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The role of intangible metrics in achieving sustainable development goals

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Abstract

The fulfillment of the Sustainable Development Goals at a global level must be approached from the perspective of human, structural and employee capital, because their fulfillment stems from the productivity that stands out in the observation of intangible metrics. The research focuses on investigating how intangible metrics contribute to the financial performance of companies listed on the Quito Stock Exchange (BVQ), as well as determining how SDG 8 (Decent Work and Economic Growth) and SDG 9 (Industry, Innovation and Infrastructure) are affected by the results of the measurement of intangible metrics. Sixty-seven companies are considered which have been studied in the calculation of the Value-Added Intellectual Value (VAIC), to evaluate the intangible metrics on the other hand the calculation of return on assets (ROA) and return on equity (ROE). Results show that capital employed, and structural capital have an impact on profitability (ROA) and (ROE), however, human capital did not have an effect on the variable. It can be concluded that the importance of inquiring about structural capital and capital employed in the performance of companies is emphasized, since this contributes to the fulfillment of sustainability, which are contributing to the fulfillment of the (SDGs).

Keywords: Intangible metrics, Structural capital, Employed capital, Sustainable Development, Commercial sector.

1. Introduction

The purpose of organizations is to generate economic and structural growth, which is achieved over time. Although the generation of business value has remained a fundamental goal, this process continues to be rooted in traditional approaches that prioritize tangible assets over intangible ones [1]. This traditional perspective does not always recognize elements such as human capital, innovation, process quality, or relationships with customers and communities, which are fundamental to the sustainability and performance of organizations [2], [3], [4].

Intangible metrics, composed of human, structural and relational capital, play a crucial role in creating added value and driving sustainable business strategies. However, their immaterial nature makes it difficult to measure them through traditional accounting systems, limiting their integration into business strategies and the evaluation of their impact [4], [5], [6]. This situation underscores the need for a shift towards paradigms that include intangible metrics in the search for sustainable development, particularly in emerging economies such as Ecuador [7], [8].

In the context of sustainability, the role of companies transcends profit generation; they must contribute to the fulfillment of the United Nations Sustainable Development Goals (SDGs). Specifically, SDG 8 (Decent work and economic growth) and SDG 9 (Industry, innovation and infrastructure) highlight the importance of promoting sustainable economies through investment in human capital, innovation and technology. In addition, companies have a responsibility to create inclusive work environments, protect workers' rights and contribute to the well-being of the communities in which they operate, thus ensuring responsible growth that integrates the economic, social and environmental areas [9].

Previous studies have demonstrated the importance of intellectual capital in the sustainability of companies [10]. In [11], a positive relationship was identified between the value-added intellectual capital (VAIC) ratio and business performance in emerging economies. Similarly, studies in the banking and manufacturing sectors have highlighted the positive influence of structural and human capital in strengthening innovation and competitiveness [9], [12]. VAIC research, as can be seen in the previous paragraph, has a direct influence on the sustainability of companies, in other words, it boosts their performance.

Companies in the commercial sector in Ecuador are an important element of analysis for the research, since, due to their relevant participation in the country's economy, it is necessary to identify how capital, human, structural and employee, allow the generation of profitability, in the same way as the latter allows the fulfillment of the SDGs. In this way, it is expected to contribute to the debate on the relevance of intangibles in the promotion of inclusive and resilient economies, aligned with global sustainability principles.

This document is structured in five main sections. The first two, corresponding to the introduction and literature review, set the general framework of the study. The third section describes the data used and the methodology applied. The fourth section is devoted to the presentation of the results obtained and their analysis, including relevant discussions. Finally, the fifth section contains the conclusions, where the theoretical and practical implications derived from the study are presented, while pointing out the limitations inherent to the research and proposing future lines for its development

2. Background

2.1 Knowledge management

Knowledge management is a critical process that enables organizations to generate, share and use knowledge to drive innovation and organizational performance. This concept was formalized by [13] who analyzed how Japanese companies improved their production systems through knowledge. Thus, for [14], knowledge is achieved through the process of identification, codification and diffusion within organizations by understanding that it is a strategic resource.

In this sense, understanding that knowledge is implicit and explicit makes organizations need to capitalize on it to generate sustainable competitive advantages. That is why [15], considers it imperative that organizations promote the production of intellectual capital, since proper knowledge management contributes to its generation.

2.2 Resources and capabilities theory

The research recognizes that based on the Theory of Resources and Capabilities (TCR), organizations have unique intangible resources that, as mentioned [16], knowledge, organizational culture, become difficult to imitate, but are determinant in achieving sustainable competitive advantage. They also contribute to innovation and sustainability.

2.3 Human capital as a factor of sustainability

Investing in capital is a determining factor in the Human Capital Theory, because skills, knowledge and competencies are developed in the organization, which help to encourage positive results in productivity and

sustainability. Thus, according to [17], education and work experience have contributed to economic growth and therefore to the sustainability of companies, financially translated into profitability.

2.4 Intellectual capital: an integrated approach

The term that encompasses all intangible elements is intellectual capital (IC), which encompasses the knowledge and skills of workers, processes in companies, technological capital, forms of innovation, the way of relating to customers, etc. [18]. Human capital (HC), structural capital (SC) and relational capital (RC) are the three dimensions that make up intellectual capital [19], [20]. The CH refers to the knowledge, experience, capacity and skills possessed by the firm's workers [21]. Likewise, the CE is the infrastructure on which the CH is cemented [22], [23]. Finally, the CR refers to the relationships that the firm possesses and generates through the CH in an external context [23], [24]

Specifically, Human Capital (HC) relates to experience, knowledge and training to solve problems and participate in the market (Morales-Molina et al., 2025). Its efficiency (HCE) is key to financial performance, more so than relational and structural capital [25]. Structural Capital sustains the CH through internal processes, culture and systems [26], [27]. For its part, Relational Capital encompasses links with external agents, based on long-term knowledge exchange [28], [29]

In accordance with the above, there are studies that affirm the relationship between profitability and sustainability and the efficient management of intellectual capital, as shown by [30], which concludes that human capital generates competitive advantage, and that structural and relational capital strengthens innovation. The two intangible metrics allow directing in the same direction the strategic objectives with the principles of sustainability.

