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Assurance Practices in Colombia's Non-Financial Sectors: Enhancing Sustainability Report Reliability

Fanery Andrea Hoyos Giraldo [1,*], María de los Ángeles Baeza Muñoz [2] and Edinson Delgado-Martínez [1]

[1] Faculty of Business Administration, Universidad Autónoma de Occidente, Santiago de Cali 760030, Colombia; edelgadom@uao.edu.co
[2] Faculty of Business and Economic Sciences, Universidad de Granada, 18071 Granada, Spain; mabaeza@ugr.es
* Correspondence: fhoyos@uao.edu.co; Tel.: +57-3107306709

Abstract: This research enhances the reliability of sustainability reports in Colombia's mining–hydrocarbons, construction, and manufacturing sectors. Amid growing demands for corporate transparency, this study evaluates assurance practices and proposes a model for measuring sustainability report reliability. Using bootstrapping regression, this study provides credible coefficient estimates without assuming a normal distribution. Key findings show that SDG application, assurance scope, and auditing firm consistency significantly influence report reliability, affirmed by 95% confidence intervals. This study's pragmatic approach suggests best-case and worst-case scenarios for policymakers and companies to optimize report reliability. Furthermore, the proposed model paves the way for future research, with the International Standard on Sustainability Assurance (ISSA) 5000 by the International Auditing and Assurance Board (IAASB), potentially acting as a catalyst for mandatory sustainability reporting in Latin America. This proposed standard promises to enhance sustainability assurance practices. This research contributes to academic discourse on sustainability assurance and guides improvements in corporate reporting transparency and accountability. Future research should expand this model to other sectors and regions, validating its applicability and exploring broader temporal scopes to strengthen its empirical foundations.

Keywords: sustainability report; audit; internal assurance; external assurance; combined assurance

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1. Introduction

In the last decade, organizations have been transforming the presentation of their reports, experiencing important changes in terms of content, going from providing financial information to non-financial and integrated information with economic–financial, social, environmental, and corporate governance indicators that contributed to the sustainability and value creation of any organization [1,2].

The former is evidenced by the publication and application of guidelines and/or standards of different international organizations, such as the Global Reporting Initiative (GRI), Sustainability Accounting Standards (SASB), the Integrated Reporting (IR), among other international frameworks, for the preparation and presentation of the sustainability report. The existence of different frameworks for reporting sustainability information demonstrates a lack of global consensus on the matter, creating difficulties for information users in comprehending the report and making informed decisions.

Ref. [3] analyzed the progress on the implementation and reporting of integrated information globally using the 2016 GRI database. He observed that 6645 companies reported integrated information, with the following regional composition: 34.82% were companies from Asia; 34.48% from Europe; 12.57% from Latin America and the Caribbean; 10.31% from North America; 4.68% from Africa; and 3.15% from Oceania. South Africa is a pioneer in sustainability reporting and is the first country in the world to adopt it as a component of corporate governance [4]. In 2014, the South African Integrated Reporting Committee

(IRC OF SA) issued a guidance, updated in 2018, to support the development of integrated reporting and thinking. In addition, this Committee has published technical information documents with the aim of assisting preparers and users to apply and understand the international integrated reporting framework [5].

On the other hand, ref. [6] studied the assurance practices of sustainability reporting in South African companies and concluded that sustainability reporting has grown but has not been accompanied by an increase in public trust, given its voluntary nature and the lack of consistency and completeness in the reporting of non-financial information. Although assurance is a means to improve the reliability of information, the adoption and quality of assurance practices vary significantly. The authors also conclude that only a limited number of companies obtained assurance in their sustainability reports. This study provides information to stakeholders, shareholders, and investors on how companies use assurance as a strategy to maintain legitimacy and provides information to assurance preparers and providers on the need to develop a new standard and define who should be responsible for providing assurance on sustainability reporting.

Ref. [7] conducted research on sustainability reporting assurance, studying the perceptions of auditors and users in Spain. The responses suggest that assurance of sustainability reporting is important, but there are many challenges (both methodological and related to the characteristics of non-financial information) that auditors and companies must work to overcome these problems. For example, improving the quality of non-financial information and adapting the audit to the new requirements for verification of non-financial information. This study provides valuable information on preferences regarding the form and content of the audit report on integrated information.

Ref. [8] explored the diversity of sustainability assurance practices in the UK and found that suppliers' understanding of sustainability assurance practices varied significantly. This study identifies four types of sustainability assurance, which are designated as social assurance, integrated assurance, formative assurance, and compliance assurance. Such categorization provides a broad understanding of the implementation of sustainability assurance and the degree of heterogeneity within it.

The practices for assurance of the sustainability report are also not standardized in the global context. This research promotes the study of current practices with a view to improving and projecting them toward robust development, such as combined assurance with a full scope of the report and a reasonable level of assurance, as well as proposing a model to measure the reliability of sustainability information with variables that contribute to users of financial and non-financial information accessing relevant and reliable communications for decision-making.

In Colombia, there is no obligation to present integrated information; however, since 2010, some companies, mainly those classified as large, have communicated financial and non-financial information within their corporate reports. Ref. [9] analyzed sustainability reporting in Colombia and evaluated the situation and the factors that drove its implementation in the period 2013–2018. The results show that sustainability reporting is not fully institutionalized in Colombia, and its implementation is evolving. Companies use different strategies for communicating sustainability reporting standard GRI, IR, or other denominations.

From the previous landscape, the research interest emerges, given that in the global context, there are no standardized practices for the preparation and presentation of the sustainability report nor for providing assurance to the report. This study is motivated to understand how the large Colombian companies, classified by their income, are assuring their reports, and specifically those in environmentally sensitive sectors. Based on this, this study proposes a model with variables that allow for measuring the reliability of the information.

As sustainability reporting develops, assurance is a key aspect of building trust, guaranteeing the relevance and faithful representation of information for the decision-making of companies in the short, medium, and long terms [10]. The research and application of

assurance practices to ensure the reliability of financial information has been more widely developed than for non-financial information, so different studies have addressed assurance from various approaches: internal assurance; external assurance; and combined assurance.

Through agency theory, legitimacy theory, stakeholder theory, and information utility theory, the objective of this research is to determine the assurance methods applied to sustainability reporting in Colombia.

There is research on the development, implementation, and assurance of sustainability reports in different contexts, but there are no standardized practices or models to measure their reliability. This gap presents an opportunity to investigate and develop the literature in the field of audit and assurance.

This study fills this gap by proposing a model to measure the reliability of the sustainability report and proposing the implementation of combined assurance with a full scope of reasonable assurance in the information assurance process.

The results of this research can be useful for the regulation of the standardization of assurance practices by national and international organizations. In addition, it contributes to the preparers and auditors of sustainability reporting in the development of their work. Future lines of research can be derived from this research, such as the study of integrated information in small and medium-sized companies and their assurance.

After the introduction, this paper defines the theoretical framework that helps to identify the theories that support the research hypotheses, defines the methodology, builds the statistical measurement model, analyzes the results, and establishes some final considerations.

