tourism offices. The strongest correlation is observed between green knowledge and regulatory and policy compliance ($R = 0.733$), indicating that tourism personnel with higher levels of environmental literacy are better equipped to understand, interpret, and adhere to sustainability regulations. This finding is consistent with previous research emphasizing that environmental awareness strengthens organizational capacity to meet regulatory standards and adopt compliance-oriented practices [6]. A similarly strong correlation with innovation and technology in sustainability ($R = 0.670$) suggests that green knowledge enables tourism offices to adopt eco-friendly technologies and operational improvements. Prior studies further argue that knowledge-oriented leadership fosters greater innovation, efficiency, and environmental performance within tourism departments [8]. The significant relationship between green knowledge and economic and financial sustainability ($R = 0.625$) also

indicates that knowledgeable personnel are more capable of identifying cost-saving opportunities, optimizing resource use, and recognizing the long-term financial benefits of sustainable tourism investments [7]. Notably, the weakest correlation is observed between green knowledge and community engagement (R = 0.469). Although still statistically significant, this comparatively lower association suggests that internal environmental knowledge does not automatically translate into strong external stakeholder involvement. Similar observations highlight that while many local government units possess basic environmental awareness, gaps in community outreach, stakeholder coordination, and participatory governance often limit broader engagement [5].

Table 5. Relationship Between Green Strategies and Sustainable Operation

Predictors (Green Strategies)	**Criterion Variables (Sustainable Operation)**	**R-value/ Interpretation**	**p-value**	**Decision on Ho3**
	Regulatory and Policy Knowledge	-.358/ Moderate Relationship	.000	Significant/ Reject Ho3
	Community Engagement and Social Responsibility	-.185/ Moderate Relationship	.006	Significant/ Reject Ho3
Green Strategies	Innovation and Technology Sustainability	-.124/ Moderate Relationship	.064	Not Significant/ Accept Ho3
	Economic and Financial Aspects of Sustainability	-.034/ Moderate Relationship	.613	Not Significant/ Reject Ho3
	Overall Sustainable Operation	-.099/ Moderate Relationship	.140	Not Significant/ Reject Ho3

Table 5 the analysis examining the relationship between green strategies and sustainable operations reveals a complex and somewhat counterintuitive interplay. Contrary to widely held assumptions that green strategies inherently lead to better sustainability outcomes, the findings show that two indicators regulatory and policy knowledge (R = -0.358) and community engagement (R = -0.185) demonstrate statistically significant moderate negative correlations with sustainable operations. These results suggest that increased application of green strategies does not necessarily equate to higher regulatory awareness or stronger community involvement. In fact, local tourism offices may be adopting sustainability practices in ways that are misaligned with policy frameworks, possibly due to inadequate regulatory training or limited integration of green strategies into broader institutional mandates [3]. This points to a potential compliance gap that undermines the effectiveness of sustainability efforts. Additionally, the negative correlation with community engagement raises concerns that environmental initiatives may be implemented without sufficient attention to local inclusion and participation [7]. Rather than fostering social responsibility, some green strategies may focus narrowly on environmental performance metrics, neglecting the equally critical dimensions of equity and stakeholder collaboration. Meanwhile, other predictors such as innovation and technology sustainability (R = -0.124), economic and

financial sustainability (R = -0.034), and overall sustainable operations (R = -0.099) display weak negative relationships, none of which reach statistical significance. While these do not provide conclusive evidence of ineffectiveness, the trend suggests that green strategies may currently be fragmented or lack cross-sectoral integration, particularly in terms of driving innovation or realizing economic benefits. Overall, the findings highlight that the mere presence of green strategies does not guarantee comprehensive improvements in sustainability performance. Instead, local tourism offices must adopt a more strategic and holistic approach that aligns green practices with regulatory compliance, community empowerment, and financial sustainability [13]. These insights underscore the importance of critically evaluating how sustainability is operationalized within tourism governance, with particular attention to implementation gaps and the multidimensional nature of sustainable development.