2.5 Contribution of intangible metrics in the Ecuadorian business context

When considering that business development translated into improving financial performance indicators, in Ecuador, particularly in the commercial sector, measuring VAIC becomes a necessity when considering that productive systems are largely enriched by human capital. Thus, studying it in general in the business world dignifies not only the management of responsible business conduct towards employees but also provides a broader view of the contribution of intangible capital, which is ratified by [31], in his research that evaluates how human and structural capital influence performance.

3 Methodology

3.1 Research focus

By identifying and calculating the intangible metrics in this research and on the other hand calculating the profitability of companies in the commercial sector listed on the BVQ, the research is considered quantitative because it allowed measuring the level of impact that human, structural and employee capital have on the level of profitability (ROA) and (ROE), and at the same time establishing the way in which compliance with the above allows the fulfillment of the SDGs.

3.2 Population and sample

The study focuses on companies in the commercial sector listed on the Quito Stock Exchange (BVQ). The selection of the population was based on two criteria:

1. availability of complete financial statements for the entire study period between 2018-2023.
2. Incorporation prior to 2017, ensuring consistency of data from 2018.
3. Absence of inconsistent or null values in the financial reports.

After the debugging process, the final sample consisted of 67 companies that met the established criteria.

3.3 Data sources

The data used in this study are secondary, obtained from the financial reports published on the website of the Superintendence of Companies, Securities and Insurance (SUPERCIAS). Additionally, macroeconomic indicators provided by the Central Bank of Ecuador were used to contextualize the results within national economic trends.

3.4 Analysis tool

To carry out the correlational study, the financial data of the commercial sector companies analyzed were subjected to normality tests to evaluate their behavior, with the aim of selecting the most appropriate correlation tool according to the behavior of the data collected. Thus, the Kolmogorov-Smirnov (K-S) test was used. Once the K-S test was quantified, it was determined that the data did not follow a normal distribution. This led to the use of Spearman's rank correlation coefficient.

To evaluate the intangible metrics, the VAIC (Value Added Intellectual Coefficient) model was used, which decomposes intellectual capital into three key components:

Human Capital (HCE): represents the efficiency of employee knowledge and skills.

1. Structural Capital (SCE): Measures the capacity of the organizational infrastructure to support performance.
2. Employed Capital (CEE): It values the efficiency of the tangible assets used in the generation of value.

Financial performance was evaluated using two key indicators:

1. Return on assets (ROA): measures the efficiency of asset utilization.
2. Return on equity (ROE): Evaluates the profitability generated for shareholders.

The data analysis was performed using regression models with panel data. This approach made it possible to evaluate the relationship between intangible metrics and financial performance, considering both differences between companies and variations over time.

The econometric modeling was done using Stata statistical software. The process used to perform the regression with panel data is detailed below:

Data were collected for the study variables:

- X: The independent variable (VAIC). VAIC = HCE+SCE+CEE
- Y: The dependent variable (ROA and ROE).

The models were formulated using a mathematical equation, first, for the model that has Return on Assets (ROA) as the regressed variable:

$$log(ROA_{it}) = \beta_0 + \beta_1 * log(\mathrm{HCE_{it}}) + \beta_2 * log(\mathrm{SCE_{it}}) + \beta_3 * log(\mathrm{CEE_{it}}) + \mu_i + \in_{it} \quad (1)$$

For the model with Return on Equity (ROE) as the endogenous variable:

$$log(ROE_{it}) = \beta_0 + \beta_1 * log(\mathrm{HCE_{it}}) + \beta_2 * log(\mathrm{SCE_{it}}) + \beta_3 * log(\mathrm{CEE_{it}}) + \mu_i + \in_{it} \quad (2)$$

Where:

- β_1: slope of the model
- $log(HCE)$: Human Capital Efficiency Coefficient (logarithmic)
- $log(SCE)$: Structural Capital Efficiency Coefficient (logarithmic)
- $log(CEE)$: Capital Employed Efficiency Ratio (logarithmic)
- $log(ROA)$: Return on Assets (logarithmic)
- $log(ROE)$: Return on equity (logarithmic)

- β_0: Intercept
- μ: Firm-specific fixed or random effects
- $\in_{it}$: Error term
- t: Time period (2018-2023)
- i: Number of companies under study

3.5 Statistical validation

Normality tests (Kolmogorov-Smirnov) were applied to determine the distribution of the data. Since the data did not follow a normal distribution, Spearman's rank correlation coefficient was used to analyze the initial associations between variables. Subsequently, random and fixed effects models were used, the adequacy of which was assessed using the Hausman and Breusch-Pagan tests.

4 Results

4.1 Correlational analysis between intangible metrics and performance

A distribution analysis was performed to select the appropriate statistical tool to correlate the variables of interest. Since the data set exceeds 50 observations, the Kolmogorov-Smirnov (K-S) test was used to assess the normality of the variables. The hypotheses were

- H0: The data follow a normal distribution.
- H1: The data do not follow a normal distribution.

Table 1 shows the results obtained from the Kolmogorov-Smirnov test which indicate that all the variables analyzed, i.e., Intellectual Capital and its components and performance (ROA and ROE), do not follow a normal distribution, since all the p-values obtained are extremely low (less than 0.05). This means that the distributions of the data present significant differences with respect to the theoretical normal distribution, i.e., they do not have a normal trend.

