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Cocoa producer's sustainability practices assess impact. A PLS-SEM application

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Abstract

In recent years, sustainability has emerged as a crucial element in organizational planning and management, particularly within the context of micro and small enterprises (MSEs). This study aims to analyze the impact of sustainable practices on the market performance of cocoa-producing MSEs in Peru, employing the partial least squares structural equation modeling (PLS-SEM) approach. The results show that the adoption of sustainable practices exerts a positive and significant effect on the market performance of these companies. Furthermore, the ReSOLVE framework was proposed as a guide for analyzed companies to adopt such practices, highlighting benefits not only in environmental terms but also in enhancing competitiveness and success in international markets. These findings seek to encourage MSEs to integrate sustainability into their management strategies, thereby improving their position in an increasingly demanding global environment.

Keywords: Supply Chain, Sustainable practices, Market performance, PLS-SEM

Introduction

In recent years, sustainability has become a key topic in organizational planning and management, as well as in supply chains (Rodriguez, 2018). This growing emphasis responds to the increasing recognition that unsustainable economic growth trajectories jeopardize future development and human well-being worldwide (WTO, 2018). In Latin America, these challenges are reflected in unsustainable consumption and production patterns that accelerate environmental degradation, biodiversity loss, and climate change, ultimately limiting long-term economic growth opportunities (De Miguel & Sánchez, 2023). Against this backdrop, organizations seeking to compete in globalized markets developing competitive capabilities and implementing environmental strategies that enable them to comply with the stringent sustainability standards of demanding markets such as the European Union and the United States (Alvarez et al., 2021).

At the macro level, competitiveness and environmental sustainability are neither mutually exclusive nor conflicting goals (Kámiche, 2024). Global metrics such as the World Competitiveness Ranking (WCR) and the Environmental Performance Index (EPI) demonstrate that highly competitive economies consistently exhibit strong environmental performance (IMD, 2024; Yale University, 2024). This positive correlation underscores that environmental sustainability can actively enhance firm and national competitiveness, shifting away from historical models favored by lax regulations.

In this context, the transition toward sustainable and circular economic models requires coordinated action across local, national, regional, and global levels, supported by cooperation among multiple stakeholders to preserve natural resources and ecosystem services (McKinsey & Company, 2016). This transformation is particularly relevant in sectors such as agro-exports, where international regulations and environmental policies increasingly pressure firms to adopt more sustainable supply chains. Nevertheless, measuring the effects of sustainable practices on business performance remains a major challenge, as few studies have evaluated how sustainability-oriented actions and reporting influence financial outcomes (Correa & Hernández, 2017).

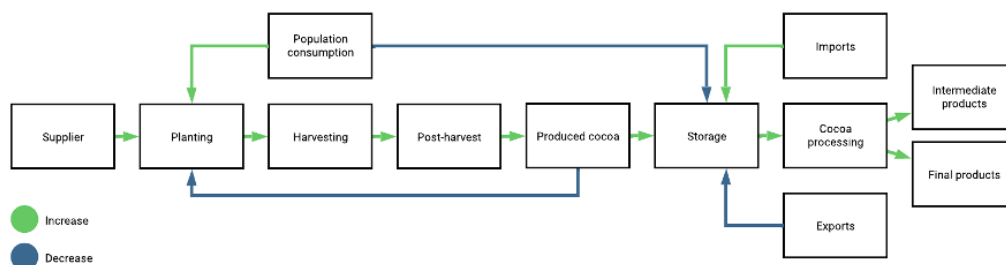
In this sense, this study focuses on micro and small enterprises (MSEs) in the Peruvian cocoa supply chain. MSEs are pivotal to Peru's economy, representing 99.20% of formal enterprises and driving significant employment and national production (Ministerio de la Producción [PRODUCE], 2024). However, as integral links in global supply chains, these businesses face mounting pressure to adopt green practices driven by large buyers, state resources, and stringent international regulations (WCED, 1987). For instance, the European Union Deforestation Regulation (EUDR) requires raw materials to be strictly deforestation-free (European Commission, 2023). While this represents a compliance burden for producers, it simultaneously offers a strategic opportunity to access premium markets. Consequently, the primary objective of this study is to evaluate and quantify the impact of sustainable practices on the market performance of cocoa-producing MSEs in Peru. Therefore, this study seeks not only to assess and quantify the relationship between sustainable practices and market performance, but also to provide empirical evidence that adopting environmentally responsible strategies represents a sound business decision.

