International Journal of Management and Sustainability
2026 Vol. 15, No. 3, pp. 547-564
ISSN(e): 2306-0662
ISSN(p): 2306-9856
DOI: 10.18488/11.v15i3.5156

Environmental management accounting as a mediating mechanism between green intellectual capital and sustainability performance

Ni Luh Putu Mita Miati[1+]
Dodik Ariyanto[2]
Anak Agung Gde Putu Widanaputra[3]
I Gusti Ayu Made Asri Dwija Putri[4]

[1,2,3,4]*Faculty of Economics and Business, Udayana University, Bali, Indonesia.*
[1]*Faculty of Economics and Business, Warmadewa University, Bali, Indonesia.*
[1]*Email: mitamiati91@gmail.com*
[2]*Email: dodikariyanto@unud.ac.id*
[3]*Email: widanaputra@unud.ac.id*
[4]*Email: igustiayumadeasri@unud.ac.id*

(+ Corresponding author)

Article History
Received: 13 February 2026
Revised: 5 May 2026
Accepted: 26 May 2026
Published: 7 September 2026

Keywords
Environmental management accounting
Green human capital
Green relational capital
Green structural capital
Quintuple sustainability performance.

ABSTRACT

The concept of organizational sustainability has evolved from initially only covering economic, social, and environmental aspects to also including governance, cultural, and spiritual dimensions. Nonetheless, the accounting literature remains insufficient in elucidating the conversion of eco-based resources into holistic sustainability performance, especially within the hospitality sector. This study aims to examine the role of Environmental Management Accounting (EMA) as a mediating variable in the relationship between Green Intellectual Capital and Quintuple Sustainability Performance (QSP). This research employs a survey-based quantitative approach involving 162 managers from four- and five-star hotels in Bali Province. Data were collected through a structured questionnaire adapted from previous studies. Partial Least Squares–Structural Equation Modeling (PLS-SEM) was used to analyze the data. This was followed by mediation testing and robustness checks. The results indicate that EMA significantly increases QSP. Results show that EMA significantly improves QSP. Green Human Capital and Green Structural Capital have a significant positive impact on QSP, whereas Green Relational Capital has no significant positive impact on QSP. However, all the dimensions of Green Intellectual Capital show significant indirect effects on QSP via EMA. The EMA plays a full mediation role in the relationship between Green Relational Capital and QSP. The EMA plays a partial mediation role in the relationship between Green Human Capital and QSP and between Green Structural Capital and QSP. These results confirm the strategic role of EMA as a key tool to improve multidimensional sustainability performance. This research contributes to the sustainability accounting literature by integrating Environmental Management Accounting into the quintuple bottom line paradigm, while offering practical implications for the hospitality industry in designing structured and contextual sustainability initiatives.

Contribution/Originality: This study enhances the sustainability accounting literature by synthesizing Green Intellectual Capital, Environmental Management Accounting, and Quintuple Sustainability Performance into a cohesive framework. It emphasizes EMA's role as a vital mediation mechanism and provides actual data from the hospitality sector within cultural and spiritual frameworks.

1. INTRODUCTION

Sustainability performance has become a key topic in business and accounting literature as companies look for long-term value in areas like economics, society, the environment, and governance. Modern literature views sustainability performance as a cohesive notion that signifies a company's capacity to embed sustainability throughout its operational processes, strategies, and performance evaluation frameworks (Deng et al., 2022; Elkington, 1997; Pasamar, Bornay-Barrachina, & Morales-Sánchez, 2025). This shift reflects a transition from a short-term financial performance orientation to a more comprehensive, stakeholder-oriented approach to sustainability (Cantele, Landi, & Vernizzi, 2024). The triple bottom line and quadruple bottom line are commonly employed to evaluate sustainability performance; however, their actual application and assessment continue to pose significant challenges. This complexity originates from the multifaceted character of sustainability, which necessitates trade-offs among various variables, and from the constraints of measuring systems that remain unstandardized and frequently fragmented (Cantele et al., 2024). Numerous studies indicate that these constraints may result in incomplete sustainability evaluations that may not accurately represent the operational realities of businesses (Jámbor & Zanócz, 2023; Pazienza, De Jong, & Schoenmaker, 2023).

Given such complexity, sustainability literature emphasises an organization's internal capacity to execute and manage sustainable practices. The Natural Resource-Based View (NRBV) holds that a firm's ability to manage environmental resources and activities, such as pollution control, resource efficiency, and environmental management, can produce significant advantages that competitors cannot match (Hart, 1995; Hart & Dowell, 2011). Therefore, environmentally oriented internal resources are considered a strategic basis for achieving sustainability performance.

The internal skills of an organization are determined by its Green Intellectual Capital, which includes environmentally oriented, conceptual, and relational human capital (Asiaei, O'Connor, Barani, & Joshi, 2023; Chen, 2008; Yusoff, Omar, Zaman, & Samad, 2019). But studies also show that Green Intellectual Property ownership alone does not necessarily result in optimal sustainability performance without the support of management mechanisms capable of regulating and converting that power into operational practices (Asiaei et al., 2023).

Consequently, this work elucidates the theory of resource orchestration to convert green intellectual resources into sustainability performance. This theory stresses that structuring, bundling, and leveraging processes must be used to organise resources in order to get better results (Sirmon, Hitt, Ireland, & Gilbert, 2011). EMA is a way to bring together environmental information with management accounting systems and strategic decision-making. This ensures that firms align their business operations with their future sustainability targets (Huynh & Nguyen, 2024; Swalih, Ram, & Tew, 2024). This research utilizes the Quintuple Sustainability Performance (QSP) paradigm as a comprehensive method for evaluating sustainability performance, incorporating financial, social, sustainability management, environmental, and cultural/spiritual elements. The incorporation of cultural and spiritual dimensions enhances traditional methodologies by encompassing the values, ethics, and significance of work as factors influencing long-term sustainability (Luetz & Nunn, 2023). In the realm of Balinese hospitality, this aspect is grounded in the philosophy of Tri Hita Karana, serving as the normative basis for sustainability practices (Ashrama, 2005; Saputra, Subroto, Rahman, & Saraswati, 2022).