2. Materials and Methods

2.1. Theoretical Model

From agency theory [11], legitimacy theory [12,13], stakeholder theory [14], and information utility theory [15], contributions are made to the field of research related to assurance focused on the reliability of integrated corporate information. Sustainability reports are communications made by the company to inform stakeholders about its management in the three pillars of sustainability: economic–financial; social; and environmental [16]. Increasingly, users of this information demand verification. In fact, information assurance is important in the business context to improve public trust in information [6,17–21].

Considering the types of internal, external, or combined assurance, the objective of this study is to determine the assurance methods applied to the sustainability report of the mining–hydrocarbons, construction, and manufacturing sector in Colombia in 2021; the non-financial sectors are those that have a production process of transforming raw materials, offering goods and products to the economy. Another objective of this study is to measure the reliability dimension in the integrated reports, sustainability reports, or other reports published by Colombian companies on a voluntary basis.

Internal assurance starts from the basis of internal control as a process designed, implemented, and monitored by the organization's management to provide reasonable assurance regarding the reliability of financial and non-financial information, the effectiveness and efficiency of operations, and compliance with legal and regulatory provisions [22,23].

For its part, the control architecture is made up of five components, which are the Control environment, Risk management, Control activities, Information and communication in the organization, and Monitoring [24–26].

Ref. [27] approaches assurance from the internal perspective, stating that the mechanisms for improving credibility are those of internal assurance (corporate governance practices, internal auditing, management processes, internal control processes, and identification processes of alternative, genuine, and profitable risks). Ref. [28] concludes that stakeholder expectations, perceived importance of Corporate Social Responsibility (CSR), and proactivity influence the existence of formal and informal controls related to CSR in a positive and significant way on corporate performance.

Regarding external assurance, refs. [24,29] start from the understanding of the reporting entity and its control architecture to determine the nature, scope, and timing of the analytical and substantive procedures on which the engagement conclusion or opinion is based.

Assurance can be either limited assurance or reasonable assurance. Both involve the application of procedures to obtain sufficient and appropriate evidence and differ in the emphasis of the procedures, as limited assurance applies documentation review procedures, investigation, observation, and analytical procedures, while reasonable assurance applies both analytical and substantive procedures with greater emphasis, evaluates the design and implementation of the organization's controls for the preparation of the sustainability report, and obtains evidence from external sources.

The reliability of the information is conditioned by the existence and effectiveness of the internal control mechanisms and by the fulfillment of affirmations of the following order: Integrity; Existence; Accuracy; Valuation; Ownership; Presentation; and disclosure [30,31].

Currently, with the adoption of international auditing and assurance standards in the world [22], the auditor performs work that seeks to provide assurance on financial and non-financial information, such as audits of financial statements, assurance of information other than audits or reviews of historical financial information, agreed-upon procedures, which involve limited assurance, reasonable assurance, or different degrees of assurance.

ISAE 3000, and ISRS 4400 are examples of standards where the auditor performs information assurance contracts that involve the application of different procedures [22]. Obtaining sufficient and appropriate evidence to support their conclusion or opinion depends on the case. These standards include the assurance of financial and non-financial information.

Finally, refs. [32–37] examined the combined assurance approach, the restoration of investors' willingness to invest when there are significant reporting reliability risks, providing evidence of the benefits of combined assurance as an innovative mechanism that enhances credibility.

In accordance with the above, the need arises to study the following aspects: scope of assurance (assurance of the entire report or only of specific sections such as the greenhouse gas effects section), level of assurance (limited, reasonable assurance), type of assurance (internal, external, combined), and standards applied (ISAE 3000, Assurance Standard AA1000AS or others).

The information assurance process has important phases for those who prepare the information and subsequently audit it, with the aim of contributing to the reliability of the information for stakeholders' decision-making. Therefore, to measure reliability, the following variables were identified as keys to the theoretical model: standard applied to prepare the sustainability report (SATPR); scope of assurance (A. Scope); type of assurance (A. Type); level of assurance (A. Level); assurance standard applied; auditing company of integrated information; author of the sustainability report; environmental certifications; sustainability manager; comparison of indicators; correspondence between the company auditing the financial statements and the company auditing the integrated information (SFACFIR), which are depicted in Figure 1.

2.2. Research Objectives

This research focuses on the assurance of sustainability reports, focusing on determining the assurance practices applied to such reports in the mining–hydrocarbons, construction, and manufacturing sector in Colombia in 2021, as well as establishing a model to measure the reliability of these reports.

2.3. Research Philosophy and Methodological Choices

Based on the research model proposed in previous paragraphs and the literature on the subject (Table 1), a series of variables were proposed to measure the reliability dimension of the integrated information for practical and theoretical purposes for companies and government entities. Therefore, this study embraces pragmatism as a philosophy that

prioritizes practical solutions. Pragmatism rejects the notion of singular truths, instead valuing knowledge that demonstrably improves real-world situations, in this case, how companies and governments in Colombia and LATAM countries measure the reliability of sustainability reports. This study selects methods based on their effectiveness in tackling specific research hypotheses, not adherence to rigid frameworks. This flexibility allows for experimentation and the integration of diverse approaches [38], ultimately aiming for impactful contributions to the academic discourse on sustainability assurance, as well as improving corporate practices on enhancing their sustainable reports and shade light on how governments can enhance those corporate practices through policies directed to the most influencing variables that affect the reliability of integrated reports.

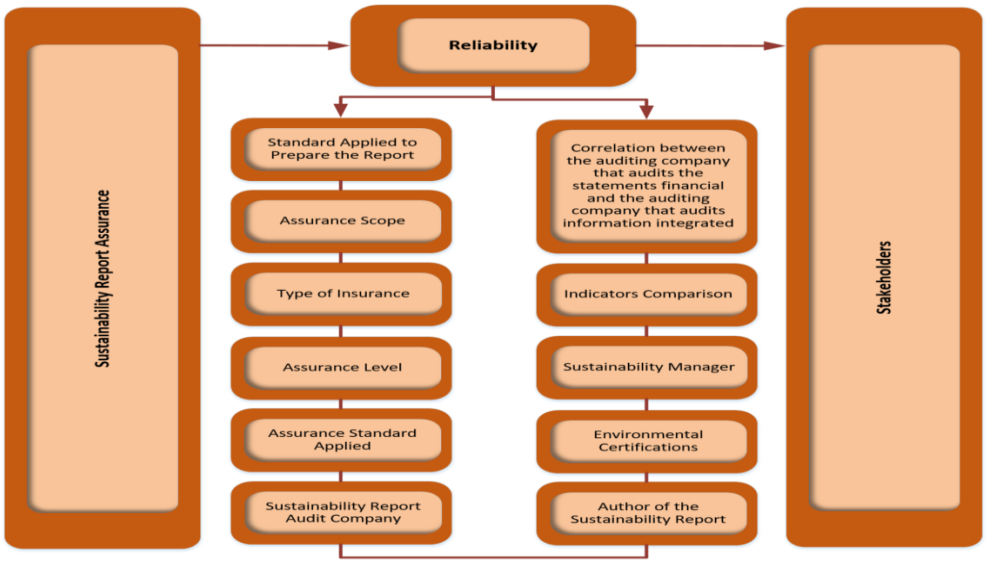

Figure 1. Reliability of Sustainability report. Source: authors.