Literature Review

Agricultural Supply Chains

Perishable supply chains require efficient information management and stakeholder collaboration to mitigate risks and protect product shelf life. The cocoa supply chain begins with the production stage (planting, harvesting, and collection), continues with collection (intermediation) and processing, and concludes with marketing or distribution (Ministerio de Desarrollo Agrario y Riego [MIDAGRI], 2024). Cocoa industrial processing spans three critical links: primary production (where essential product characteristics develop), transformation (ensuring measurement accuracy and quality), and industrial marketing (controlling raw material batches for optimal processing) (Armuelles & Peñalba, 2023). Figure 1 shows a theoretical model of the cocoa supply chain.

Figure 1: Model of the cocoa supply chain.



Note. Adapted from Armuelles and Peñalba (2023).

Speech Analytics

Echeverry (2016) highlights that the increase in the volume of information services has prompted interest in data processing. Given the vast amount of information available, it is not feasible for humans to manage all this information manually. Automated text processing techniques, such as Speech Analytics, provide an effective solution to information overload. These techniques facilitate the exploration of large text volumes, their classification into categories, their routing to specific destinations, and even the generation of summaries.

Structural Equation Modeling with Partial Least Squares (PLS-SEM)

Structural Equation Modeling (SEM) is a statistical technique used to test hypotheses and analyze theoretical relationships associated with a specific phenomenon (Alvarez & Dicoyskiy, 2022). This technique allows researchers to assess complex interdependent relationships among variables while simultaneously accounting for measurement error in the structural coefficients (Cupani, 2012).

SEM includes two primary approaches: covariance-based (CB-SEM) and partial least squares (PLS-SEM). While CB-SEM focuses on parameter estimation to validate established theories under strict multivariate normality and large sample assumptions, PLS-SEM is geared toward prediction and exploration (Hair et al., 2021; Henseler et al., 2015). PLS-SEM handles smaller sample sizes, non-normal data patterns, and complex models with formative latent variables effectively, whereas CB-SEM is restricted to reflective specifications (Martínez & Fierro, 2018; Valencia & Restrepo, 2016).

Partial Least Squares (PLS) aims to reduce latent variables by applying Ordinary Least Squares (OLS) estimation and Principal Component Analysis (PCA) (Cepeda-Carrión & Roldán Salgueiro, 2004). PLS-SEM maximizes the explained variance of endogenous variables (Varian, 2014), making it an effective tool to identify factors that significantly influence the behavior of these variables (López-Bonilla & Bonilla, 2006). Moreover, PLS-SEM has been widely applied across economics, business, and education to model complex causal relationships in exploratory research, including agricultural competitiveness, ecotourism loyalty, and digital competencies (Cabero et al., 2022; Florensa et al., 2020; Valencia, 2018).

Research Methodology

Conceptualization and relationship of constructs

This study evaluates two core constructs: sustainable practices and market performance. Sustainable agricultural practices entail efficient resource use, environmental impact reduction, and climate resilience, promoting food safety and farmer well-being (FAO, 2007) through strategies like crop rotation, cover crops, and integrated pest management. Market performance denotes a firm's capacity to meet financial objectives, address market demands, and maintain competitiveness via innovation and adaptation (De la Hoz et al., 2008; Robayo, 2016). Prior literature establishes a positive link between these constructs, demonstrating that sustainability-oriented policies drive long-term financial outcomes, competitiveness, and resilience in small and medium enterprises (Eccles et al., 2014; Genovese et al., 2021).

Preliminary study: Speech analytics

First, a preliminary study was conducted using the Speech Analytics technique. To this end, a database was created with approximately 228 comments on cocoa production and export in Peru, collected from the Facebook posts of the Ministerio de Comercio Exterior y Turismo (MINCETUR). Subsequently, Speech Analytics was applied to identify relevant information by detecting recurring topics and keywords.