This study aims to enhance understanding of the internal mechanisms that enable the hospitality industry to achieve sustainability performance. It positions Green Intellectual Capital as a strategic resource, Environmental Management Accounting as an orchestration mechanism, and Quintuple Sustainability Performance as the endogenous performance construct. This research is grounded in Resource Orchestration Theory and the Natural Resource-Based View (NRBV). The NRBV explains how competitive advantage can be developed through environmental capabilities (Hart, 1995; Hart & Dowell, 2011). Meanwhile, Resource Orchestration Theory describes how resources and capabilities are structured and leveraged to generate performance through managerial mechanisms (Sirmon et al., 2011). For NRBV, Green Intellectual Property encompasses sustainable human capital, green structural wealth, and sustainable relationship prosperity (Chen, 2008; Yusoff et al., 2019). Green human resources demonstrate employees' ability, awareness, and commitment to environmental issues and support innovation and sustainability practices (Chen, 2008; Yusoff et al., 2019). Green Structural Capital includes infrastructure, systems, and procedures that allow sustainability to be consistently internalized in the company's operating processes (Asiaei et al., 2023). The organization's relationships with external stakeholders that support legitimacy and continued cooperation are noted in Green Relational Capital (Asiaei et al., 2023; Chen, 2008). In the context of Quintuple Sustainability Performance, the three dimensions are anticipated to enhance all facets of the business's sustainability, encompassing cultural and spiritual dimensions that reinforce long-term sustainability orientation (Luetz & Nunn, 2023).

H_{1a}: Green Human Capital positively influences Quintuple Sustainability Performance.

H_{1b}: Green Structural Capital positively influences Quintuple Sustainability Performance.

H_{1c}: Green Relational Capital positively influences Quintuple Sustainability Performance.

An organization's internal capacity is environmentally oriented, influencing the implementation of environmental accounting management, according to NRBV and Resource Orchestration Theory (Burritt, Schaltegger, & Christ, 2023; Schaltegger, 2013). Green capital supports the utilization of environmental information, green structure capital provides the EMA system, and green relationship capital drives the adoption of EMA through stakeholder pressure and cooperation.

H_{2a}: Green Human Capital positively influences Environmental Management Accounting.

H_{2b}: Green Structural Capital positively influences Environmental Management Accounting.

H_{2c}: Green Relational Capital positively influences Environmental Management Accounting.

The EMA makes it possible to include environmental factors in cost control, resource efficiency, and performance evaluation. This affects the whole sustainability performance dimension (Burritt et al., 2023; Schaltegger, 2013).

H_3: Environmental Management Accounting positively influences Quintuple Sustainability Performance.

The EMA functions as a system to convert green intellectual capital into quantifiable sustainability outcomes, aligned with resource management philosophy (Sirmon et al., 2011).

H_{4a}: Environmental Management Accounting serves as a mediator in the interaction between Green Human Capital and Quintuple Sustainability Performance.

H_{4b}: Environmental Management Accounting serves as a mediator in the interaction between Green Structural Capital and Quintuple Sustainability Performance.

H_{4c}: Environmental Management Accounting serves as a mediator in the interaction between Green Relational Capital and Quintuple Sustainability Performance.

To see the research concept, Figure 1 presents the research concept.

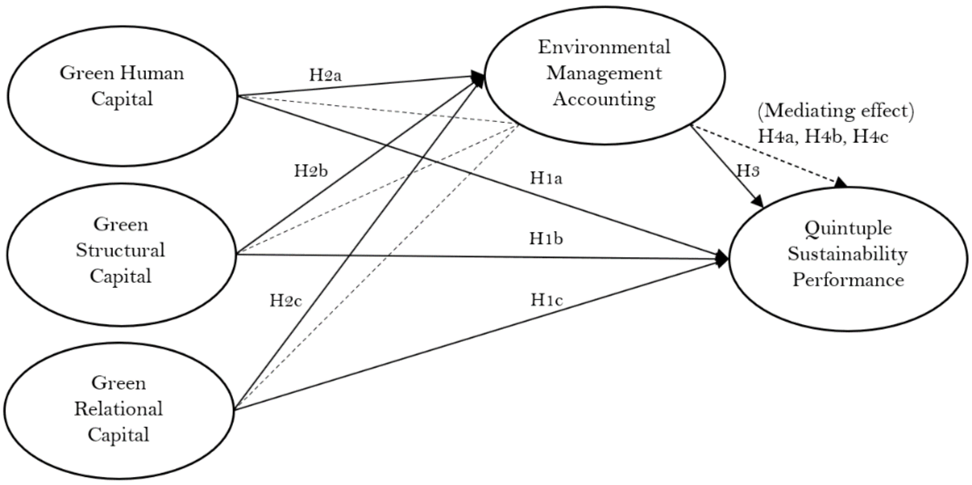

Figure 1. Research concept.

2. RESEARCH METHOD

2.1. Sample Selection

This study investigated the four- and five-star hospitality industry in the Province of Bali. The industry was chosen because of its high resource utilization rate and increasingly complex sustainability demands. The study included 261 officially listed four- and five-star hotels.