Table 1. Integrated Information Assurance.

Dimension	Variables
Reliability	Standard applied to prepare the report (SATPR)
	Assurance standard applied
	Author of the sustainability report
	Environmental certifications
	Sustainability Manager
	Comparison of indicators
	Correspondence between the company auditing the financial statements and the company auditing the integrated information (SFACFIR)

Source: authors.

This methodology employed manual content analysis to assess both the quantity and thematic content of sustainability reporting assurance practices [39–41]. Following [42], the analysis focused on the assurance practices of the 95 largest Colombian companies by operating income for the year 2021. Data were extracted from the database of the Colombian Superintendency of Companies, from the companies' integrated reports hosted on their websites, and from the Colombian Securities Exchange [43].

The methodological choices for this study, guided by the research philosophy of pragmatism, involved using a mixed methods approach. Pragmatism allows for flexibility in research design and emphasizes the use of different methods to analyze assurance of sustainability reports, focusing on determining the assurance practices applied to such reports

in the mining–hydrocarbons, construction, and manufacturing sectors in Colombia in 2021, as well as establishing a model to measure the reliability of these reports. Consequently, the mixed methods approach, guided by pragmatism, ensures a robust and comprehensive analysis of the research objectives, integrating qualitative content analysis on all sustainability reports from the 95 largest Colombian companies together with quantitative statistical techniques to enhance the validity and depth of this study's findings.

2.4. Research Strategy

Aligned with the pragmatist philosophy and employing a mixed methods approach, this research adopts a secondary data analysis strategy, utilizing accessible and reliable data from the Colombian government and private companies that align with the research objectives. As [44] states, perhaps the most crucial step in secondary analysis is knowing exactly what you are looking for—that is, having clearly articulated research objectives and understanding what types of data might answer those objectives. This study employs content analysis and quantitative analysis, specifically, multiple linear regression and non-parametric bootstrapped regression analysis, to comprehensively address the research objectives.

2.4.1. Content Analysis

The objective of the content analysis is to systematically code and evaluate the assurance methods applied to sustainability reports of companies in the mining–hydrocarbons, construction, and manufacturing sectors in Colombia for the year 2021.

Process:

Selection of Reports: A total of 95 sustainability reports from the specified sectors were selected for analysis, with report lengths ranging from 20 to 400 pages each.

Coding Scheme Development: Following [42], a coding scheme was developed based on themes such as assurance methods, specifically assurance scope (A. Scope), assurance level (A. Level), assurance type (A. Type), SDG inclusion, and environmental certifications. Additionally, binary coding was applied to the Colir Index and SFACFIR variables.

Data Extraction: Qualitative data were extracted from the companies' integrated reports hosted on their websites and also from the Colombian Securities Exchange; both data were coded according to the developed scheme mentioned above.

Thematic Analysis and Justification: Patterns and themes related to the assurance practices, their presence in the Colir Index (ESG index), and the reliability of sustainability reporting were identified.

The content analysis allowed for an in-depth understanding of the qualitative aspects of the sustainability reports, providing insights into the practices and contexts of sustainability disclosure. Basic content analysis, as stated by [45], is a research technique for the objective, systematic, and quantitative description of the manifest content of communication.

2.4.2. Quantitative Analysis (Correlation and Regression Analyses)

The correlation and regression analyses were conducted using R (version RStudio 2023.06.0+421) to examine relationships among variables relevant to sustainability reporting assurance. The primary goal of this quantitative analysis was to statistically evaluate the factors influencing the reliability of sustainability reports and to develop a robust model for measuring this reliability. Each step of the analysis process is detailed below to facilitate replication.

Process:

Variable Selection: Key independent variables were selected to capture the primary factors affecting report reliability. These included assurance scope (A. Scope), assurance level (A. Level), assurance type (A. Type), SDG inclusion, company size (measured by assets), return on assets (ROA), leverage, inclusion in the COLIR index, Environmental

Sensitive Industry (ESI), and SFACFIR. The dependent variable was defined as the reliability of sustainability reports.

Data Preparation and Cleaning: Missing values were addressed using list-wise deletion for the Spearman correlation analysis, while the lm() (linear regression model) function internally applied a na.omit process for the multivariable regression model. Data distribution by industry was visualized through boxplots. Variance Inflation Factor (VIF) for all independent variables was checked and plotted. Outliers were examined by plotting Influential Observations and Cook's Distance, ensuring that only observations within an acceptable range of influence were retained. Specifically, standardized residuals were assessed, with observations falling within ± 3 standard deviations preserved to maintain data integrity.

Model Specification: A multiple linear regression model (OLS) was constructed using the lm() function in R to analyze the relationships between the selected variables. Correlation matrices provided preliminary insights, while variance inflation factors (VIFs) from the car package were calculated to explore multicollinearity.

Validation via Bootstrapping: To validate the regression coefficients and enhance robustness, non-parametric bootstrapped regression was applied, using 10,000 random samples generated with the boot() function from the "car" package [46]. This technique strengthened the reliability of the results by validating coefficients without assuming normality.

Model Hypothesis Testing and Assumptions: Model assumptions were rigorously evaluated. Normality was assessed using the Shapiro-Wilk test through the shapiro.test() function. The normality of residuals, linearity, and homoscedasticity of the model were verified using Q-Q plots and residual versus fitted value plots, respectively. Influential observations were identified using Cook's distance. For comparisons of ranked distributions (medians) in non-normal distributions, the Kruskal–Wallis Rank Sum Test was employed using the kruskal.test() function. Finally, a correlation matrix was computed with a test for association/correlation between paired samples using the cor.test() function.

Results and Model Fit: The final model fit was evaluated using R-squared and Adjusted R-squared values, confirming its explanatory power. Global tests, including the F-statistic and *p*-value, were also applied to assess the model. Diagnostic checks through model plots confirmed model validity, ensuring that no patterns in the residuals indicated misspecification.

In summary, the regression analysis provided a rigorous statistical framework for quantifying the impact of various variables on the reliability of sustainability reports. Bootstrapping further strengthened the reliability of the results by validating the coefficients without assuming a normal distribution.

2.4.3. Integration of Strategies

The integration of content analysis and quantitative regression analyses ensured a comprehensive approach to addressing the research objectives. Content analysis provided qualitative insights into the assurance practices applied to the sustainability reports, as well as coding important variables by theme, while regression analyses offered a quantitative assessment of the factors influencing the reliability of these reports.

Rationale for Combined Strategies:

Content Analysis: Captured the richness and depth of the sustainability reports, especially their assurance practices and methods;

Correlation and Regression Analyses: Statistically validated the relationships among key variables and measured the reliability of sustainability reports, as well as validated the generazability of variables' coefficients.

In conclusion, the combined use of content analysis together with correlation and quantitative regression analyses aligns with the pragmatist philosophy, ensuring a robust, flexible, and comprehensive approach to understanding and analyzing the reliability of sus-

tainability reports in Colombia's mining–hydrocarbons, construction, and manufacturing sectors in 2021 for practical purposes.