This preliminary stage was integrated into the research design as an exploratory input for construct development. The comments were grouped according to recurring keywords and themes, mainly related to value addition, fair pricing, technology, training, and cocoa quality. These findings were contrasted with the theoretical framework to support the contextual relevance of the constructs and indicators presented in Table 1, particularly those associated with quality improvement, buyer appreciation, international market access and perceived cocoa value.

Population and sample

The study population consisted of cocoa producers in Peru. According to MIDAGRI (2024), the country has approximately 90,000 cocoa producers distributed across 16 regions, with the highest concentration in San Martín, Junín, Ucayali, Huánuco, and Cuzco. Given the exploratory nature of the study and the difficulty of accessing a complete sampling frame of cocoa-producing MSEs, a non-probabilistic purposive sampling strategy was applied. Purposive sampling is appropriate when participants are deliberately selected because they possess specific characteristics, experience, or knowledge relevant to the research phenomenon (Etikan et al., 2016). In this study, participants were selected based on three criteria: (a) belonging to a cocoa producer cooperative or association, (b) being classified as micro or small entrepreneurs according to the number of employees, and (c) having more than five years of experience in cocoa production. These criteria were used to ensure that respondents were information-rich cases with direct knowledge of sustainable practices and market-related outcomes in the cocoa supply chain. Therefore, the sample should not be interpreted as statistically representative of the entire population of Peruvian cocoa producers, but as analytically relevant for examining the proposed relationships within the selected group of experienced cocoa-producing MSEs.

Regarding sample size, PLS-SEM was considered suitable because it is commonly used in exploratory and predictive research, particularly when models include complex relationships, formative constructs, or relatively small samples (Hair et al., 2021). Following Hair et al. (2021), a minimum of 25 observations can be acceptable under a significance level of 5% and an expected minimum path coefficient of 0.5. Accordingly, the final sample of 30 cocoa producers meets the minimum methodological requirement for estimating the proposed PLS-SEM model. However, the sample size remains limited in relation to the target population; therefore, the findings should be interpreted as preliminary empirical evidence rather than as generalizable conclusions for all cocoa producers in Peru.

Data collection and processing

The questionnaire was structured with 17 closed-ended questions, utilizing a five-point Likert scale ranging from 1 to 5, where 1 corresponds to “Strongly Disagree” and 5 to “Strongly Agree”. It is important to emphasize that the development of the measurement instrument was grounded in a robust theoretical framework. In addition, clear and concise questions were formulated to prevent respondents from feeling overwhelmed by an excess of questions, thereby facilitating their interpretation.

For data collection, a digital questionnaire was distributed through Google Forms, aimed at the primary cooperatives and associations of cocoa producers and exporters in Peru, affiliated with the Asociación Peruana de Productores de Cacao (APPCACAO). These organizations were tasked with distributing questionnaires among cocoa producers. The form ensured the confidentiality of the responses.

Given that the study relied on self-reported survey data collected from a single group of respondents, potential common method bias and respondent bias were considered. Common method bias may arise when part of the observed covariance among variables is attributable to the measurement method rather than to the theoretical constructs themselves (Podsakoff et al., 2003). In this study, this risk was partially mitigated through procedural remedies, including the use of clear and concise questions, a theoretically grounded

measurement instrument, and the assurance of confidentiality to reduce evaluation apprehension and socially desirable responses. Nevertheless, because both sustainable practices and market performance were measured using the same survey instrument, common method bias cannot be completely ruled out. Therefore, the results should be interpreted with caution, and future studies should complement survey data with objective indicators, such as export volumes, sales growth, certification records, productivity measures, or third-party assessments of sustainability practices.

The questionnaire was structured into two blocks of closed-ended items measured on a five-point Likert scale, where 1 corresponded to “Strongly disagree” and 5 to “Strongly agree”. The first block measured sustainable practices through items related to integrated pest management, responsible water use, soil conservation, waste reduction and recycling, reuse of materials and equipment, renewable energy use, investment in sustainable technologies, and participation in sustainability certification or training programs. In addition, a global item asked respondents whether they considered that they applied sustainable practices in the cocoa production process; this item was used as an alternative global measure for the redundancy analysis of the formative construct. The second block measured market performance through items referring to perceived improvements in production efficiency, cocoa quality, buyer appreciation, demand, revenue, the impact of waste reduction, access to international markets, and increased trust and value of cocoa in the market. The item wording followed survey design recommendations by using direct, specific, and concise statements to reduce respondent burden and improve interpretability (DeVellis, 2017; Dillman et al., 2014). To analyze the relationship between sustainable practices and the market performance of cocoa-producing MSEs in Peru, the PLS-SEM technique was used. This methodology was chosen because it allows the estimation of complex relationships among latent constructs and supports the assessment of both formative and reflective measurement models (Hair et al., 2021). Accordingly, Table 1 summarizes the variables, constructs, and indicators used in the study, while the questionnaire operationalized these indicators through Likert-scale statements aligned with each construct.