Everyone in the population was chosen as a respondent using the saturation sampling approach. This technique was selected to improve data representativeness and the external validity of research findings. A significant informational strategy, either a general manager or a personnel manager, is employed to identify respondents.

2.2. Variable Measurement

The study used five latent variables. The three exogenous variables are Green Human Capital (GHC), Green Structural Capital (GSC), and Green Relational Capital (GRC), and one intervening variable is EMA. Quintuple Sustainability Performance (QSP) is an endogenous variable. Reflective indicators were used, modified from previous research, and adapted to the Balinese hospitality industry. Measurements were made using the Likert scale.

2.3. Pilot Test

Prior to the extensive distribution of the questionnaire, brief trials were conducted to ascertain the instrument's clarity, contextual relevance, validity, and initial reliability of research indicators. The subjects of this study were managers from the upscale hospitality sector, exhibiting characteristics similar to those of the research cohort. The pilot test results were used to assess the clarity of responses, consistency of answers, and whether the indicators were clear or not.

2.4. Data Analysis Technique

PLS-SEM is a methodology for data analysis. This approach is efficacious for intricate research models as it utilizes multidimensional constructs and does not necessitate a normal data distribution. It operates efficiently for samples of intermediate dimensions (Hair et al., 2021).

The proposed research model allows us to write the structural correlations in the following equations.

$$EMA = \beta_1 \cdot GHC + \beta_2 \cdot GRC + \beta_3 \cdot GSC + \varepsilon_1 \quad (1)$$

$$QSP = \beta_4 \cdot GHC + \beta_5 \cdot GRC + \beta_6 \cdot GSC + \beta_7 \cdot EMA + \varepsilon_2 \quad (2)$$

Information:

EMA: Environmental Management Accounting.

GRC: Green Relational Capital.

GHC: Green Human Capital.

GSC: Green Structural Capital.

QSP: Quintuple Sustainability Performance.

Table 1 presents the stages of data analysis employed in this study based on the PLS-SEM approach, following the guidelines of Hair et al. (2021). The analysis procedure includes the evaluation of the reflective outer model through indicator loadings, internal consistency reliability, convergent validity, and discriminant validity, as well as the assessment of the inner model through collinearity diagnostics, path coefficient estimation, coefficient of determination (R^2), predictive relevance (Q^2), and PLSpredict. In addition, the table outlines the mediation testing procedures and robustness tests, including measurement model assessment and structural model evaluation.

Table 1. Stages of data analysis.

Model	Criteria	Threshold	Description
Measurement Model (Reflective Outer Model)	Indicator loadings	≥ 0.708	Evaluates the reliability of each indicator
	Internal consistency reliability	≥ 0.70 (≥ 0.60 for exploratory research)	Assessed using Cronbach's alpha and composite reliability
	Convergent validity	AVE ≥ 0.50	Indicates the variance explained by the construct
	Discriminant validity	HTMT < 0.90	Ensures distinctiveness among constructs
Structural Model (Inner Model)	Collinearity (VIF)	< 3 (ideal), 3–5 (acceptable), ≥ 5 (critical)	Assesses multicollinearity among predictors
	Path coefficients	$p < 0.05$	Estimated using bootstrapping
	Effect size (f^2)	≥ 0.02 (small), ≥ 0.15 (medium), ≥ 0.35 (large)	Measures the impact of exogenous variables
	Coefficient of determination (R^2)	0.75 (strong), 0.50 (moderate), 0.25 (weak)	Indicates explanatory power of the model
	Predictive relevance (Q^2)	> 0	Assesses predictive accuracy
	PLSpredict	Lower RMSE/MAE than LM	Evaluates out-of-sample predictive power
Mediation Analysis	Mediation testing	$p < 0.05$ (direct and indirect effects)	Assesses mediation effects
Robustness Tests	Measurement model	CTA-PLS	Confirms measurement model specification
	Structural model	Nonlinear effects, endogeneity, unobserved heterogeneity	Tests robustness of structural relationships

3. RESULTS

From August to October 2025, data was gathered. After sorting the answers into first and last groups. Non-response bias was assessed using an independent-samples t-test. The results indicated no significant disparity in perception between the two groups, as p-values for each indicator surpassed 0.05. Consequently, this study did not identify response bias. In this study, 162 questionnaires were received and analyzed, as shown in Table 2.

Table 2. Questionnaire return rate.

No.	Remarks	Total	Percentage (%)
1	The quantity of questionnaires distributed	261	100%
2	The quantity of questionnaires was not disclosed	99	38%
3	Quantity of questionnaires submitted	162	62%
4	The system is unable to process the volume of surveys	0	0
5	The quantity of surveys that can be handled.	162	62%

3.1. Respondent Characteristics

The profiles of the study participants are presented to provide an overview of the study respondents. Data were obtained from 162 respondents at star hotels in Bali Province. The characteristics analyzed included gender, age, position, length of work, and classification of the hotel where the respondent worked. Respondent Characteristics are more clearly presented in Table 3.

Table 3. Characteristics of respondents.