2.5. Approaches to Theory Development

This study employed a deductive approach to theory development, which aligns with the research philosophy and objectives outlined. A deductive approach begins with the establishment of hypotheses derived from the existing theories and the literature, followed by empirical testing of these hypotheses using collected data [47]. This methodology is well-suited to this study, which seeks to validate theoretical constructs related to the reliability of sustainability reports through rigorous statistical analysis.

The theoretical framework for this research is rooted in established auditing and assurance theories, particularly those pertaining to sustainability reports. Key concepts such as the influence of specific section vs. without specific section on assurance scope, the impact of internal versus external assurance types, the effect of limited vs. without assurance level, and the influence of company characteristics (e.g., size, financial, and leverage) on the reliability of sustainability reporting are central to this study's hypotheses.

Based on all of the former, the following hypotheses were verified, taking advantage of the analysis with statistical tools using the R software.

2.5.1. Integrated Information Assurance (HP1)

Assurance of financial information is more developed than assurance of integrated information. Therefore, it is assumed that sustainability reports present a type of internal assurance that, for the most part, does not allow to know the level of assurance, assuming that it is reasonable assurance. Companies that contract an external assurance provider have a limited level of assurance.

HP1: *There is a positive relationship between the type and level of assurance.*

2.5.2. Scope of Assurance (HP2)

As explained in the theoretical framework, in Colombia, there is no obligation to submit integrated information, and for companies that submit it voluntarily, there is no obligation to submit it audited, so the scope of the assurance is not determined. We assume that the scope of assurance depends on the type of assurance. That is, if the company internally ensures the integrated information, the scope cannot be determined; it is assumed that it is for all the information. When the company hires an external assurance, the scope is determined in the auditor's report, assuring a specific section and not the entire report.

HP2: *There is a positive relationship between the type and scope of assurance.*

2.5.3. COLIR Index (HP3)

Indexes allow us to measure some companies against others on a specific topic. COLIR is a Colombian market that belongs to the ESG (Environmental, Social, and Governance) category and captures social, environmental, or corporate governance initiatives. These initiatives are presented and reported in sustainability reports, integrated reports, or other denominations that contribute to legitimizing the company and strengthening trust among stakeholders.

HP3: *The COLIR index has a positive relationship with the reliability variable.*

2.5.4. Assurance Provider (HP4)

When a company makes the sustainability report by reference to a standard, the standard recommends an external verification of the integrated information. The company may engage the same auditing firm for the financial statements. This can contribute to generating greater reliability of the information since the auditor of the financial statements knows the business model, profitability, costs, resources, and shareholders' decisions and

can, therefore, contribute to the verification of integrated information with a comprehensive view of the company.

HP4: *The correspondence between the company auditing the financial statements and the company auditing the integrated information has a positive effect on the reliability variable.*

2.5.5. Environmentally Sensitive Sector (HP5)

Companies in the mining–hydrocarbons sector in Colombia generate a significant environmental impact, so they are obliged to develop initiatives that contribute to reversing these impacts and informing their stakeholders.

HP5: *There are differences between the medians of the reliability variable of the environmentally sensitive sector and the construction and manufacturing sectors in Colombia.*

2.6. Time Horizon, Sample, Techniques, and Procedures

2.6.1. Sample and Time Horizon

The sample framework is made up of the report of the 1000 largest companies in Colombia that report information to the agency that carries out inspection, surveillance, and control of commercial companies [48]. The database of the year 2021 is analyzed since it was the most updated fiscal year by the beginning of 2023 when this research started. Subsequently, three macro sectors were selected: mining–hydrocarbon; construction; and manufacturing since they are environmentally sensitive sectors. The total number of companies that report information to the Superintendence of Companies of Colombia belonging to the selected sectors is 396, of which only 95 companies present integrated reports, sustainability reports, or other denominations because, in Colombia, it is not yet mandatory. The distribution of analysis of the reports by sector is as follows: 14 reports from the construction sector; 19 from the mining–hydrocarbon sector; and 62 from the manufacturing sector. Table 2 shows the percentage distribution of the companies in relation to the macro sector.

Table 2. Frequency and percentage of the sample by industry.

Industry	Frequency	Percentage
Construction	14	15%
Mining–hydrocarbon	19	20%
Manufacturing	62	65%
Total	95	100%

Source: authors.

2.6.2. Quantitative Data Collection

Variable Identification: Key independent variables, such as assurance type (A. Type), assurance scope (A. Scope), assurance level (A. Level), company size, ROA, leverage, inclusion in the COLIR index, SDG inclusion, and Environmental Sensible Industry (ESI), and the dependent variable (reliability of sustainability reports) were selected.

Data Sources: Sustainability reports, financial statements, and additional company information were obtained from public databases and company disclosures, as stated at the beginning of this section. The links to the Superintendence of Companies of Colombia and the Colombian Securities Exchange databases are provided in the reference section of this research.

3. Statistical Analysis and Discussion

The average values of the different variables that measure the reliability dimension (scored from 0 to 10) are reported in Table 3. This scale was based on the methodology used by the authors [42], which is similar to the min–max methodology of [49]. The minimum value reported (0.95), which is the variable with the lowest impact on the overall value of the reliability of Sustainability reporting in Colombian companies in 2021, is one that refers

to the correspondence between the company auditing the financial statements and the company auditing the sustainability report. This situation arises because only 9 companies have the same auditing company; in 17 companies, there is no correspondence between the auditing companies, and for the remaining 69 companies, it was not possible to find the information because the financial statements could not be accessed or because the sustainability report did not have external verification.

Table 3. Mean values of the variables that measure reliability.

Variables	Average Value (0–10)
Standards applied in the sustainability report	2.53
Assurance Standard	1.63
CSR Manager	1.58
Environmental Standard	8.42
Internal Author	10.00
KPI period comparison	10.00
The same company audits the financial statements	0.95

Source: authors.

The maximum value (8.42), that is, the variable with the greatest positive impact on the overall reliability value, refers to environmental certifications that contribute to generating confidence in the company's environmental management with respect to caring for the environment and preserving resources for future generations.

There are also two values without variation in the mean, which are the variables' internal author of the integrated information and the comparison in the indicators. For all the companies analyzed, it was possible to verify that the preparation of the report took place internally and that they presented comparisons between the economic, financial, environmental, and social indicators for the years 2020 and 2021.

The seven reliability variables and the reliability itself are shown in Table 4. The average value of CSR Manager (1.58) represents that only 16% of the companies analyzed have a sustainability manager. The assurance standard applied variable had an average value of 1.63, which means that only 6% applied a single ISAE 3000 or AA 1000 standard, which are the most widely known and applied standards, and only 3% applied two standards for the audit of financial information, such as ISO and ISAE 3410.

Table 4. Reliability Variables: descriptive statistics.

Variables	Obs.	Average	Std. Dev.	Min	Max
KPI Period Comparison	95	10.00	0.00	10.00	10.00
CSR Manager	95	1.58	3.67	0.00	10.00
Reliability	95	5.02	1.26	2.86	9.08
Variable: Standard Assurance	95	1.63	2.87	0.00	10.00
Environmental Standard	95	8.42	3.67	0.00	10.00
Internal Author	95	10.00	0.00	10.00	10.00
Same Finance Auditing Comp. for I.R. (SFACFIR)	95	0.95	2.94	0.00	10.00
Standards Applied to Prepare Report (SATPR)	95	2.53	1.71	0.00	10.00

Source: authors.