Table 1: Variables, constructs, and indicators of the study

Variable	Constructs	Indicator	Questionnaire Item
Independent variable	ξ_1 : Sustainable practice	x11: Integrated pest management	Have you implemented integrated pest management (IPM) techniques in your crops?
		x12: Responsible water use	Do you practice responsible and efficient water resource management in your production?
		x13: Soil conservation	Do you execute specific soil conservation practices to prevent degradation?
		x14: Waste reduction/recycling	Have you actively applied waste reduction and recycling actions in your processes?
		x15: Materials/equipment reuse	Do you reuse agricultural materials and equipment whenever possible?
		x16: Renewable energy use	Do you utilize renewable energy sources within your production process?
		x17: Sustainable tech investment	Have you invested financial resources into sustainability-oriented technologies?
		x18: Training program participation	Do you continuously participate in sustainability certifications or training programs?
Dependent variable	ξ_2 : Market performance	x21: Production efficiency	Have sustainable practices improved your overall production efficiency?

Variable	Constructs	Indicator	Questionnaire Item
		x22: Cocoa quality improvement	Has the quality of your cocoa significantly improved due to green practices?
		x23: Buyer appreciation	Do your buyers express greater appreciation and preference for your sustainable cocoa?
		x24: Demand increase	Has market demand for your cocoa increased in recent periods?
		x25: Revenue increase	Have your total revenues grown because of your sustainability positioning?
		x26: Waste reduction impact	Have waste reduction efforts had a positive impact on your economic results?
		x27: Int. market access	Has sustainability compliance granted you better access to international markets?
		x28: Cocoa trust/value increase	Have the market trust and overall perceived value of your cocoa increased?

Model Construction

The estimated structural model, presented in Figure 2, facilitates visualization and analysis of how indicators influence constructs and how these constructs subsequently affect one another. Using the PLS-SEM technique, direct relationships between constructs and potential indirect effects are effectively captured. Regression coefficients (β_{ij}) and indicator weights (ω_{ij}) provide precise evaluations of the strength and direction of these relationships, while error terms (ϵ_i and ϵ_{ij}) highlight unexplained variability, emphasizing the complexity of the analysis and the necessity to consider additional factors (Hair et al., 2021). It is crucial to recognize that in the formative model (ξ_1), indicators exert a direct influence on the construct and are not linked to error terms in the same way as in the reflective model (ξ_2).

The construct “sustainable practices” was modeled using a formative approach, while the construct “market performance” was modeled with a reflective approach. This choice was based on the theoretical nature of each construct. “Sustainable practices”, being composed of various indicators that contribute to the construct, require a formative measurement model. In contrast, “market performance”, being a concept reflected by variables such as “sustainable practices”, is better suited to a reflective measurement model.