Table 1. Kolmogorov-Smirnov test

Variables	Statistic	Significance (p-value)
Value Added	0,366	3,44E-155
Human Capital Efficiency Coefficient	0,367	9,00E-156
Coefficient of Structural Capital Efficiency	0,267	9,32E-81
Coefficient of Efficiency of Employed Capital	0,168	8,73E-31
Coefficient of Intellectual Value Added	0,329	2,35E-124
Return on Assets	0,178	9,78E-35
Return on Equity	0,402	9,55E-188

Note. Nonparametric statistical test for more than observations.

Accordingly, Spearman's Rho nonparametric correlation coefficient was used to evaluate the relationships between intangible metrics and the performance of companies in the commercial sector listed on the stock exchange in Ecuador as shown in Table 2:

Table 2. Correlation matrix (Spearman's Rho)

	VA	HCE	SCE	CEE	VAIC	ROA	ROE
VA	1						
HCE	0,006	1					
SCE	-0,009	0,985**	1				
CEE	0,074	0,014	-0,001	1			
VAIC	-0,036	0,925**	0,940**	0,223**	1		
ROA	0,222	0,335	0,320	0,452**	0,390	1	
ROE	0,102	0,366	0,351	0,443**	0,454**	0,838**	1

Note. The correlation is significant at the ** 0.01 level (bilateral).

Human Capital and Structural Capital present a strong positive correlation between the Human Capital Efficiency Coefficient (HCE) and the Structural Capital Efficiency Coefficient (SCE) ($\rho = 0.985$, $p < 0.01$). This indicates that both components are mutually reinforcing in the analyzed companies. Intellectual Value Added (VAIC), is highly correlated with HCE ($\rho = 0.925$, $p < 0.01$) and SCE ($\rho = 0.940$, $p < 0.01$), evidencing that these intangible elements are determinants of value creation. In relation to performance, the Capital Employed Efficiency Coefficient (CEE) shows moderate correlations with ROA ($\rho = 0.452$, $p < 0.01$) and ROE ($\rho = 0.443$, $p < 0.01$), standing out as an important factor for financial performance. In addition, VAIC shows a positive correlation with ROE ($\rho = 0.454$, $p < 0.01$), although its relationship with ROA is weaker ($\rho = 0.390$, $p < 0.01$). ROA has a strong positive correlation with ROE ($\rho = 0.838$, $p < 0.01$), underscoring the relationship between both profitability metrics.

4.2 Importance of intangible metrics in the generation of returns

Panel data regression analyses were performed to evaluate the influence of intangible metrics on financial results (ROA and ROE). Statistical tests were performed to determine the most appropriate models:

1. Hausman test: fixed effects and random effects models were compared.
2. Breusch-Pagan LM test: Confirmed the suitability of the random effects model for ROA.

4.3 Panel Data Regression - log(ROA) model

Initially, two models were estimated for the dependent variable logROA: one with fixed effects and the other with random effects, by means of the Hausman test, and the significance level of the random models and the pooled model can be compared with the Langrage multiplier (LM) test.

4.4 Hausman's test: choice between fixed or random effects - log(ROA) model

Using Hausman's test provides the research with relevant information in terms of seeking precision in the decision to use fixed and random effects models in a panel data analysis, the main purpose of the test is to check whether the explanatory variables are correlated with unobserved effects [32]. That is why the following hypotheses are put forward.

The synthesized hypotheses are as follows:

- H0: The random effects model is appropriate.
- H1: The fixed effects model is not appropriate.

The decision rule is to reject the null hypothesis if the p-value is less than 0.05, which implies that the fixed effects model is preferable; however, if the p-value is greater than 0.05, the null hypothesis is accepted.

Table 3. Results of Hausman's test - log(ROA) model

Variable	Coefficients		Difference	Standard Error of the Difference
	Fixed effects	Random effects		
Log(HCE)	-0.183368	-0.155865	-0.0275029	0.082735
Log(SCE)	0.4306238	0.4849892	-0.0543654	0.0314874
Log(CEE)	0.7048447	0.7251631	-0.0203184	0.1154624

Note: Chi2 result: 3.47. Prob > Chi2: 0.3251.

Since the p-value = 0.3251 is greater than 0.05, the null hypothesis (H0) is not rejected, as shown in Table 3. This indicates that there is no systematic difference between the estimated coefficients in the fixed effects model and the random effects model. This indicates that there is no systematic difference between the estimated coefficients in the fixed effects model and the random effects model. In other words, the random effects model is the most appropriate in this case.

4.5 Breusch-Pagan Lagrange multiplier (LM) test

To confirm the adequacy of the random effects model, the Breusch-Pagan Lagrange multiplier (LM) test, which evaluates the significance of the random effects compared to a pooled model, will be applied. This test allows verifying whether it is necessary to incorporate random effects or whether the pooled model is sufficient, providing an additional basis for the selection of the appropriate model [33]. This test is based on the following hypotheses.

- H0: There are no significant random effects (pooled model).
- H1: There are significant random effects.

If the p-value associated with the test statistic is less than 0.05, the null hypothesis is rejected and it is concluded that the random effects model is adequate, given that the differences between the groups are significant.

Table 4. Results of the Breusch-Pagan Lagrange multiplier (LM) test - log(ROA) model

Estimator	Variance	Standard deviation
log(ROA)	6.482928	2.54616
Variance of prediction errors (e)	3.458007	1.859572
Variance of random effects (u)	1.45957	1.208127

Note. Chi-Bar2 result^2: 80.66. Prob > Chi-bar^2: *0.0000*.