Features	Category	Frequency	Percentage
Gender	Male	87	54%
	Female	75	46%
	Total	162	100%
Age (Years)	Under 30 years	0	0%
	Between 30 - 39 years	88	54%
	Between 40 - 49 years	66	41%
	50 years or above	8	5%
	Total	162	100%
Departments within the hotel	General manager	0	0%
	Assistant general manager	73	45%
	Human resource manager	89	55%
	Environmental/Sustainability manager	0	0%
	Others:	0	0%
	Total	162	100%
Long stay at this hotel	Under 1 year	0	0%
	Between 1 - 3 years	0	0%
	Between 4 - 6 years	68	42%
	6 years or above	94	58%
	Total	162	100%
Hotel type	4 stars	144	89%
	5 stars	18	11%
	Total	162	100%

3.2. Descriptive Statistics

Descriptive statistics show how each research variable is distributed. Table 4 reveals that the average value for all latent variables is 0.000, indicating that the data have been normalized before further analysis. The median values of all variables were also close to zero, indicating that the data distribution was relatively symmetrical and that there were no extreme deviations. The range of values indicated by the minimum and maximum observations shows variations in respondents' responses that remain within reasonable limits. The EMA variable sits between -2.38 and 1.732, while the GHC variable spans -2.72 to 1.770. The GRC variable has the widest range, from -3.188 to 1.607, indicating greater variation in respondents' perceptions than in other variables. Meanwhile, GSC and QSP have value ranges of -2.230 to 1.714 and -2.562 to 1.821, respectively. Table 4 shows additional details.

Table 4. Description of the research variables.

Construct	Mean	Median	Observed min.	Observed max.
EMA	0.000	0.097	-2.388	1.732
GHC	0.000	-0.094	-2.723	1.770
GRC	0.000	0.080	-3.188	1.607
GSC	0.000	0.073	-2.230	1.714
QSP	0.000	-0.045	-2.562	1.821

3.3. Common Method Bias

Common bias approaches were tested using the Harman one-factor test. The initial component failed the 50% criterion with an eigenvalue of 15.563 and a variance proportion of 26.39%. No single factor dominates variation. Thus, our study has little standard procedure bias. Table 5 presents the results of the Harman one-factor test.

Table 5. Common method bias.

Factor	Eigenvalue	Variance proportion	Variance cumulative
Component 1	15.563	0.264	0.264
Component 2	4.536	0.077	0.340
Component 3	3.126	0.076	0.393
Component 4	2.407	0.059	0.434
Component 5	2.147	0.052	0.471

3.4. Evaluation of Measurement Model

Composite dependability and Cronbach's alpha measure internal consistency. Every structure must score over 0.60, the exploratory research minimum. AVER assesses convergence validity. AVE is slightly below 0.50 on some constructs, but the composite's dependability satisfies the minimal required requirement (Hair et al., 2021). Table 6 provides details.

Table 6. Assessment of the measurement model.

Construct	Cronbach's alpha	Composite reliability (rho_a)	Composite reliability (rho_c)	Average variance extracted (AVE)
EMA	0.662	0.663	0.667	0.461
GHC	0.624	0.625	0.641	0.462
GRC	0.638	0.639	0.651	0.494
GSC	0.619	0.620	0.637	0.452
QSP	0.658	0.659	0.662	0.455

The Heterotrait Monotrait Ratio (HTMT) tests how well something can tell the difference between two things. All scores under 0.90 show that concept discrimination is working well. The results show that the measurement model is correct and reliable, which makes it easier to evaluate the structural model. Table 7 shows details.

Table 7. Heterotrait-monotrait ratio (HTMT).

Construct	EMA	GHC	GRC	GSC	QSP
EMA					
GHC	0.322				
GRC	0.436	0.221			
GSC	0.231	0.310	0.103		
QSP	0.396	0.375	0.290	0.278	

3.5. Coefficient of Determination

The Adjusted R-square values of 0.301 at the EMA and 0.276 at the QSP indicate that the model is able to explain 30.1% and 27.6% variations in endogenous constructs, respectively. Referring to Hair et al. (2021), the value is included in the moderate category, which indicates that the model has sufficient explanatory capabilities for the variables being studied.

3.6. Predictive Relevance (Q2)

Predictive Relevance (Q2) looks at how well a structural model can make predictions. The data shows that the EMA was 0.290 in Q2 and the QSP was 0.223. Hair et al. (2021) say that a Q2 number that is bigger than zero means that the model can be used to make predictions. Consequently, these findings indicate that the study model may forecast the endogenous structure under examination.

3.7. Path Coefficient

It used the road ratio to look at the direction and relevance of the links between constructs in structural models. The results showed that EMA had a positive and substantial effect on sustainability performance at a five-fold level ($\beta = 0.222$; $t = 3.853$; $p < 0.001$). This shows that utilizing EMA directly improves sustainability performance.

Moreover, evidence indicates that GHC exerts a positive and substantial influence on the EMA. The proficiency and comprehension of the human resource environment significantly improve EMA practices and sustainability performance ($\beta = 0.154$; $t = 3.477$; $p = 0.001$).

GRC had a substantial positive impact on EMA ($\beta = 0.350$; $t = 9.174$; $p = 0.001$). The effect on QSP was not significant ($\beta = 0.074$; $t = 1.257$; $p = 0.145$). The findings indicate that external environmental interactions cannot directly enhance sustainability performance without the support of internal mechanisms. Furthermore, GSC demonstrated a favorable and statistically significant effect on the EMA (β = 0.109; t = 2.646; p = 0.008) and QSP (β = 0.105; t = 2.092; p = 0.036). The environmentally oriented systems, methods, and policies of a company improve environmental management and sustainability performance. Supplementary information is included in Table 8.

Table 8. Hypothesis testing.