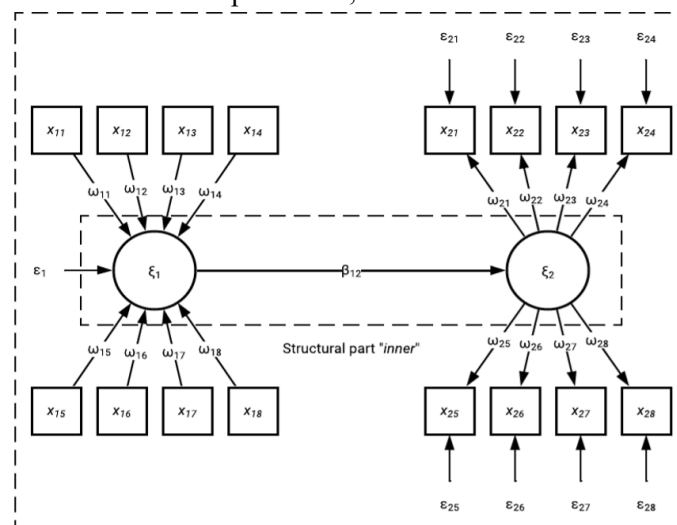


Figure 2: Estimable structural model using PLS-SEM

- ξ_i are the latent (or hidden) variables of the model, also referred to as “construct”.
- x_{ij} are the explanatory (or observable) variables of the model.
- ω_{ij} are the weights of the indicators in the model.
- β_{ij} are the regression coefficients in the model.
- ε_i are the error terms associated with the latent variables in the formative model.
- ε_{ij} are the error terms associated with the explanatory variables in the reflective model

Preliminary Study: Speech Analytics

- 1) Value addition: there is an increasing demand to add value to cocoa before export to improve the competitiveness of Peruvian MSEs in the international market. Value addition could involve processes such as origin certification, quality improvement, and diversification into products derived from cocoa, such as premium chocolates.
- 2) Fair pricing: the comments revealed widespread concern about securing fair prices for the cocoa sold by farmers. The need to establish mechanisms that ensure appropriate payment is highlighted, reflecting concerns about equity in the supply chain.
- 3) Investment in technology and training: the importance of investing in technology and training to improve agricultural practices and cocoa quality was emphasized. Participants acknowledge that modernization and ongoing education are essential to increase productivity and quality, thus strengthening MSE's positions in more demanding markets.

[illegible]

Figure 3: Word cloud of stakeholder perceptions on peruvian cocoa exports

PLS-SEM Model

Evaluation of the reflective measurement model

The reflective measurement model was first evaluated using indicator reliability thresholds. According to Hair et al. (2021), factor loadings must exceed 0.708 to ensure the construct accounts for over 50% of the indicator's variance. Initial estimations revealed that indicators x_{21} (0.476), x_{22} (0.378), x_{23} (0.366), x_{24} (-0.026), and x_{25} (0.353) fell below this threshold. Consequently, these five variables were removed to optimize the model's reliability. A second model confirmed that the retained indicators continued to exceed the required threshold, therefore, validating the reliability of the retained indicators.

The internal consistency reliability of the reflective model was also evaluated. According to Hair et al. (2021), in the context of exploratory research, the Cronbach's Alpha, rhoC, and rhoA measures should exceed the threshold of 0.600 to ensure the association among the indicators measuring the construct. The evaluation shows that the "market performance" construct exceeds the threshold, producing a Cronbach's Alpha of 0.884, a rhoC of 0.929, and a rhoA of 0.900. Thus, this result validates the internal consistency reliability of the reflective model.

Subsequently, convergent validity and discriminant validity were assessed in the model. Convergent validity refers to the extent to which a construct explains the variance of its indicators and was evaluated using the Average Variance Extracted (AVE). Following Hair et al. (2021), AVE values should be equal to or greater than 0.500; in this study, the AVE for "market performance" was 0.813, supporting convergent validity. Discriminant validity, in turn, assesses whether a construct is empirically distinct from other constructs in the structural model. For this purpose, the heterotrait–monotrait ratio of correlations (HTMT) was examined, since it is considered a sensitive criterion for detecting discriminant validity problems in variance-based structural equation modeling (Henseler et al., 2015). The HTMT inference test evaluates whether the 95% bootstrap confidence interval includes the value of 1.000; if it does, discriminant validity cannot be conclusively established (Henseler et al., 2015; Hair et al., 2021). As shown in Table 2, the HTMT value between "sustainable practices" and "market performance" was 0.962, with a 95% confidence interval ranging from 0.772 to 1.055. This result exceeds the commonly recommended thresholds of 0.850 or 0.900 and, because the confidence interval includes 1.000, suggests a potential discriminant validity concern. Nevertheless, this high association is theoretically plausible because the study assumes that sustainable practices are closely linked to market performance outcomes. Under international frameworks like the European Union Deforestation Regulation (EUDR), environmental compliance is no longer an optional social responsibility practice; rather, it functions as a mandatory entry barrier and a direct prerequisite for international commercial viability. Consequently, for small-scale producers, adopting sustainable practices is inherently fused with securing market trust, quality appreciation, and export performance. Therefore, the findings should be interpreted with caution: although the constructs are conceptually distinguishable, the empirical evidence indicates substantial overlap between them.