Based on the results obtained in Table 4, it is observed that the random effects are significant in the model, and the Chi2 statistic has a p-value below the 0.05 significance level. This leads to reject the null hypothesis that there are no significant random effects, confirming that the random effects model is the most appropriate, as also validated by the Hausman test.

Table 5. Panel data regression results -Log ROA model (random effects)

R2 within	R2 between	R2 overall	Wald Chi2	Prob > Chi2
0.1343	0.3842	0.2509	89.35	0.0000
Main estimators				
Predictor Variables	Coefficients	Standard Error	Statistic z	P > | z |
Log(HCE)	-0.1558657	0.1104713	-1.41	0.158
Log(SCE)	0.4849892	0.0712585	6.81	0.000
Log(CEE)	0.7251631	0.1065378	6.81	0.000
Constant	-4.273168	0.4584552	-9.32	0.000

Note. Outputs of the regression with panel data (random effects) as a function of: Independent variables: log(HCE), log(SCE) and log(CEE). Dependent variable: log(ROA).

As for the results of the random effects model with Profitability shown in Table 5 on Assets as the dependent variable, they reflect that the coefficients are statistically significant measured jointly through the Wald Chi2 test. In turn, the model explains 25.09% of the total variability of ROA. The independent variables, such as Structural Capital and Employee have positive and significant impacts, which is proven by the p-values of these variables, which are less than 0.05. These results are not isolated, [34], in his study on the effect of intangible resources on the financial performance of 64 Islamic financial institutions (IFIs), during the period 2007-2011, found that HCE and CEE have a positive relationship with asset-based performance, although, SCE does not, which differs from the present study. In addition, [35], identified that an increase in CEE, HCE and SCE indicators is associated with an increase in ROA of Brazilian IBRx-50 companies. Likewise, [36], obtained congruent results in his research on industrial companies listed on the Mexican Stock Exchange.

Specifically, Capital Employed is the variable with the greatest influence on ROA, since, if CEE increases by 1%, Return on Assets increases by 0.73%. These results are in line with research which found that, the significant association of CEE leads to the conclusion that tangible assets are the main driver of performance of Indian companies listed on the Centre for Economic Surveillance of India's General Stock Price Index (COSPI). In addition, [37] and [18] studied companies from emerging economies, BRICS and Indonesia, respectively, and found that CEE was a key factor in creating profitability and market value of the analyzed companies.

In contrast, Human Capital has no significant effect, in fact, it has a negative effect on ROA, in addition to a p-value of 0.158, indicating the insignificance of the variable. A 1% increase in Human Capital, by trading companies, is associated with a 0.16% decrease in ROA. These results are similar to those found by [38], in his analysis of multinational companies listed on the United States (US) stock exchanges and that carried out R&D activities during the period 2006-2013, finding that the efficiency of Human Capital has no significant relationship with the performance of R&D companies in the market.

4.6 Log(ROE) model: panel data estimation

Intangible metrics were analyzed using a panel data regression model, evaluating their impact on Return on Equity (ROE). Comparisons were made between fixed and random effects models, using the Hausman test to determine the most appropriate model. The results are presented below.

4.7 Hausman's test: selection between fixed or random effects - log(ROE) model

Hypotheses for the Hausman test.

- H0: The random effects model is appropriate.
- H1: The fixed effects model is appropriate.

Table 6 shows the results of the Hausman test. This test determined that the fixed effects model is the most appropriate, since the Chi2 value (13.78, p = 0.0032) allows rejecting the null hypothesis that the random effects model is sufficient.

Table 6. Results of Hausman's test - log(ROE) model

Variable	Coefficients		Difference	Standard Error of
	Fixed effects	Random effects		Difference
Log(HCE)	-0.005234	-0.0260695	0.0208358	0.0914479
Log(SCE)	0.4057974	0.4744289	-0.0686314	0.0349063
Log(CEE)	0.3020984	0.5950253	-0.2929269	0.1276638

Note: Chi2 result: 13.78. Prob > Chi2: 0.0032.

After selecting the fixed effects model as the most appropriate, we proceed to perform diagnostic tests to verify the assumptions of the model. By means of the Wooldridge test, used to detect the presence of first order autocorrelation, this assumption was evaluated, which poses the following hypotheses:

- H0: There is no first order autocorrelation.
- H1: There is first order autocorrelation.

If the p-value (Prob > F) is less than the significance level (0.05), we reject H0 and conclude that there is first order autocorrelation in the errors, in contrast, if the value obtained is higher than the significance level, we accept H0.

Table 7. Assumption of autocorrelation log(ROA) - Wooldridge test

Estimator	Result
Statistic F	6.969
Prob > F	0.0103

Note. The null hypothesis (H0) is rejected.

The Wooldridge autocorrelation test, Table 7, illustrates that there is first order autocorrelation in the model errors. This is deduced by the result that Prob > F is less than 0.05, which leads us to reject the null hypothesis. Therefore, it is confirmed that the model residuals are correlated over time.

In turn, the assumption of heteroscedasticity was also evaluated, by means of the Wald test for group heteroscedasticity (modified), the same test used for a fixed effects model in panel data. If the p-value (Prob > Chi2) is below the significance level (0.05), the null hypothesis is rejected, and it is concluded that group heteroscedasticity exists. The hypotheses are as follows.

- H0: There is no group heteroscedasticity (homoscedasticity).
- H1: There is group heteroscedasticity.

Table 8. Heteroscedasticity assumption log(ROA) - Wald test

Estimator	Result
Statics Chi2	1.3e+05
Prob > Chi2	0.0103

Note. The null hypothesis (H0) is rejected.