Path (Hypothesis)	Original sample (O)	Sample mean (M)	Standard deviation (STDEV)	T statistics (|O/STDEV|)	P values	Result
GHC → QSP (H1a)	0.190	0.190	0.068	4.021	0.000	Supported
GSC → QSP (H1b)	0.104	0.108	0.072	2.092	0.036	Supported
GRC → QSP (H1c)	0.074	0.075	0.085	1.257	0.145	Not Supported
GHC → EMA (H2a)	0.154	0.156	0.064	3.477	0.001	Supported
GSC → EMA (H2b)	0.109	0.110	0.060	2.646	0.008	Supported
GRC → EMA (H2c)	0.350	0.350	0.055	9.174	0.000	Supported
EMA → QSP (H3)	0.221	0.220	0.083	3.853	0.000	Supported
GHC → EMA → QSP (H4a)	0.071	0.071	0.027	2.591	0.010	Supported
GSC → EMA → QSP (H4b)	0.050	0.050	0.023	2.207	0.027	Supported
GRC → EMA → QSP (H4c)	0.111	0.111	0.046	3.474	0.001	Supported
R^2 adjusted EMA = 0.301 R^2 adjusted QSP = 0.276						
Q^2 EMA = 0.290 Q^2 QSP = 0.223.						

Figure 2 illustrates the structural model and coefficient of the research pathway, which shows the relationship between Green Human Capital, Green Structural Capital, and Green Relational Capital to Quintuple Sustainability Performance, either directly or indirectly through Environmental Management Accounting as a mediating variable.

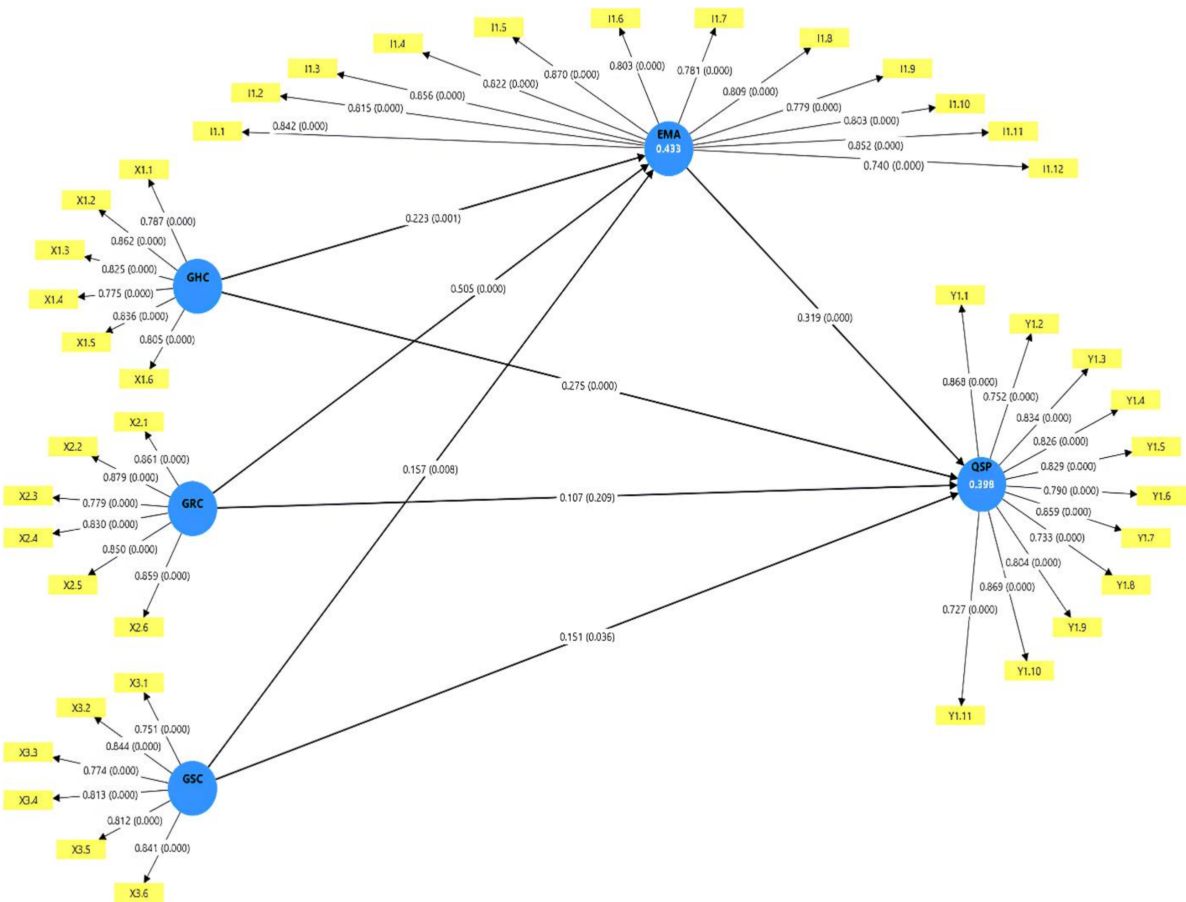

Figure 2. Path coefficient.

3.8. Mediation Analysis

According to the analysis, the EMA value was 0.290, and the QSP value was 0.223 in the second quarter. A value greater than zero in the second quarter indicates that the model is predictive. These results demonstrate that the study model predicts endogenous constructs (Hair et al., 2021).

The EMA found a substantial positive indirect influence of Green Relational Capital on QSP (β = 0.112; t = 3.474; p = 0.001). This implies that Green Relational Capital's impact on sustainability performance functions indirectly via the EMA. The path from Green Structural Capital to QSP through EMA is also statistically significant (β = 0.050; t = 2.207; p = 0.027), which means that EMA is in the middle of this relationship. Table 9 shows more information.

Table 9. Mediation analysis.

Construct	Original sample (O)	Sample mean (M)	Standard deviation (STDEV)	T statistics (|O/STDEV|)	P values
GHC -> EMA -> QSP	0.071	0.071	0.027	2.591	0.010
GRC -> EMA -> QSP	0.111	0.111	0.046	3.474	0.001
GSC -> EMA -> QSP	0.050	0.050	0.023	2.207	0.027

Table 9 shows that the mediation type was identified using the Hair et al. (2021) method of measuring the p-value in direct and indirect effects.