Table 2: Bootstrap results report for the reflective model

Dimension	Original estimate	Bootstrap mean	Bootstrap SD	t statistic	CI (2.5%)	CI (97.5%)
$\xi_1 \rightarrow \xi_2$	0.962	0.939	0.073	13.269	0.772	1.055

Evaluation of the formative measurement model

In this section, the relevance of the formative indicators was assessed using the percentile method through a bootstrap results report (Hair et al., 2021). The null hypothesis assumes that a specific parameter, such as the indicator weight, is equal to zero; if the confidence interval includes zero, the effect is not significant. Table 3 presents the relative importance of all initial indicators. Upon observing the significance levels, only indicator x18 was found to be significant.

Table 3: Bootstrap results report to evaluate the relative importance of the formative measurement model

Dimension	Original estimate	Bootstrap mean	Bootstrap SD	t statistic	CI (2.5%)	CI (97.5%)
x ₁₁ → ξ_1	-0.180	-0.175	0.181	-0.993	-0.530	0.141
x ₁₂ → ξ_1	-0.039	-0.055	0.143	-0.276	-0.346	0.219
x ₁₃ → ξ_1	0.002	-0.016	0.120	0.021	-0.255	0.219
x ₁₄ → ξ_1	0.186	0.215	0.148	1.261	-0.052	0.517
x ₁₅ → ξ_1	0.248	0.230	0.176	1.407	-0.084	0.647
x ₁₆ → ξ_1	0.081	0.074	0.172	0.472	-0.223	0.457
x ₁₇ → ξ_1	-0.026	-0.025	0.116	-0.226	-0.244	0.221
x ₁₈ → ξ_1	0.815	0.786	0.182	4.484	0.419	1.119

According to Hair et al. (2021), the criterion for eliminating non-significant indicators requires a subsequent evaluation of their absolute importance. As shown in Table 4, this second evaluation revealed that indicators x₁₃, x₁₄ and x₁₅ were indeed significant. Consequently, variables x₁₁, x₁₂, x₁₆, and x₁₇ were eliminated, while the remaining variables were retained in the model.

Table 4: Bootstrap results report to evaluate the absolute importance of the formative measurement model

Dimension	Original estimate	Bootstrap mean	Bootstrap SD	t statistic	CI (2.5%)	CI (97.5%)
x ₁₁ → ξ_1	0.106	0.114	0.308	0.345	-0.432	0.799
x ₁₂ → ξ_1	0.360	0.290	0.333	1.080	-0.416	0.837
x ₁₃ → ξ_1	0.621	0.583	0.177	3.517	0.153	0.827
x ₁₄ → ξ_1	0.678	0.655	0.156	4.351	0.302	0.893
x ₁₅ → ξ_1	0.604	0.574	0.170	3.544	0.175	0.838
x ₁₆ → ξ_1	0.264	0.244	0.271	0.974	-0.287	0.736
x ₁₇ → ξ_1	-0.168	-0.160	0.185	-0.907	-0.471	0.240
x ₁₈ → ξ_1	0.895	0.866	0.101	8.846	0.601	0.981

The formative measurement model was further assessed by examining convergent validity and collinearity. Convergent validity was established by correlating the formative construct with an alternative reflective measure of the same concept, yielding a coefficient of 0.737, which exceeds the recommended threshold of 0.708 (Hair et al., 2021). Additionally, collinearity among the retained indicators was evaluated using the Variance Inflation Factor (VIF). The calculated VIF values were 1.651 for x_{13} , 1.724 for x_{14} , 1.312 for x_{15} , and 1.381 for x_{18} . Since all values remain well below the threshold (<5), it is concluded that there are no collinearity issues within the formative measurement model.

Evaluation of the structural model

After completing the assessments of the measurement models to determine the validity and reliability of the constructs, the structural model was evaluated for potential collinearity issues using the VIF (Hair et al., 2021). The calculated VIF values for the indicators were 1.651 (x_{13}), 1.724 (x_{14}), 1.312 (x_{15}), 1.381 (x_{18}), 2.592 (x_{26}), 2.453 (x_{27}), and 4.053 (x_{28}). Since all values fall below the threshold of 5, it is concluded that there are no multicollinearity problems within the structural model. These relationships are further visualized in the correlation matrix presented in Figure 4.