The results of the modified Wald Table 8 test lead us to reject the null hypothesis of homoscedasticity, since the p-value = 0.0103 is less than the significance level of 0.05. Therefore, there is group heteroscedasticity, i.e., the variance of the errors varies among the different groups of observations, in this case, among the companies of the commercial sector listed on the BVQ.

On the other hand, to test the assumption of absence of multicollinearity, which states that independent variables should not be highly correlated with each other, since this distorts the coefficient estimates in a regression model [39], the Variance Inflation Factor (VIF) was used, which measures the degree to which the variance of a coefficient is inflated due to collinearity with other variables [40]. VIF values greater than 10 indicate severe multicollinearity problems, while values less than 5 are generally considered acceptable.

Table 9. Variance inflation factor results

Variable	Variance inflation factor (VIF)	1/VIF
Log(HCE)	1.42	0.702589
Log(SCE)	1.41	0.709781
Log(CEE)	1.05	0.951275
Average VIF	1.29	

Note. Variance Inflation Factor (VIF) results to assess multicollinearity in the independent variables

The results in Table 9 showed individual VIF values less than 5, with an average of 1.29. This confirmed that there are no multicollinearity problems between the independent variables, ensuring the stability and reliability of the estimates made in both models.

4.8 Adjustments for heteroscedasticity and autocorrelation in the panel model (fixed effects)

To ensure the validity of the model results, adjustments were made to correct for the first-order heteroscedasticity and autocorrelation problems present in the initial panel model residuals. A Prais-Winsten regression, which adjusts the coefficient estimates by accounting for temporal autocorrelation of the errors, was used, and standard errors were corrected to address group heteroscedasticity. These robust adjustments improve the precision of the estimates by adjusting the variance of the errors. With these corrections implemented, the final results were obtained, which are presented below.

Table 10. Results of the fixed effects model for the return on equity

R2	Rho (ρ)	Wald Chi2	Prob > Chi2
0.1452	0.3328191	62.37	0.0000
Main estimators			
Predictor variables	Heteroscedasticity corrected		z-statistic	P > | z |
	Coefficients	Standard Error		
Log(HCE)	0.0148099	0.1322351	0.11	0.911
Log(SCE)	0.4603224	0.091513	5.03	0.000
Log(CEE)	0.6245575	0.1217092	5.13	0.000
Constant	-2.099565	0.5057691	-4.15	0.000

Note. Outputs of the regression with panel data (fixed effects) as a function of: Independent variables: log(HCE), log(SCE) and log(CEE). Dependent variable: log(ROE)

The panel data fixed effects model with log transformation and corrected standard errors reveals that the model is statistically significant as a whole (Prob > F = 0.0000) and explains 14.52% of the variability of the return on equity (logROE). Studies such as those of [41], [42], confirm these results, demonstrating that the components of VAIC (HCE, SCE and CEE), as a whole, positively influence the generation of Return on Equity (ROE) in the sectors analyzed by each research.

Among the independent variables, Structural Capital (logSCE) and Capital Employed (logCEE) have positive and significant impacts on the dependent variable, with Capital Employed showing a particularly strong effect, as a 1% increase in CEE translates into a 0.62% increase in ROE. These results are supported by similar evidence, for example [35] determined that CEE is the only component of VAIC that presents a statistically significant relationship with ROE in non-financial companies listed on the BMF&Bovespa. Similarly, studies on IC and performance by [43], [44], also highlighted the positive and significant relationship between CEE and ROA as the most relevant, in the context of the Information and Communication Technology (ICT) industry in Serbia and 65 Indian banks, respectively.

On the contrary, Human Capital (logHCE) does not present a significant effect on Return on Equity, indicating that its influence is limited on the profitability of companies in the commercial sector listed on the BVQ. These results are similar to those obtained by [42], as they did not determine that RHCE influences profitability generation.

In contrast to these findings, research results by [45], [46], [47], established that Human Capital (HC), measured through HCE, has a significant impact on Return on Equity (ROE). Finally, the negative constant reflects that, in the absence of the contributions of the three components of VAIC, the expected value of ROE would be unfavorable in the commercial sector companies listed on the BVQ.

5 Discussions

The results obtained in this research reveal a significant association between intangible metrics (structural capital and capital employed) and the financial performance of companies in the Ecuadorian commercial sector listed on the Quito Stock Exchange (BVQ). These findings highlight the critical role that intangible assets play in promoting sustainability and corporate value, aligning with the principles of the VAIC model and the Sustainable Development Goals (SDGs).

For [48], elements such as organizational systems and efficient processes enhance sustainable competitive advantages, in this sense the research by means of structural capital (Log SCE), evidences that there is a contribution of ROA and ROE. On the other hand, capital employed (Log CEE) is the most determinant metric to obtain returns based on equity, so that 1% of capital employed produces 0.62% of profitability. This is highlighted by [18] when using structural capital as a driver of organizational innovation and [49] when

identifying CEE as the determinant of performance, likewise [37] mentions that in BRICS countries, intangibles generate sustainable financial returns.

From the research, it is clear that human capital (Log HCE), does not influence the level of profitability, and is opposed to the research of [17], [50], which emphasize the need to give relevance to skills and competencies that result in increases in productivity, however for [38] there are other factors that prevent human capital from developing freely, such as structural or technological assets. The empowerment of human capital is paramount in organizations and for [51] the way to do this is to convert tacit knowledge into explicit knowledge.

The research presents the need to promote responsible actions of companies to enhance their Structural Capital and Employed Capital, as a response to profitability, thus [30], [31], in their research highlight the importance of these metrics in organizations. However, there is still an absence of policies that promote the efficiency of Human Capital towards profitability through synergies between the components of intellectual capital that lead to increased long-term sustainability.