As for the minimum and maximum values reached by each variable, it shows that the variables CSR Manager, assurance standard applied, environmental standard certifications, correspondence between the auditing company of the financial statements, the company that audits the sustainability reporting, and the standard applied to prepare the sustainability reporting reached the limit values of 0 and 10. These extreme scores are due to the fact that there is great variability in the variables studied in the companies analyzed, and that there were limitations such as, for example, accessing all the financial statements to verify the correspondence between the company auditing the financial statements and

the company auditing the sustainability report, as well as the fact that in some cases, the information did not appear explicitly in the sustainability report.

As for the average reliability value, this is 5.02, with a minimum of 2.86 and a maximum of 9.08.

As discussed above, the assurance of integrated information increases the reliability of reports for decision-making by stakeholders. Assurance is configured from different types, scopes, levels, and applications of standards for verification; it is, therefore, essential to verify to what extent these variables are related to each other. Table 5 shows the eight variables' varying degrees of correlation, contributing to the Reliability construct. Notably, the type of assurance and level of assurance, as well as the scope of assurance and type of assurance, are strongly related, significant at the 1% level. However, a possible perfect correlation of 1 between the type of assurance and the level of assurance may cause collinearity issues.

Table 5. Spearman correlation test of the numerical variables that measure reliability (except those with a standard deviation of 0).

Correlation Matrix of Reliability Variables: Spearman's Rho								
	CSR Manager	**Assurance Standard**	**Environmental Standard**	**SFACFIR**	**SATPR**	**Assurance Type**	**Assurance Scope**	**Assurance Level**
CSR Manager		0.337 ***	0.029	−0.042	0.274 **	0.314 **	0.382 ***	0.314 **
Assurance Standard	0.337 ***		0.081	0.485 ***	0.287 **	0.814 ***	0.828 ***	0.814 ***
Environmental Standard	0.029	0.081		0.042	0.178	0.117	0.072	0.117
SFACFIR	−0.042	0.485 ***	0.042		0.265 **	0.465 ***	0.527 ***	0.465 ***
SATPR	0.274 **	0.287 **	0.178	0.265 **		0.296 **	0.315 **	0.296 **
Assurance Type	0.314 **	0.814 ***	0.117	0.465 ***	0.296 **		0.882 ***	1.000 ***
Assurance Scope	0.382 ***	0.828 ***	0.072	0.527 ***	0.315 **	0.882 ***		0.882 ***
Assurance Level	0.314 **	0.814 ***	0.117	0.465 ***	0.296 **	1.000 ***	0.882 ***	

Computed correlation used Spearman's method with listwise deletion. *** $p < 0.01$. ** $p < 0.05$. Source: authors.

Proceeding to the statistical analysis, a statistical model was created and subjected to multiple linear regression after performing the necessary tests. Our variables of interest are the scope of assurance, type of assurance, and level of assurance. Control variables we included are as follows: environmentally sensitive sector; SDGs; profitability (ROA); leverage (total liabilities/total assets); company size (total assets on a logarithmic scale based on the literature); visibility (a dichotomous variable that explains the presence or absence of the company in the COLIR index and makes it possible to compare the stocks of companies that seek to go further to strengthen confidence among the investment community and that, in turn, advance best practices in terms of investor relations and disclosure of information to the market in general); and finally, the correspondence between the auditing firm of the financial statements and the company auditing the integrated information.

$$Reliability = \alpha + \beta_1 ESI + \beta_2 SDGs + \beta_3 Assurance(Scope) + \beta_4 Assurance(Type) + \beta_5 Assurance(Level) + \beta_6 ROA + \beta_7 Leverage + \beta_8 Size + \beta_9 Colir(Index) + \beta_{10} Auditor$$

Figure 2 shows that most of the data are concentrated between 5 and 6, which allows us to conclude that there is no normal distribution, and it is skewed to the right, as noted by the red density curve and the histogram.

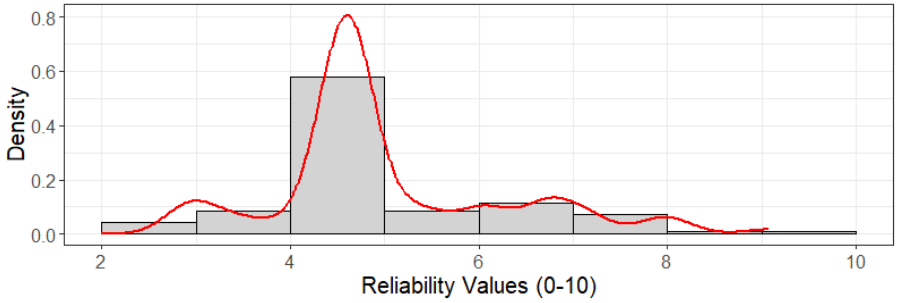

Figure 2. Reliability's Histogram and Density Curve. Source: authors.

Descriptive statistics for all variables in the model are shown in Table 6. It is interesting to note that three characteristics are widely present in the sample are the scope, type, and level of assurance. In contrast, there is a low presence of companies operating in ESI sectors and a low number of companies that are present in the COLIR stock market index. As shown in Table 7, a linear model was fitted (estimated using OLS) to predict Reliability with ESI, SDG, A.Scope, A.Type, ROA, Leverage, Size, Visibility and SFACFIR (formula: Reliability ~ ESI + SDG + A.Scope + A.Type + ROA + Leverage + Size + Visibility + SFACFIR). The model explains a statistically significant and substantial proportion of variance (R^2 = 0.61, F(9, 85) = 14.66, p < 0.001, adj. R^2 = 0.57). The model's intercept, corresponding to ESI = ESI, SDG = Not Apply SDG, A.Scope = Without Specific Section, A.Type = Internal, ROA = 0, Leverage = 0, Size = 0, Visibility = Visible in Colir Index and SFACFIR = Not Same Auditing Comp., is at 4.76 (95% CI [0.91, 8.61], t(85) = 2.46, p = 0.016). Within this model, the following can be interpreted for each variable:

Table 6. Descriptive statistics of the variables we want to measure within the statistical model.

Independent and Control Variables	Obs	Averg.	Std. Dev	Min	Max
ESI	95.00	0.20	0.40	0.00	1.00
SDG	95.00	0.57	0.50	0.00	1.00
Profitability	95.00	0.06	0.10	−0.26	0.43
Leverage	95.00	0.55	0.23	0.01	1.08
Size	95.00	20.69	1.30	18.28	25.87
Scope of Assurance (A. Scope)	95.00	2.74	4.48	0.00	10.00
Type of Assurance (A. Type)	95.00	1.63	2.36	0.00	5.00
Assurance Level (A. Level)	95.00	1.63	2.36	0.00	5.00
Visibility	95.00	0.07	0.26	0.00	1.00
The same company audits the financial statements (SFACFIR)	95.00	0.95	2.94	0.00	10.00

Table 7. Results of the statistical model.