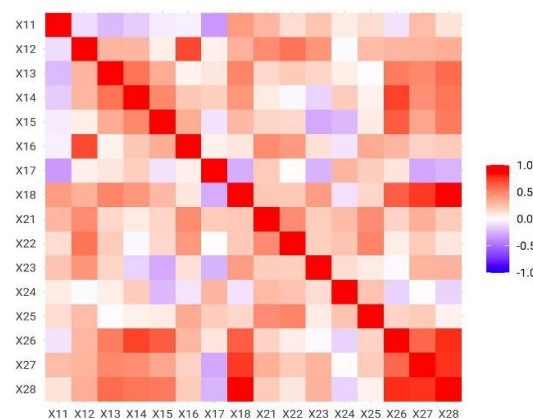


Figure 4: Correlation matrix

Next, the model's explanatory and predictive capabilities were assessed. The explanatory power was evaluated through the Coefficient of Determination (R^2) for the endogenous construct, "market performance". The model yielded an R^2 of 0.870 (adjusted $R^2 = 0.865$), indicating that the model explains 87% of the variance in market performance. According to Hair et al. (2021), values above 0.75 represent a substantial explanatory effect. Furthermore, predictive power and effect size were measured using the f^2 metric. The f^2 value for the relationship between "sustainable practices" and "market performance" was 6.685, demonstrating a considerable and highly significant effect of the exogenous construct on the endogenous one.

Based on the above, it can be concluded that the structural model is robust and reliable with respect to the evaluated relationship between the constructs. Finally, the structural model was estimated to test the proposed hypothesis regarding the relationship between the constructs:

- H_0 : The exogenous latent construct or variable does not have a direct and significant effect on the endogenous latent variable.
- H_1 : The exogenous latent construct or variable has a direct and significant effect on the endogenous latent variable.

To evaluate the importance and relevance of this relationship, path coefficients and confidence intervals were calculated using the percentile method via a Bootstrap results report (Hair et al., 2021). As shown in Table 5, the original estimate ($\beta = 0.933$) indicates a strong positive influence. The high statistical significance of the "t" statistic (27.351), combined with a 95% confidence interval [0.854, 0.977] that does not include zero, allows for the rejection of the null hypothesis. Therefore, the structural model is robust and confirms that the adoption of sustainable practices significantly enhances the market performance of cocoa-producing MSEs.

Table 5: Estimation of the structural model

Dimension	Original estimate	Bootstrap mean	Bootstrap SD	t statistic	CI (2.5%)	CI (97.5%)
$\xi_1 \rightarrow \xi_2$	0.933	0.937	0.034	27.351	0.854	0.977

Discussion and Implications

This study evaluated the impact of sustainable practices on the market performance of cocoa-producing micro and small enterprises (MSEs) in Peru. The preliminary qualitative analysis, conducted via Speech Analytics, revealed a widespread consensus among stakeholders regarding the critical need to increase value addition, ensure fair pricing, and invest in technology to improve the competitiveness of Peruvian MSEs in international markets. These qualitative insights are robustly corroborated by the main empirical findings obtained through the PLS-SEM methodology. The structural model demonstrated a positive and highly significant relationship between the "sustainable practices" and "market performance" constructs. In other words, the implementation of sustainability-oriented actions directly and positively enhances the market outcomes of cocoa MSEs. These findings theoretically reinforce the premise that environmental sustainability and competitiveness are not conflicting goals; rather, adopting an environmentally responsible approach constitutes a strategically sound decision that yields tangible market benefits.

These results align with previous literature, such as Eccles et al. (2014) and Genovese et al. (2021), who argue that integrating corporate social responsibility and environmental policies yields long-term financial and competitive advantages. However, this study extends that premise by empirically quantifying this impact specifically within the context of agricultural MSEs in emerging economies, a sector often constrained by limited resources.