Table 10 demonstrates that Green Human Capital (GHC) exerts a substantial direct and indirect effect on Quintuple Sustainability Performance (QSP), hence suggesting the presence of complementing mediation via Environmental Management Accounting (EMA).

Green Relational Capital (GRC) demonstrates a large indirect effect on QSP via EMA, lacking any notable direct effects, hence showing mediation exclusively through indirect pathways. Furthermore, Green Structural Capital (GSC) exerts a considerable direct and indirect impact on QSP, so it is classified as complementary mediation.

Table 10. Forms of mediation.

Construct	Indirect Effect (p-value)	Direct Effect (p-value)	Types of Mediation
GHC	0.010	0.000	Complementary Mediation (Partial Mediation)
GRC	0.001	0.101	Indirect-only Mediation (Full Mediation)
GSC	0.027	0.036	Complementary Mediation (Partial Mediation)

4. DISCUSSION

The findings indicate that QSP in the hotel sector is influenced by the relationship between green intellectual resources and EMA. EMA helps strategic decision-making and turns intangible resources into measurable sustainability practices (Rehman, Bhatti, Kraus, & Ferreira, 2021). These findings support earlier studies showing internal governance and intangible resources increase multidimensional and context-specific sustainability performance (Bag, 2024; De Sena Silva, Gomes, Filho, & Galina, 2025; Tanveer, Yusliza, Ngah, & Khan, 2023).

GHC positive and large impact on QSP, both directly and through EMA, showing that green human resources' skills, knowledge, and involvement are vital to sustainable performance. EMA helps managers make strategic decisions based on GHC capabilities (Ahmad et al., 2023; Murad & Zou, 2024; Nabi, Liu, & Fahim, 2025). Mediation results showed that GHC contributed more to QSP when EMA integrated environmental information into managers' planning and decision-making. EMA integrates green human resource capabilities with information and decision support systems to improve sustainability performance and quality of strategic decisions (Kochanek, Generowicz, & Zacłona, 2025; Smallman, Milodowski, & Williams, 2022; Tahri, Kaspar, Vacik, & Marusak, 2021). This suggests that individual capabilities can generate optimal sustainability outcomes only when they are orchestrated through organizational mechanisms that strategically structure, integrate, and leverage those capabilities. In line with Resource Orchestration Theory and the NRBV, organizational learning, managerial integration, and dynamic capabilities constitute essential elements in the creation of sustainability value (Ademi, Sætre, & Klungseth, 2024; Alqatan et al., 2025; Andersén, 2023; Bhadra, Kamalanabhan, & Singh, 2024; Westover, 2025).

Research also shows that GRC affects QSP indirectly through EMA. The results show that environment-based external relationships cannot automatically generate sustainability performance if there are no internal systems that can integrate and manage the value of those relationships when making strategic decisions (De Sena Silva et al., 2025; El Mokadem & Khalaf, 2025; Stål, Riumkin, & Bengtsson, 2023). When organizations have an EMA, they can build new relational relationships. EMA can process, measure, and monitor environmental information obtained from interactions with external stakeholders. It lets you combine knowledge, make decisions based on facts, and keep an eye on sustainability (Abdelhalim, Ibrahim, & Alomair, 2023; Bai, Xu, & Jiao, 2022; Cepa & Schildt, 2023; Santos & Carvalho, 2025). Therefore, EMA serves as an internal mechanism that connects resources to sustainability performance. The EMA incorporates environmental information from external sources into organizational performance control and strategic decision-making, enabling effective environmental and cooperation efforts (Appannan, Mohd Said, Ong, & Senik, 2023; Gerged, Zahoor, & Cowton, 2024; Swalih et al., 2024; Zahoor & Gerged, 2021).

The GSC also improved QSP directly and indirectly through EMA. Connecting organizational culture, operational procedures, and strategic decision-making with sustainability goals, environmental management systems, environmental management control systems, and green information systems may improve sustainability performance (Afzal & Lim, 2022; Barani, 2026; Fuzi et al., 2022; Morgan, Fok, & Zee, 2024; Wang, Ismail, & Abas Azmi, 2022). However, when an environmentally oriented organizational structure (Green Structural Capital) is supported by an integrated EMA system, its contributions become more effective. This is because EMA enables organizational systems, procedures, and policies to align with sustainability goals through measurement, control, and strategic decision-making based on environmental information (Huynh & Nguyen, 2024; Suengkamolpisut, Dhar, Elkhwesky, & Sarkar, 2026; Swalih et al., 2024; Tanveer et al., 2023). An organization's structural capabilities may not be properly utilised to promote sustainability without a management system to regulate, coordinate, and integrate them into operational routines and sustainability performance. Therefore, without the integration of EMA into the management control system, these capabilities may fail to translate into actual sustainability outcomes (Liao & Lu, 2025; Seidu, Chan, Edwards, & Owusu-Manu, 2025; Wang et al., 2022).

These findings show that Environmental Management Accounting (EMA) organises, integrates, and applies heterogeneous green intellectual capital to improve sustainability performance. These results corroborate prior studies indicating that the EMA associates green competence with innovation (Andersén, 2023; Asiaei, Jusoh, Barani, & Asiaei, 2022; Gerged et al., 2024; Hoai, Minh, Van, & Nguyen, 2023; Huynh & Nguyen, 2024; Martínez-Falcó, Sánchez-García, Marco-Lajara, & Zaragoza-Sáez, 2025). In the context of Bali's hospitality industry, the EMA is a way to make sure that the organization's sustainability goals are in line with local values. These principles encompass economic, environmental, social, governance, cultural, and spiritual factors. In addition, the EMA supports local stakeholders in designing and evaluating environmental practices as well as in strategic decision-making based on environmental information (Cascadden, Heales, Kingston, Heidak, & Jennings, 2025; Dushkova & Ivlieva, 2024; Swalih et al., 2024).