Predictors	Beta	95% CI [1]	*p*-Value	q-Value [2]
(Intercept)	4.0	0.43, 7.6	0.029	0.072
ESI				
No ESI–ESI	0.12	−0.43, 0.67	0.7	0.8
SDG				
Apply SDG–Not Apply SDG	0.58	0.20, 0.97	0.003	0.011
A. Scope				
Specific Section–Without Specific Section	1.3	0.46, 2.2	0.003	0.011
A. Type				
External–Internal	0.33	−0.45, 1.1	0.4	0.7
ROA	−0.28	−2.2, 1.6	0.8	0.9
Leverage	0.19	−0.71, 1.1	0.7	0.8
Size	−0.01	−0.17, 0.15	>0.9	>0.9

Table 7. *Cont.*

Predictors	Beta	95% CI [1]	*p*-Value	q-Value [2]
Visibility				
Visible in Colir Index–No Visible in Colir Index	0.74	0.01, 1.5	0.048	0.10
SFACFIR				
The Same Auditing Company–Not The Same Auditing Company	1.1	0.40, 1.8	0.002	0.011
R^2	0.608			
Adjusted R^2	0.567			
p-value	<0.001			
Statistic	14.7			
No. Obs.	95			
Sigma	0.830			

[1] CI = Confidence Interval. [2] False discovery rate correction for multiple testing. Source: authors.

Environmental Sensitive Industry (ESI): The effect of ESI is positive but statistically non-significant (β = 0.12, $p = 0.672$). This implies that being in an environmentally sensitive industry does not significantly affect the reliability of sustainability reports. This result may suggest that without additional sustainability measures or specific frameworks, the industry's environmental sensitivity alone does not impact report reliability;

Sustainable Development Goals (SDG): The effect of incorporating SDG practices in the reports is significant and positive (β = 0.58, $p = 0.003$), suggesting that firms actively engaging in SDG-related initiatives tend to produce more reliable reports. This may reflect the comprehensive nature of SDGs as a guiding framework that enhances transparency and standardization;

Assurance Scope (A.Scope): A.Scope also shows a significant positive effect (β = 1.32, $p = 0.003$), indicating that reports with a specific section dedicated to peculiar issues, such as the greenhouse gas effects, are perceived as more reliable. This finding highlights the importance of structured and dedicated sections within reports, possibly due to their increased transparency and focus on specific areas;

Assurance Type (A.Type): The coefficient for external assurance (β = 0.33) is positive but statistically non-significant ($p = 0.398$). This suggests that while external assurance could add perceived credibility, it does not significantly affect report reliability within this model's framework. This non-significance may indicate that the quality of reporting could depend more on the reporting structure than on whether the assurance is internal or external;

Return on Assets (ROA): The negative coefficient for ROA (β = −0.28, $p = 0.771$) is also non-significant. This suggests that firm profitability may not be a crucial determinant of sustainability report reliability, which aligns with findings that profitability metrics do not necessarily translate into better reporting practices;

Leverage: The positive but non-significant effect of Leverage (β = 0.19, $p = 0.674$) indicates that a company's debt level does not play a substantial role in determining the reliability of its sustainability reporting;

Size: The effect of firm size is very close to zero and statistically non-significant (β = −0.007, $p = 0.930$). This suggests that the size of a firm, as measured in this study, does not influence the reliability of its sustainability reporting. This could imply that both large and small firms are equally capable of producing reliable reports;

Visibility: Visibility in the COLIR index has a significant positive coefficient (β = 0.74, $p = 0.048$), suggesting that firms listed in the COLIR index produce reports with higher reliability. This could indicate a tendency among listed firms to prioritize transparency to maintain public trust;

Same Auditing Company for Financial and Integrated Reports (SFACFIR): Finally, using the same auditing firm for both financial audits and assurance (SFACFIR) is positively significant (β = 1.08, $p = 0.002$), suggesting that consistency in audit firms may enhance

report reliability. This consistency might be attributed to greater alignment and understanding of firm-specific practices by the auditing firm, thereby boosting report quality.

From the results above, a significant ($p < 0.05$) and positive ($\beta = 0.74$) relationship with the independent visibility variable COLIR is present. This result confirms Hypothesis 3. This is an important confirmation, given that the COLIR index presents companies with sustainable initiatives and strengthens trust among their stakeholders. Companies that are listed in the COLIR index and present integrated information have greater reliability in their reported information. This aligns with the Legitimacy Theory [12,13] as it enables firms to present themselves as responsible and transparent to the public. By reporting on their ESG initiatives, companies use the COLIR index as a tool to legitimize their actions and build trust with stakeholders. Thus, a positive relationship between the COLIR index and reliability suggests that companies with strong ESG performance are perceived as more reliable due to their efforts to conform to societal and environmental expectations.

The multiple regression model showed a positive effect ($\beta = 1.08$, $p < 0.002$) for the variable (SFACFIR)—the auditing company of the financial statements is the same company that audits the integrated information. This result confirms Hypothesis 4, highlighting that the use of the same auditing firm for both financial statements and integrated information enhances stakeholder trust in the reliability of disclosures. This finding aligns with Agency Theory [11], which emphasizes the reduction in information asymmetry and agency costs. When the same firm audits both financial and integrated reports, it helps minimize inconsistencies and miscommunication, thereby improving report reliability. This practice can be seen as a mechanism to reduce agency costs by ensuring consistency in oversight and information quality, benefiting stakeholders who rely on both financial and non-financial information.

Regarding Hypotheses 3 and 4, the visibility variable (COLIR index) and the correspondence between the auditing company of financial statements and sustainability reports (SFACFIR) as independent variables are confirmed to be significantly related to reliability ($p < 0.05$ and $p < 0.01$, respectively).

This analysis also confirms Hypotheses 1 and 2, showing a positive relationship between the type and level of assurance, as well as between the scope and type of assurance, at the 1% significance level (see Table 5). This aligns with findings from [2,30], who argue that information reliability is influenced by the existence and effectiveness of internal control mechanisms and adherence to key assertions such as integrity, existence, accuracy, valuation, ownership, presentation, and disclosure. Additionally, this is consistent with [27] view, which emphasizes that credibility is enhanced through internal assurance mechanisms, including corporate governance practices, internal auditing, management processes, internal control, and risk identification procedures.

However, The R software removed the A.Level variable from the model due to collinearity with the A.Type variable, noted in Table 5's correlation matrix. This led to the loss of crucial information. Pearson's chi-squared test with Yates' continuity correction for independence between A.Type and A.Level quantity indicate a statistically significant and very large effect ($\chi^2 = 90.506$, df = 1, $p < 0.001$), with effect sizes labeled according to [50] recommendations, confirming that both variables are strongly associated (Figure 3).

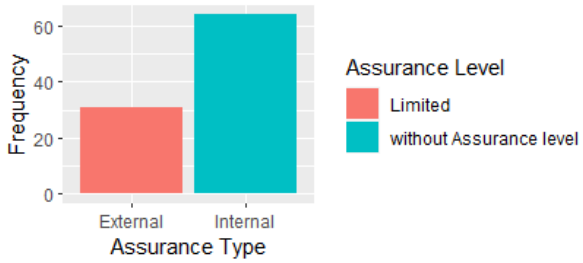

Figure 3. Frequency between Assurance Type and Assurance Level. Source: authors.