Practical Implications

Based on these findings, the adoption of comprehensive strategies for sustainable cocoa supply chain management is strongly recommended. The transition toward a circular economy, where resources are kept in use for as long as possible to extract their maximum value (WRAP, 2018) is critical. To establish this foundation, coordinated action across all sectors is necessary (McKinsey & Company, 2016). In this context, the ReSOLVE framework (Regenerate, Share, Optimize, Loop, Virtualize, Exchange) developed by the Ellen MacArthur Foundation offers a highly applicable roadmap for governments and businesses (Finamore & Oltean-Dumbrava, 2024). Furthermore, this approach aligns with other comprehensive models, such as the 9R framework (Potting et al., 2017), which systematically explores circularity levels to prevent waste generation and create deeper potential value (Hunger et al., 2024).

For the Peruvian public and private sectors, these frameworks must be translated into actionable policies. MINCETUR (2023) has already recommended specific circularity strategies for the cocoa sector, such as

composting harvest residues, utilizing solar drying chambers, and implementing sustainable agroforestry systems. To scale these efforts effectively, it is crucial to review and update the objectives outlined in the National Strategic Export Plan (PENX) and the Regional Strategic Export Plan (PERX). Incorporating circular frameworks like ReSOLVE into these policy documents will provide robust guidelines and support tools for institutional capacity building, explicitly establishing sustainability as a core pillar. This policy shift will guide exporting MSEs toward more sustainable development and responsible internationalization (MINCETUR, 2023).

Limitations and Future Research Directions

While this study provides valuable insights, several limitations should be acknowledged. First, the sample size ($n = 30$) is small compared with the total population of Peruvian cocoa producers, and the use of non-probabilistic purposive sampling limits the statistical generalizability of the findings. Although the selected participants met predefined criteria that ensured their relevance to the research objective, the results should be interpreted as analytical and exploratory evidence rather than as representative estimates for the entire sector. Second, the cross-sectional design captures the relationship between sustainable practices and market performance at a specific point in time, which limits the ability to establish causal effects over time. Third, because the study relied on self-reported survey data from the same respondents, the findings may be affected by common method bias, social desirability bias, recall bias, or subjective perceptions of business performance. Although procedural measures such as confidentiality, concise wording, and theoretically grounded items were used to reduce these risks, they cannot fully eliminate them (Podsakoff et al., 2003; Fuller et al., 2016). Fourth, while PLS-SEM is suitable for exploratory research with small samples and models involving formative constructs, future studies should expand the sample size, include producers from a broader range of cocoa-producing regions, and apply probabilistic or stratified sampling techniques to improve external validity and strengthen the robustness of the conclusions. Future research should also triangulate survey responses with objective performance indicators, such as export volumes, sales growth, certification records, productivity measures, or third-party assessments of sustainability practices.

Conclusions

In conclusion, this research demonstrates that for Peruvian cocoa MSEs, environmental responsibility represents a strategic business decision. The transition toward circular economy models, supported by frameworks such as ReSOLVE and aligned with national export strategies, is essential to navigate emerging international regulations like the EUDR. By integrating these practices, cocoa producers can move beyond traditional linear models toward a more resilient, efficient, and competitive position in the global market, ensuring long-term economic development while preserving the natural capital of the region.

This study successfully evaluated and quantified the impact of sustainable practices on the market performance of cocoa-producing MSEs in Peru using a combined PLS-SEM and Speech Analytics approach. The empirical results demonstrate a positive and significant relationship with high explanatory power ($R^2 = 0.870$), confirming that adopting sustainable practices is a driver of competitiveness, quality improvement, and international market access. Furthermore, the preliminary qualitative analysis reveals that supply chain stakeholders no longer view environmental compliance as an optional cost, but as a fundamental prerequisite for value addition and fair pricing in the global market. From an Information Systems perspective, this research contributes by demonstrating how analytics-based methods function as decision-support tools that transform abstract, multidimensional sustainability perceptions into measurable indicators and actionable evidence. Ultimately, environmental responsibility proves to be a strategically sound business decision for Peruvian cocoa MSEs navigating stringent international regulations like the

EUDR. Transitioning toward circular economy models via the ReSOLVE framework and national export strategies allows these firms to shift away from traditional systems into a resilient, efficient, and globally competitive position that ensures long-term economic growth while preserving the region's natural capital.

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