This study uses Environmental Management Accounting (EMA), which integrates human, structural, and green relational capital into an organisational measurement and decision-making framework, to better understand how green intellectual capital affects Quintuple Sustainability Performance (QSP). The EMA integrates green capabilities into governance, economic, environmental, social, and cultural performance, following the Quadruple–Quintuple Bottom Line concept (Asiaei, Jusoh, et al., 2022; Martínez-Falcó et al., 2025; Seidu et al., 2025). This study found that a sustainability plan's success depends on the organization's ability to organise, integrate, and utilise green resources as meta-capabilities. Resource orchestration and dynamic capabilities support this plan (Andersén, 2023; Chin, Amy, & Ling, 2026; Hu, Xu, & Yang, 2025; Nguyen & Kanbach, 2024).

4.1. Robustness Checks of the Measurement Model

Table 11 shows the results of the Confirmatory Tetrad Analysis (CTA) test. Confidence values (CI low adjusted and CI upper adjusted) for each construct, including QSP, EMA, GHC, and GSC, indicate the lower limit of negative values and upper limits of positive values. This condition indicates that the confidence interval includes a value of zero, so the overall structure is considered reflective.

Table 11. Confirmatory tetrad analysis (CTA).

Construct	CI low adj.	CI up adj.
QSP	-0.020	0.095
EMA	-0.083	0.050
GHC	-0.044	0.098
GRC	-0.063	0.069
GSC	-0.060	0.074

4.2. Robustness Checks of the Structural Model Nonlinear Effects

To assess nonlinear effects, each structural relationship in the model was added with quadratic terms. The p-values for the quadratic effects of GHC on EMA, GRC on EMA, and GSC on EMA exceed the 0.05 significance level.

GSC quadratic influence on QSP is nonlinear and statistically significant (β = 0.083; t = 2.229; p = 0.026), signifying a nonlinear association between these constructs. Nonetheless, since nonlinearity is detected in only a single structural link, the model can be deemed to fulfill the linearity assumption and is thus suitable for subsequent analysis with a linear PLS-SEM methodology.

Table 12 presents the results of the analysis of nonlinear effects that include quadratic relationships between constructs. The results show that most quadratic effects are not significant, except for the statistically significant relationship between Green Structural Capital and Quintuple Sustainability Performance.

Table 12. Nonlinear effects.

Construct	Original sample (O)	Sample mean (M)	Standard deviation (STDEV)	T statistics (|O/STDEV|)	P values
QE (GHC) -> EMA	0.009	0.007	0.053	0.116	0.602
QE (GRC) -> EMA	0.011	0.012	0.044	0.179	0.552
QE (GSC) -> EMA	0.030	0.033	0.052	0.404	0.388
QE (EMA) -> QSP	0.077	0.072	0.066	1.158	0.171
QE (GHC) -> QSP	0.055	0.051	0.055	1.002	0.219
QE (GRC) -> QSP	-0.020	-0.025	0.059	0.240	0.506
QE (GSC) -> QSP	0.082	0.081	0.053	2.229	0.026

4.3. Robustness Checks of the Structural Model Endogeneity

Endogeneity testing is performed to ensure that the structural relationships in the model are not affected by correlations between exogenous latent variables and term errors, which can lead to distortions in parameter estimation. Referring to the recommendations of Hair et al. (2021), endogeneity in PLS-SEM was tested using the Gaussian Copula approach by including the quadratic effects of each latent construct. The p-values in Table 13 show that the quadratic effects of GHC, GRC, and GSC on the EMA as well as on the QSP are not significant. These findings indicate that most of the Gaussian copula pathways do not show statistical significance.

The quadratic effect of GSC on QSP showed statistical significance (β = 0.098; t = 2.763; p = 0.006), but these results did not indicate systematic endogeneity. There is no consistent pattern in other structural relationships. Thus, it can be concluded that the structural model in this study is generally free from endogeneity bias, so that the relationships between the estimated constructs can be interpreted with a high degree of confidence.

Table 13. Endogeneity testing.

Construct	Original sample (O)	Sample mean (M)	Standard deviation (STDEV)	T statistics (|O/STDEV|)	P values
QE (GHC) -> EMA	0.016	0.016	0.050	0.219	0.522
QE (GRC) -> EMA	0.012	0.012	0.042	0.202	0.535
QE (GSC) -> EMA	0.032	0.035	0.051	0.443	0.363
QE (EMA) -> QSP	0.071	0.069	0.066	1.562	0.081
QE (GHC) -> QSP	0.090	0.088	0.057	1.572	0.080
QE (GRC) -> QSP	0.004	-0.002	0.056	0.067	0.656
QE (GSC) -> QSP	0.097	0.095	0.051	2.763	0.006

5. CONCLUSION

In Bali's hospitality industry, Environmental Management Accounting (EMA) mediates the relationship between Green Intellectual Capital and Quintuple Sustainability Performance (QSP). The findings indicate that EMA converts green intellectual capital into multidimensional sustainability performance and directly influences QSP.

The study found that Green Relational Capital does not directly affect QSP, while Green Human and Structural Capital do. Additionally, EMA indirectly affects QSP across the entire Green Intellectual Capital dimension. EMA fully mediates Green Relational Capital and QSP and partially mediates Green Human and Structural Capital.