6. Conclusions

The research underlines the importance for companies, particularly those belonging to the commercial sector and listed on the BVQ, of enhancing the Capital Employed, Structural Capital, in the generation of profitability on assets and equity, but not only focuses on the relationship, but rather discovers that it is necessary to properly manage intangibles in establishing practices that allow strengthening the fulfillment of Sustainable Development Goals (SDGs) 8 and 9.

Investment is the primary stage in the development of companies since managing resources towards organizational systems, infrastructure and efficient processes lead to increase the levels of innovation and competitiveness, which is as established by the goals of SDG 9, in the research the Structural Capital becomes a driver of profitability through investment. In the same sense, the Employed Capital becomes the factor that promulgates satisfactory results of profitability, through the generation of own resources, as promoted by SDG 8. The intangible metrics analyzed in this study provide a valuable tool for companies to integrate sustainable practices into their strategies. This includes further alignment with the SDGs by fostering innovation, equity and inclusive economic development.

Limitations and future research

Despite its contributions, this study has limitations that should be addressed in future research. The specific nature of the business sector may limit the generalizability of the results to other sectors. In addition, it would be valuable to study how interactions between the components of intellectual capital influence other aspects of sustainability, such as corporate social responsibility and environmental impact.

Declaration of competing interest

The authors declare that they have no known financial or non-financial competing interests in any material discussed in this paper.

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Author contribution

Conceptualization, A.N.N and S.C.M; Data curation, A.N.N and A.C.P; Funding acquisition, A.N.N; Investigation, AN.N, S.C.M and A.C.P ; Methodology, A.N.N and A.C.P; Project administration, A.N.N and A.C.P; Resources, A.N.N; Software, A.C.P and S.C.M; Supervision, A.N.N and S.C.M; Validation, A.C.P; Visualization A.N.N; Writing – original draft, S.C.M; Writing – review & editing, A.N.N and A.C.P

References

[1] A. J. Flores-Flores, I. Bernal-González, and L. Louis Valentín-Mballa, "Análisis bibliométrico del capital intelectual y desempeño organizacional," *Ciencias Adm. Teoría y Prax.*, vol. 16, no. 2, pp. 123–142, Jan. 2021, https://doi.org/10.46443/catyp.v16i2.265.

[2] W. A. V. Clark, D. Yi, and Y. Huang, "Subjective well-being in China's changing society," *Proc. Natl. Acad. Sci.*, vol. 116, no. 34, pp. 16799–16804, Aug. 2019, https://doi.org/10.1073/pnas.1902926116.

[3] C. M. Pulgarín-Fernández, J. E. Ormaza-Andrade, and J. C. Erazo-Álvarez, "Gestión del Capital Intelectual en las Organizaciones," *Rev. Arbitr. Interdiscip. Koinonía*, vol. 5, no. 3, p. 779, Aug. 2020, https://doi.org/10.35381/r.k.v5i3.921.

[4] L. E. Morales Clark, "Capital intelectual y desempeño organizacional: el caso de las instituciones de educación básica en México," *Rev. científica Pensam. y Gestión*, vol. 47, pp. 180–202, Feb. 2024, https://doi.org/10.14482/pege.47.6342.

[5] F. Tejedo Romero, "Información de los recursos intangibles ocultos: ¿memorias de sostenibilidad o informe anual?," *Eur. Res. Manag. Bus. Econ.*, vol. 22, no. 2, pp. 101–109, May 2016, https://doi.org/10.1016/j.iedee.2015.06.001.

[6] A. F. Núñez-Naranjo, X. Morales-Urrutia, and A. Martínez-Jumbo, "Governance and subjective well-being in the Countries of the Andean Community (CAN)," *Herit. Sustain. Dev.*, vol. 6, no. 2, pp. 459–482, Jul. 2024, https://doi.org/10.37868/hsd.v6i2.575.

[7] D. G. Mavridis, "The intellectual capital performance of the Japanese banking sector," *J. Intellect. Cap.*, vol. 5, no. 1, pp. 92–115, Mar. 2004, https://doi.org/10.1108/14691930410512941.

[8] A. Méndez Arias, J. Montoya Jiménez, and N. Ugalde Binda, "Capital intelectual del emprendador," *LATAM Rev. Latinoam. Ciencias Soc. y Humanidades*, vol. 5, no. 1, Mar. 2024, https://doi.org/10.56712/latam.v5i1.1797.

[9] A. Núñez-Naranjo, X. Morales-Urrutia, and L. Simbaña-Taipe, "Social capital, education, and subjective well-being in Ecuador," *Front. Sociol.*, vol. 9, no. 1417538, 2024, https://doi.org/10.3389/fsoc.2024.1417538.

[10] Núñez-Naranjo, A. F., Morales-Urrutia, X., & Villegas, R. Subjective Well-Being and Corruption in Latin America. *Journal of Educational and Social Research*, vol. 14, no. 6, 389, 2024, https://doi.org/10.36941/jesr-2024-018.

[11] K. Moh'd Khier Al Momani, N. Jamaludin, W. Z. @ W. Zanani Wan Abdullah, and A.-N. Ibrahim Nour, "The effects of intellectual capital on firm performance of industrial sector in Jordan," *Humanit. Soc. Sci. Rev.*, vol. 8, no. 2, pp. 184–192, Mar. 2020, https://doi.org/10.18510/hssr.2020.8222.

[12] A. F. Núñez-Naranjo, D. M. L. Haro, J. P. M. Mesías, and M. J. S. Sarzosa, "Firm Size and Growth in Ecuador's Trade Sector: An Analysis from an Industrial Economics Perspective," *J. Ecohumanism*, vol. 3, no. 6, pp. 2060–2073, Sep. 2024, https://doi.org/10.62754/joe.v3i6.4159.