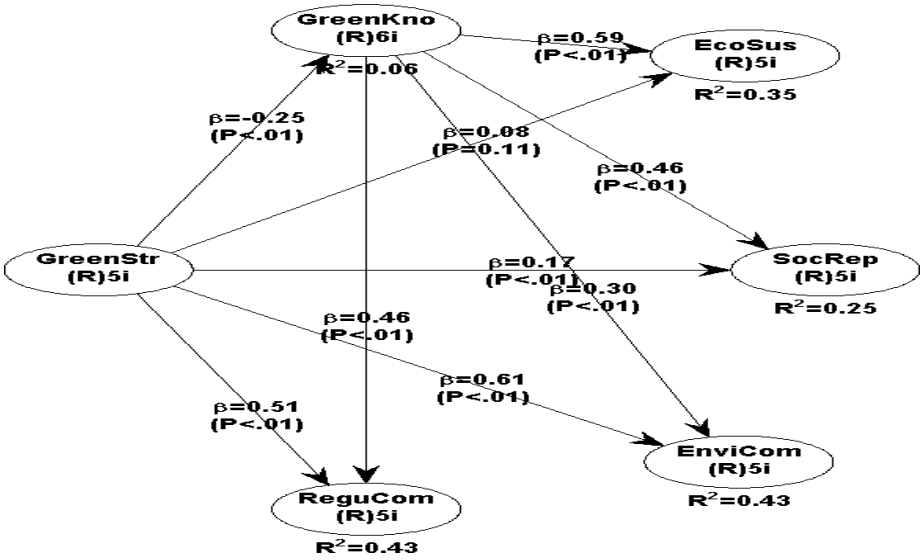

Fig. 3. Mediating Effect of Green Knowledge between Green Strategies and Sustainable Operation

Figure 3. or Model validation, PLS-SEM includes robustness checks and validation procedures to ensure that the identified relationships were statistically significant and dependable, thereby enhancing the reliability of the findings derived from the model. Below were the results of the Model fit indices.

Table 6. Model Fit Indices for Green Knowledge between Green Strategies and the sustainable operation

Model Fit Indices	**Coefficient**	**Result**
Average path coefficient (APC)	0.382***	Significant
Average R-squared (ARS)	0.304***	Significant
Average adjusted R-squared (AARS)	0.299***	Significant
Average block VIF (AVIF)	1.007	Ideally
Average full collinearity VIF (FVIF)	2.365	Ideally
Tenenhaus GoF (GoF)	0.388	Large

Simpson's paradox ratio (SPR)	0.889	Acceptable
R-squared contribution ratio (RSCR)	0.996	Acceptable
Statistical suppression ratio (SSR)	1.000	Acceptable
Nonlinear bivariate causality direction ratio (NLBCDR)	0.889	Acceptable

Table 6 the model fit indices for the structural model are presented. The analysis provides a comprehensive assessment of the structural relationships among green knowledge, green strategies, and sustainable operations. The results indicate that green knowledge significantly contributes to both the implementation of green strategies and the enhancement of sustainable operational practices in local tourism offices. This is supported by an Average Path Coefficient (APC) of 0.382, reflecting a strong and statistically significant positive relationship among the constructs. The Average R-squared (ARS) value of 0.304 and the Average Adjusted R-squared (AARS) value of 0.299 indicate that approximately 30% of the variance in sustainable operations is explained by green knowledge and its associated strategies, confirming the model's moderate predictive power while acknowledging the influence of other potential external variables. Multicollinearity diagnostics further affirm the reliability of the structural model. The Average Block Variance Inflation Factor (AVIF = 1.007) and the Average Full Collinearity Variance Inflation Factor (AFVIF = 2.365) fall well within acceptable thresholds, indicating that the constructs are independent and free from problematic overlap. Similarly, the Tenenhaus Goodness-of-Fit index (GoF = 0.388), categorized as "large," demonstrates a strong overall model fit. Additional indicators—including the Simpson's Paradox Ratio (SPR = 0.889), R-squared Contribution Ratio (RSCR = 0.996), Statistical Suppression Ratio (SSR = 1.000), and Nonlinear Bivariate Causality Direction Ratio (NLBCDR = 0.889)—further validate the stability, robustness, and statistical coherence of the model. Despite the strong model fit, the findings suggest that green knowledge alone does not automatically result in increased employee engagement or consistently applied sustainability behaviors. Previous studies emphasize that environmental knowledge must be supported by structured organizational systems, incentive mechanisms, and clear operational guidelines to translate into sustained practice [3]. Likewise, without leadership support, institutional alignment, and dedicated resources, green knowledge may remain largely theoretical rather than operational [7]. Knowledge-oriented leadership has also been identified as a critical factor in transforming environmental awareness into innovation and performance improvements [13], while capacity gaps within local government units continue to hinder the effective translation of knowledge into sustained sustainability action [5].