Green intellectual capital and systematic Environmental Management Accounting approaches enhance sustainability performance, according to this study. It indicates that hotel management must improve Environmental Management Accounting (EMA) and synchronize Green Human Capital and Green Structural Capital investments. Policymakers should also provide regulatory support and training to promote local values-based EMAs like Tri Hita Karana, ensuring their sustainability and longevity.

Funding: This research received no external funding.
Institutional Review Board Statement: This study was approved by the Health Research Ethics Commission (KEPK), Faculty of Medicine and Health Sciences, Warmadewa University, Indonesia (Approval No.: 037/Unwar/FKIK/EC-KEPK/III; Protocol No.: 822). Informed consent was obtained from all respondents prior to data collection, and all data were anonymized to ensure participant confidentiality.
Transparency: The authors state that the manuscript is honest, truthful, and transparent, that no key aspects of the investigation have been omitted, and that any differences from the study as planned have been clarified. This study followed all writing ethics.
Competing Interests: The authors declare that they have no competing interests.
Authors' Contributions: All authors contributed equally to the conception and design of the study. All authors have read and agreed to the published version of the manuscript.
Disclosure of AI Use: The authors used OpenAI's ChatGPT to improve the manuscript's readability, language editing, and paraphrasing. The authors carefully reviewed and verified all outputs to ensure academic integrity.

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Appendix.

The Appendix presents the measurement items used in this study for each construct, including Environmental Management Accounting, the Green Intellectual Capital dimension, and the Quintuple Sustainability Performance. The items are adapted from previous research and adapted to the context of the hospitality industry.

Table A1 presents the measurement indicators for each construct, including Environmental Management Accounting, Green Human Capital, Green Structural Capital, Green Relational Capital, and Quintuple Sustainability Performance, along with their loading values, reliability, and validity test results.

Table A1. Scale items.

Constructs	Item	Measurement	Reference
QSP	QSP1	Our hotels generate a profit contribution from waste management as part of sustainability practices.	Asadi et al. (2020); Fatoki (2019); Saputra et al. (2022), and Werastuti, Sitawati, Rinandiyana, and Badriatin (2024)
	QSP2	Our hotels maintain operational stability through efficient, sustainable operations.	
	QSP3	Our hotels support local businesses, specialty foods, and communities around the hotels.	
	QSP4	Our hotel maintains strong relationships among management, employees, and guests.	

Constructs	Item	Measurement	Reference
	QSP5	Our hotel governance system is long-term oriented by involving the community around the hotel as stakeholders.	
	QSP6	Our hotel's strategic decisions are guided by sustainability principles rooted in local wisdom.	
	QSP7	Our hotel implements environmental management that is in harmony with the surrounding nature.	
	QSP8	Our hotel uses natural resources wisely in our daily activities.	
	QSP9	Our hotel sorts organic and inorganic waste.	
	QSP10	Our hotel integrates local cultural values into its internal services and activities to preserve local culture.	
	QSP11	Our hotel serves as a sanctuary within a spiritual tradition.	
EMA	EMA1	Our hotel identifies operational costs related to environmental activities.	Asiaei, Bontis, Alizadeh, and Yaghoubi (2022)
	EMA2	Our hotels classify costs arising from environmental activities.	
	EMA3	Our hotel has a special charge account for environmental activities.	
	EMA4	Our hotel estimates environmental liability due to sanctions from the authorities.	
	EMA5	Our hotel allocates environmental costs to the operational service process.	
	EMA6	Our hotels allocate environmental costs to the products provided to guests.	
	EMA7	Our hotel is improving its environmental cost management system.	
	EMA8	Our hotels use performance indicators to monitor environmental management.	
	EMA9	Our hotels assess costs based on the service lifecycle that affects the environment.	
	EMA10	Our hotel analyzes Material usage, energy consumption, and waste volume.	
	EMA11	Our hotel assesses the environmental impact of the available product designs.	
	EMA12	Our hotels identify opportunities to improve services and reduce environmental impact.	
GHC	GHC1	We have better hotels in terms of efficiency and employee contribution to the environment.	Asiaei et al. (2022)
	GHC2	When it comes to environmental protection, our employees are more proficient than our main competitors.	
	GHC3	The environmentally friendly goods and services that our hotel staff offers are superior to those of our primary rivals.	
	GHC4	When it comes to environmental protection, we have a higher level of teamwork than our main competitors.	
	GHC5	In order to achieve the goal of environmental protection, our hotel management fully supports our employees.	
	GHC6	The manager ensures the achievement of the hotel's environmental goals.	
GRC	GRC1	Our hotel designs products according to guests' preferences regarding environmental issues.	Asiaei et al. (2022)
	GRC2	The hotel's services reflect its commitment to customer demands for sustainability.	
	GRC3	Hotels establish sustainable environmental protection cooperation with major suppliers.	

Constructs	Item	Measurement	Reference
	GRC4	The hotel maintains a stable relationship with its guests regarding environmental protection.	
	GRC5	Hotels are committed to building strategic partnerships for environmental protection.	
	GRC6	Hotels maintain the trust of strategic partners through commitment to eco-friendly practices.	
GSC	GSC1	The environmental management system at our hotel is superior to that of our primary rivals.	Asiaei et al. (2022)
	GSC2	Hotels have a greater environmental advantage than their main competitors.	
	GSC3	We have a larger investment ratio in environmental protection development than our significant competitors.	
	GSC4	We have more innovations for environmental protection than our significant competitors.	
	GSC5	We have made more efforts to protect the environment in our hotels than our main competitors.	
	GSC6	Our hotel's environmental knowledge management system adds to our environmental management knowledge.	

Note: QSP = Quintuple Sustainability Performance, EMA = Environmental Management Accounting, GHC = Green Human Capital, GRC = Green Relational Capital, GSC = Green Structural Capital.