[13] A. Abdillah, I. Widianingsih, R. A. Buchari, and H. Nurasa, "The knowledge-creating company: How Japanese companies create the dynamics of innovation," *Learn. Res. Pract.*, vol. 10, no. 1, pp. 121–123, Jan. 2024, https://doi.org/10.1080/23735082.2023.2272611.

[14] A. Hurtado Ayala and J. L. Duque Ceballos, "ANÁLISIS BIBLIOMÉTRICO DE PUBLICACIONES SOBRE RETENCIÓN DEL PERSONAL Y SU RELACIÓN CON GESTIÓN DEL CONOCIMIENTO," *Rev. Efic.*, vol. 1, no. 1, Feb. 2024, https://doi.org/10.15765/egd6dw38.

[15] A. Rahmat, "Intellectual Capital and Knowledge Management in Higher Education: Concept,

Implementation, and Barriers," *AL-ISHLAH J. Pendidik.*, vol. 14, no. 1, pp. 561–570, Apr. 2022, https://doi.org/10.35445/alishlah.v14i1.1952.

[16] J. Barney, "Firm Resources and Sustained Competitive Advantage," *J. Manage.*, vol. 17, no. 1, pp. 99–120, Mar. 1991, https://doi.org/10.1177/014920639101700108.

[17] G. S. Becker, *Human Capital: A Theoretical and Empirical Analysis, with Special Reference to Education*. 1975. [Online].

[18] M. Rossi, G. Festa, S. Chouaibi, M. Fait, and A. Papa, "The effects of business ethics and corporate social responsibility on intellectual capital voluntary disclosure," *J. Intellect. Cap.*, vol. 22, no. 7, pp. 1–23, Dec. 2021, https://doi.org/10.1108/JIC-08-2020-0287.

[19] L. Gómez-Bayona, E. Londoño-Montoya, and B. Mora-González, "Modelos de capital intelectual a nivel empresarial y su aporte en la creación de valor," *Rev. CEA*, vol. 6, no. 11, pp. 165–184, Jan. 2020, https://doi.org/10.22430/24223182.1434.

[20] X. Du, H. Zhang, and Y. Han, "How Does New Infrastructure Investment Affect Economic Growth Quality? Empirical Evidence from China," *Sustainability*, vol. 14, no. 6, p. 3511, Mar. 2022, https://doi.org/10.3390/su14063511.

[21] M. I. Nazir, Y. Tan, and M. R. Nazir, "Intellectual capital performance in the financial sector: Evidence from China, Hong Kong, and Taiwan," *Int. J. Financ. Econ.*, vol. 26, no. 4, pp. 6089–6109, Oct. 2021, https://doi.org/10.1002/ijfe.2110.

[22] M. L. Sanchez Limon, Y. Sanchez Tovar, and J. Jasso Villazul, "Caracterización del capital intelectual en las universidades publicas. Estudio comparativo.," *Int. J. Prof. Bus. Rev.*, vol. 6, no. 1, p. e203, Jan. 2021, https://doi.org/10.26668/businessreview/2021.v6i1.203.

[23] M. R. Saadatmand, N. Safaie, and H. Hamidi, "An Empirical Study of Mediating Role of Knowledge Management in the Impact of Intellectual Capital on Organizational Performance," *Int. J. Eng.*, vol. 38, no. 11, pp. 2776–2795, 2025, https://doi.org/10.5829/ije.2025.38.11b.23.

[24] G. Ginesti, A. Caldarelli, and A. Zampella, "Exploring the impact of intellectual capital on company reputation and performance," *J. Intellect. Cap.*, vol. 19, no. 5, pp. 915–934, Aug. 2018, https://doi.org/10.1108/JIC-01-2018-0012.

[25] S. Nimtrakoon, "The relationship between intellectual capital, firms' market value and financial performance," *J. Intellect. Cap.*, vol. 16, no. 3, pp. 587–618, Jul. 2015, https://doi.org/10.1108/JIC-09-2014-0104.

[26] C. R. Ficco, "Una revisión del concepto de capital intelectual y de las principales alternativas para su identificación y medición," *Rev. Act.*, vol. 18, no. 1, Sep. 2020, https://doi.org/10.15332/25005278/6162.

[27] M. Rojo, V. Peralta, and N. Romero, "STRUCTURAL CAPITAL: DIAGNOSTIC ANALYSIS IN GROUPS OF RESEARCH AND DEVELOPMENT (R&D) OF PUBLIC UNIVERSITIES IN COLOMBIA," *Rev. Universo Contábil*, pp. 132–149, Sep. 2015, https://doi.org/10.4270/ruc.2015325.

[28] N. Beltramino and M. cecilia Conci, *El capital intelectual*. 2012, https://doi.org/10.52550/26j9v7.

[29] A. Yuksel, "Relationship between human capital and entrepreneurship orientation from the intellectual capital perspective of innovative literacy," *J. Intellect. Cap.*, vol. 25, no. 5/6, pp. 1259–1284, Nov. 2024, https://doi.org/10.1108/JIC-12-2023-0285.

[30] N. Smriti and N. Das, "The impact of intellectual capital on firm performance: a study of Indian firms listed in COSPI," *J. Intellect. Cap.*, vol. 19, no. 5, pp. 935–964, Aug. 2018, https://doi.org/10.1108/JIC-11-2017-0156.

[31] A. O. Bravo Martinez and J. E. Sánchez Gómez, "Capital Intelectual en el sector bancario peruano," *Rev. Venez. Gerenc.*, vol. 29, no. 105, pp. 160–176, Jan. 2024, https://doi.org/10.52080/rvgluz.29.105.11.

[32] J. A. Hausman, "Specification Tests in Econometrics," *Econometrica*, vol. 46, no. 6, p. 1251, Nov. 1978, https://doi.org/10.2307/1913827.