Likewise, the density is analyzed by type of macro sector; initially, we thought that the companies that belong to the mining–hydrocarbon sector, considered an environmentally sensitive sector, had a normal distribution compared to the other sectors, measured with the kernel density; however, Figure 4 shows as a result that the densities are different and do not present normal distribution, independent of the macro sector to which the company belongs.

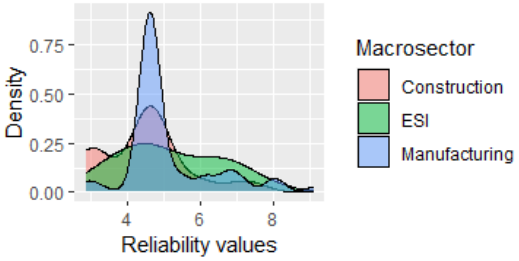

Figure 4. Density by Macrosector. Source: authors.

We confirm our analysis with the Shapiro–Wilk test W = 0.88004, *p*-value = 0.00, where it is observed that the data do not have a normal distribution, which reaffirms Figure 2.

An analysis of the medians among the sectors was carried out (Figure 5). The medians by sector appear to be similar. To confirm this analysis and address Hypothesis 5, the Kruskal–Wallis non-parametric test was calculated. The results were as follows: chi-squared = 2.8107; df = 2; *p*-value = 0.2453. Therefore, Hypothesis 5 cannot be confirmed, as there are no significant differences among the medians by sector. This outcome contradicts the expectation based on the environmental disclosure literature [16,27] which suggests that environmentally sensitive industries (ESI) companies emphasize heightened environmental and social reporting.

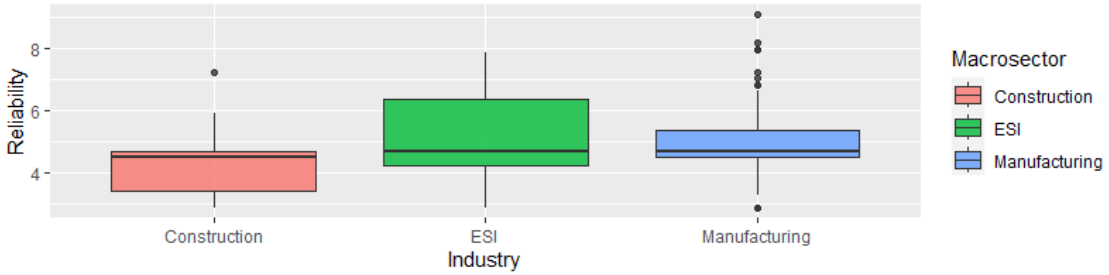

Figure 5. Boxplot of the Reliability Variable by Macrosector. Source: authors.

Before checking the assumptions of the statistical model under normal distribution, there are certain findings that need to be highlighted for policymakers and companies' management boards in Colombia and LATAM. Looking at the pairwise comparisons in Table 7, it is important to highlight the following:

- Companies that apply the SDGs in their sustainability reports have an average score on the reliability measurement scale that is 0.58 points higher than companies that do not apply SDG standards;
- Companies that apply Assurance Scope with a specific section in their sustainability reports have an average score on the reliability measurement scale that is 1.3 points higher than companies with reports without a specific section;
- Companies that are included in ESG indexes on securities markets have an average score on the reliability measurement scale that is 0.74 points higher than companies not included in these indexes; however, after applying the false discovery rate correction for multiple testing, this difference is only significant at the 10% level;

- Companies that use the same auditing company for both financial and ESG information have an average score on the reliability measurement scale that is 1.1 points higher than companies that do not use the same auditing company for both types of information.

The "performance" package in R developed by [51] was employed to rigorously validate our proposed reliability measurement model. This comprehensive package allows us to thoroughly assess and test the statistical model. The outputs generated from the analysis were as follows: Firstly, Figure 6 examined the VIF for all independent variables, revealing that their VIF values were below the threshold of 5. However, the variable "Assurance Scope" exhibited a moderate correlation VIF of 5.10. Secondly, the influential observations were analyzed, and it was determined that all data points resided within the contour lines, as shown in Figure 7, signifying that they all fell below the model's Cook's distance. Furthermore, the normality of residuals was evaluated, and it was observed that certain extreme values deviated from the expected normal distribution, as shown in Figure 8. Lastly, in terms of linearity, the plot of fitted values against residual values displayed a moderately flat curve in comparison to the reference line, as shown in Figure 9. This thorough analysis utilizing the "performance" package provided valuable insights into the strengths and limitations of the reliability measurement model. The software's functionalities greatly facilitated the validation process and contributed to the robustness of the findings. Last but not least, it is worth mentioning that the "ggplot2" package by [52] was used; it is an R package for creating elegant graphics for data analysis. This package was used to visualize the various components and behavior of the reliability variable, such as the boxplot and the density curve by sector (Figures 3–5).

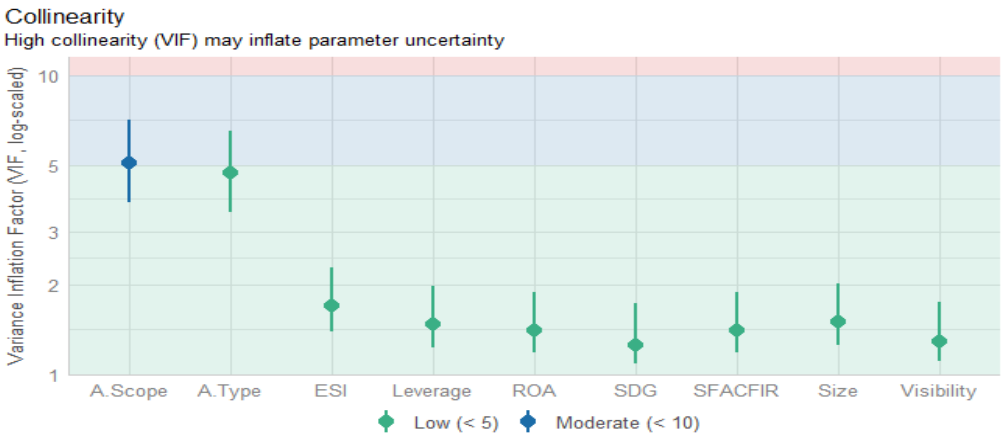

Figure 6. Variance Inflation Factor Plot. Source: authors.