Table 7. Parameter Estimates of Mediation Model

Model	B	SE	P-value	Interpretation
Direct Effect (c')				
Ho1*: Green Knowledge→ Green Strategies*	0.082	0.064	<0.001	*Significant*
Ho2*: Green Knowledge→ Sustainable Operation*	0.595	0.047	<0.001	*Significant*
Ho3: *Green Strategies → Sustainable Operation*	0.596	0.048	<0.001	*Significant*
Indirect Effect (a*b)				
Ho4a: *Green Strategies → Green Knowledge→ Economic Sustainability*	0.082	0.060	<0.001	*Significant*

Ho4b: *Green Strategies → Green Knowledge→ Social Responsibility*	0.515	0.062	<0.001	*Significant*
Ho4c: *Green Strategies → Green Knowledge→ Environmental Commitment*	0.609	0.063	<0.001	*Significant*
Ho4d: *Green Strategies → Green Knowledge→ Regulatory Compliance*	0.171	0.061	<0.001	*Significant*

Table 7 the mediation model results are presented. providing a comprehensive analysis of how green knowledge and green strategies interact to influence sustainable operations within local tourism offices. The findings reveal significant direct and indirect effects, underscoring the central role of green knowledge in enabling sustainability. Specifically, green knowledge significantly predicts both green strategies ($\beta = 0.082$, $p < 0.001$) and sustainable operations ($\beta = 0.595$, $p < 0.001$), while green strategies also demonstrate a comparably strong direct effect on sustainable operations ($\beta = 0.596$, $p < 0.001$). These results confirm that knowledge and strategy function as complementary components of sustainability performance, working together to enhance operational effectiveness. Previous research emphasizes that green training and knowledge development are critical in transforming environmental awareness into actionable strategies, thereby bridging the gap between intent and implementation [7].

Further reinforcing this relationship, the mediation analysis confirms that green knowledge plays a vital role in strengthening the impact of green strategies across multiple dimensions of sustainable operations. All indirect effects were statistically significant, including economic sustainability ($\beta = 0.082$, $p < 0.001$), social responsibility ($\beta = 0.515$, $p < 0.001$), environmental commitment ($\beta = 0.609$, $p < 0.001$), and regulatory compliance ($\beta = 0.171$, $p < 0.001$). These findings indicate that strategies grounded in robust environmental knowledge are substantially more effective in achieving multidimensional sustainability outcomes. Well-informed strategies enable tourism offices not only to align with environmental objectives but also to enhance stakeholder engagement and regulatory adherence. Overall, the mediation results highlight a critical insight: green knowledge is not merely a foundational element but a transformative force that enables tourism offices to develop more integrated, adaptive, and effective sustainability strategies.

5 Conclusion

This study underscores the pivotal role of green knowledge in driving sustainable operations within local tourism offices. The findings reveal that green knowledge has a statistically significant and moderately positive correlation with various dimensions of sustainability, including innovation, regulatory compliance, community engagement, and financial sustainability. This validates the hypothesis that knowledge is a foundational enabler of effective environmental practices in the tourism sector. However, contrary to conventional expectations, green strategies though essential exhibited mixed results. Some strategies demonstrated negative or non-significant correlations with key sustainability indicators, such as regulatory alignment and community engagement. These findings challenge the prevailing assumption that green strategy implementation alone is sufficient to foster sustainable operations. Instead, the evidence points to the need for a knowledge-informed strategic approach. The mediation analysis further solidifies this view by illustrating that green knowledge significantly mediates the relationship between strategy and sustainable outcomes, particularly in terms of economic sustainability, social responsibility,

environmental commitment, and regulatory compliance. This highlights the importance of not just having green strategies but ensuring that such strategies are deeply embedded in a knowledge-rich organizational culture. Moreover, model fit indices confirmed the robustness of the hypothesized framework, with strong path coefficients and acceptable collinearity indicators, suggesting that the integration of green knowledge and strategy forms a sound predictive model for sustainability performance in tourism governance.

6 Recommendations

Based on the findings of this study, it is strongly recommended that local tourism offices institutionalize green knowledge through structured training programs, workshops, and ongoing environmental education. These initiatives must focus not only on internal capacity building but also on strengthening regulatory literacy and aligning sustainability practices with existing policies. The significant mediating role of green knowledge highlights the need for tourism offices to integrate knowledge into the strategic development and execution of green initiatives. Furthermore, the negative and non-significant correlations between green strategies and some sustainability dimensions emphasize the importance of adopting a more holistic and participatory approach. Tourism offices should ensure that strategies are not only environmentally sound but also socially inclusive and economically viable. Greater community involvement and stakeholder engagement must be pursued to avoid superficial or performative sustainability efforts. Additionally, tourism offices are encouraged to explore green innovation and improve financial planning mechanisms to enhance their sustainability outcomes. The weak associations found in innovation and economic aspects suggest that current strategies may lack the necessary support structures or investment to yield substantial impact. Finally, it is advised that future research expand the model by including variables such as organizational leadership, digital transformation, and cultural attitudes toward sustainability, which could further illuminate the complexities behind effective green strategy implementation in tourism governance.

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