[33] T. S. Breusch and A. R. Pagan, "The Lagrange Multiplier Test and its Applications to Model Specification in Econometrics," *Rev. Econ. Stud.*, vol. 47, no. 1, p. 239, Jan. 1980, https://doi.org/10.2307/2297111.

[34] T. Nawaz and R. Haniffa, "Determinants of financial performance of Islamic banks: an intellectual capital perspective," *J. Islam. Account. Bus. Res.*, vol. 8, no. 2, pp. 130–142, Apr. 2017, https://doi.org/10.1108/JIABR-06-2016-0071.

[35] C. Evangelho Meyr, S. Boruck Klein, W. Dantas de Souza Junior, and D. Dall'Asta, "Efeito Dos

Componentes Do Capital Intelectual Sobre O Desempenho Financeiro De Empresas Brasileiras Listadas No Ibrx-50 Da B3 De 2013 a 2017," *Context. – Rev. Contemp. Econ. e Gestão*, vol. 17, no. 3, pp. 88–113, 2019, https://doi.org/10.19094/contextus.v17i3.42289.

[36] E. Villegas González, M. A. Hernández Calzada, and B. C. Salazar Hernández, "La medición del capital intelectual y su impacto en el rendimiento financiero en empresas del sector industrial en México," *Contaduría y Adm.*, vol. 62, no. 1, pp. 184–206, Jan. 2017, https://doi.org/10.1016/j.cya.2016.10.002.

[37] M. Nadeem, C. Gan, and C. Nguyen, "Does intellectual capital efficiency improve firm performance in BRICS economies? A dynamic panel estimation," *Meas. Bus. Excell.*, vol. 21, no. 1, pp. 65–85, Mar. 2017, https://doi.org/10.1108/MBE-12-2015-0055.

[38] A. H. M. Ariff, A. Islam, and T. van Zijl, "Intellectual capital and market performance: The case of multinational R&D firms in the U.S.," *J. Dev. Areas*, vol. 50, no. 5, pp. 487–495, 2016, https://doi.org/10.1353/jda.2016.0052.

[39] V. Morales Oñate and B. Morales-Oñate, "MTest: a bootstrap test for multicollinearity," *Rev. Politécnica*, vol. 51, no. 2, pp. 53–62, May 2023, https://doi.org/10.33333/rp.vol51n2.05.

[40] M. Zreik and N. F. Haron, "The Impact of Social Financial Grants on Poverty Alleviation in Rural Indonesia: A Demographic and Econometric Analysis," *Asian Soc. Work Policy Rev.*, vol. 19, no. 2, Jun. 2025, https://doi.org/10.1111/aswp.70011.

[41] M. del C. Gómez Romo, E. V. Totoy Sinalin, and A. F. López Gómez, "El capital intelectual en el sector de confección textil. Un estudio explicativo de la rentabilidad," *Ad-gnosis*, vol. 12, no. 12, pp. 1–21, Dec. 2023, https://doi.org/10.21803/adgnosis.12.12.635.

[42] M. H. Shahbaz and S. A. Malik, "Driving firm performance with green intellectual capital: the key role of business sustainability in SMEs," *J. Intellect. Cap.*, vol. 26, no. 3, pp. 691–715, Apr. 2025, https://doi.org/10.1108/JIC-07-2024-0211.

[43] A. Mondal and S. K. Ghosh, "Intellectual capital and financial performance of Indian banks," *J. Intellect. Cap.*, vol. 13, no. 4, pp. 515–530, Oct. 2012, https://doi.org/10.1108/14691931211276115.

[44] V. Dženopoljac, S. Janoševic, and N. Bontis, "Intellectual capital and financial performance in the Serbian ICT industry," *J. Intellect. Cap.*, vol. 17, no. 2, pp. 373–396, Apr. 2016, https://doi.org/10.1108/JIC-07-2015-0068.

[45] M. Paunović, "The Impact of Human Capital on Financial Performance of Entrepreneurial Firms in Serbia," *Manag. Sustain. Bus. Manag. Solut. Emerg. Econ.*, Jul. 2020, https://doi.org/10.7595/management.fon.2020.0010.

[46] M. Chen, S. Cheng, and Y. Hwang, "An empirical investigation of the relationship between intellectual capital and firms' market value and financial performance," *J. Intellect. Cap.*, vol. 6, no. 2, pp. 159–176, Jun. 2005, https://doi.org/10.1108/14691930510592771.

[47] B. Komnenic and D. Pokrajčić, "Intellectual capital and corporate performance of MNCs in Serbia," *J. Intellect. Cap.*, vol. 13, no. 1, pp. 106–119, Jan. 2012, https://doi.org/10.1108/14691931211196231.

[48] G. Malynovska *et al.*, "Methodology and Practical Test of Human Capital Assessment of Ukrainian Oil and Gas Enterprises in the Context of Sustainable Development," *Sustainability*, vol. 17, no. 6, p. 2366, Mar. 2025, https://doi.org/10.3390/su17062366.

[49] Q. L. Kweh, I. W. K. Ting, J. Asif, and W.-M. Lu, "Managerial ability and firm growth: intellectual capital components," *Manag. Decis.*, vol. 63, no. 5, pp. 1519–1544, Apr. 2025, https://doi.org/10.1108/MD-01-2024-0183.

[50] T. W. Schultz, "Investment in Man: An Economist's View," *Soc. Serv. Rev.*, vol. 33, no. 2, p. 9, 1959, [Online].

[51] I. Nonaka and H. Takeuchi, *The Knowledge-Creating Company: How Japanese Companies Create the Dynamics of Innovation.*, Oxford Uni. New York., 1995. [Online].