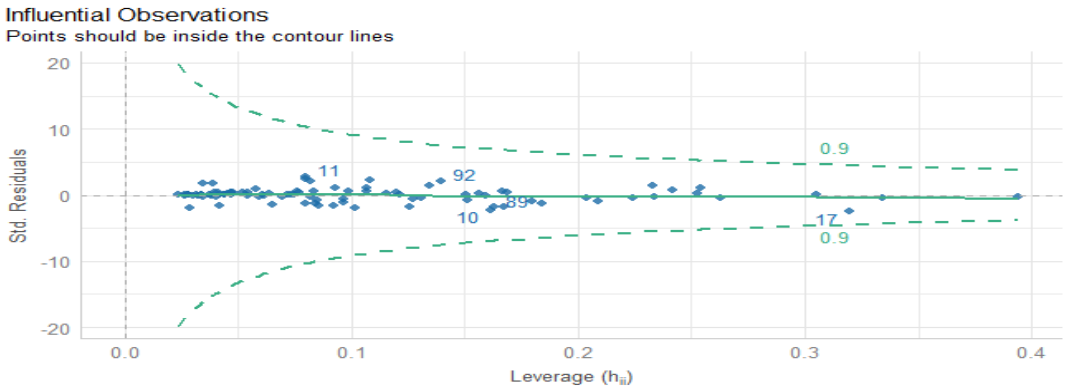

Figure 7. Influential Observations and Cooks' Distance Plot. Source: authors.

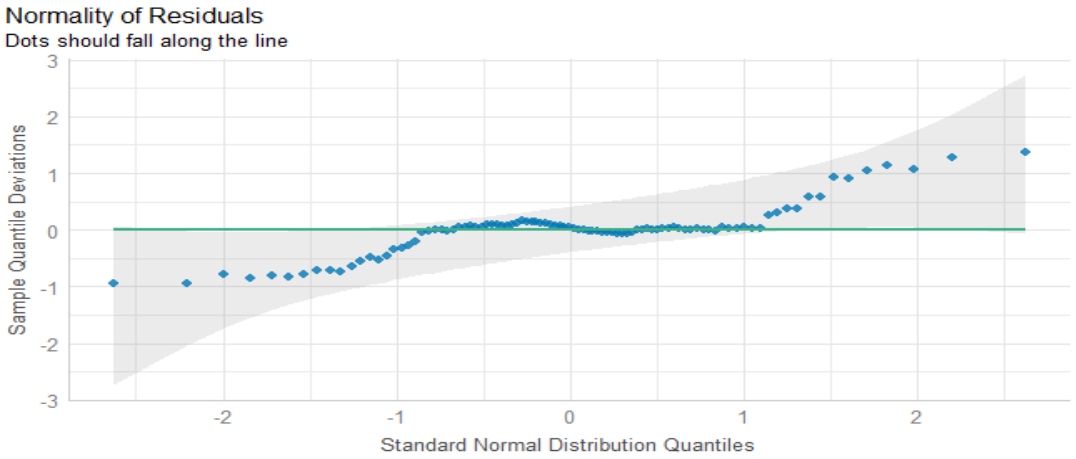

Figure 8. Q-Q Plot. Source: authors.

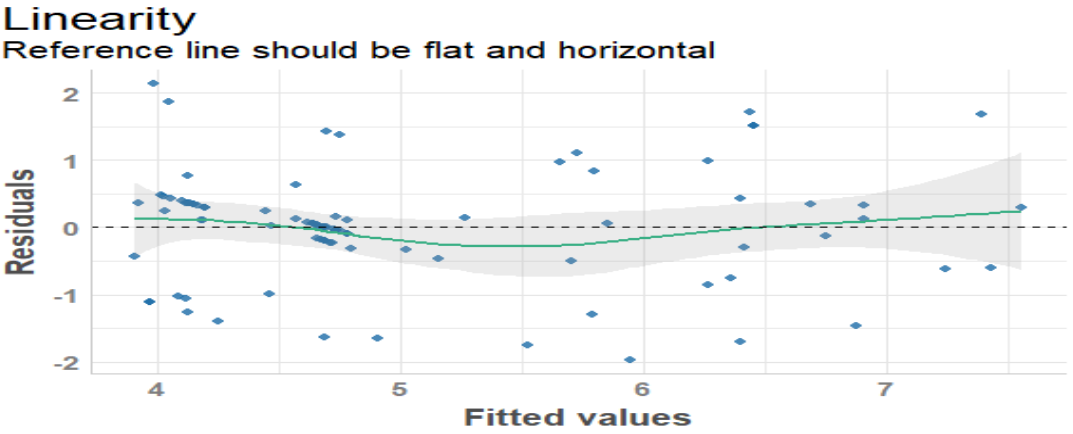

Figure 9. Relationship Between Fitted Values and Residual Values. Source: authors.

Nonetheless, before generalizing these findings to Colombia and other LATAM countries as a first approximation, this model was subjected to bootstrapping regression to validate the coefficients of the variables without assuming a normal distribution. This involved 10,000 random samples with replacements from the initial 95 observations under study. The Boot function from the "car" package by [46] was used for this analysis. It is important to note that the Visibility variable was removed from the bootstrapped regression. This is because it had few positive observations (companies included in the COLIR index) compared to zero observations (companies not included in the COLIR index). This imbalance caused R software to throw a "factor with one level error", essentially indicating "insufficient variation error". Consequently, this model's variables coefficients show slight variations from the original values. However, the results are as follows:

Table 8 highlights that the bootstrapped median values of the coefficients are almost identical to the mean values from the regression model. This suggests that the original OLS model is a good representation of reality. Table 9 shows the confidence intervals at the 95% level. The estimates for the variables SDG, A.Scope, and SFACFIR do not cross zero, indicating that these variables truly represent the population parameters.

Consequently, Figure 10 presents separate histograms for each bootstrapped coefficient estimate, along with the kernel density (blue solid line)estimates and the normal density (fuchsia dashed line) based on the bootstrap mean and standard deviation. The vertical black dashed line marks the original point estimate, and the thick horizontal black line shows the confidence interval based on the bootstrap. The two density estimates for the intercept and the coefficients are similar, and the normal approximation appears to be valid

as well. However, the confidence intervals for the ROA and A.Type variables are not close to symmetric about the original values.

Table 8. Bootstrapped Regression.

Variables	Bootstrap Replications	Original	bootBias	bootSE	bootMed
(Intercept)	9934	3.10	0.12	1.71	3.24
ESI [No ESI]	9934	0.09	−0.05	0.34	0.05
SDG [Apply SDG]	9934	0.58	0.00	0.17	0.58
A.Scope [Specific Section]	9934	1.25	0.01	0.39	1.26
A.Type [External]	9934	0.42	−0.00	0.26	0.40
ROA	9934	−0.61	−0.18	1.46	−0.68
Leverage	9934	0.04	−0.04	0.41	0.00
Size	9934	0.05	−0.00	0.08	0.04
SFACFIR [Same Auditing Comp.]	9934	1.06	−0.03	0.44	1.02

Source: authors.

Table 9. Confidence Interval at 95% Level.

Variables	Estimate	2.5%	97.5%
(Intercept)	3.10	−0.12	6.46
ESI [No ESI]	0.09	−0.51	0.82
SDG [Apply SDG]	0.58	0.27	0.93
A.Scope [Specific Section]	1.25	0.46	1.99
A.Type [External]	0.42	−0.00	1.10
ROA	−0.61	−3.36	2.35
Leverage	0.04	−0.73	0.90
Size	0.05	−0.12	0.19
SFACFIR [Same Auditing Comp.]	1.06	0.27	2.01

Source: authors.

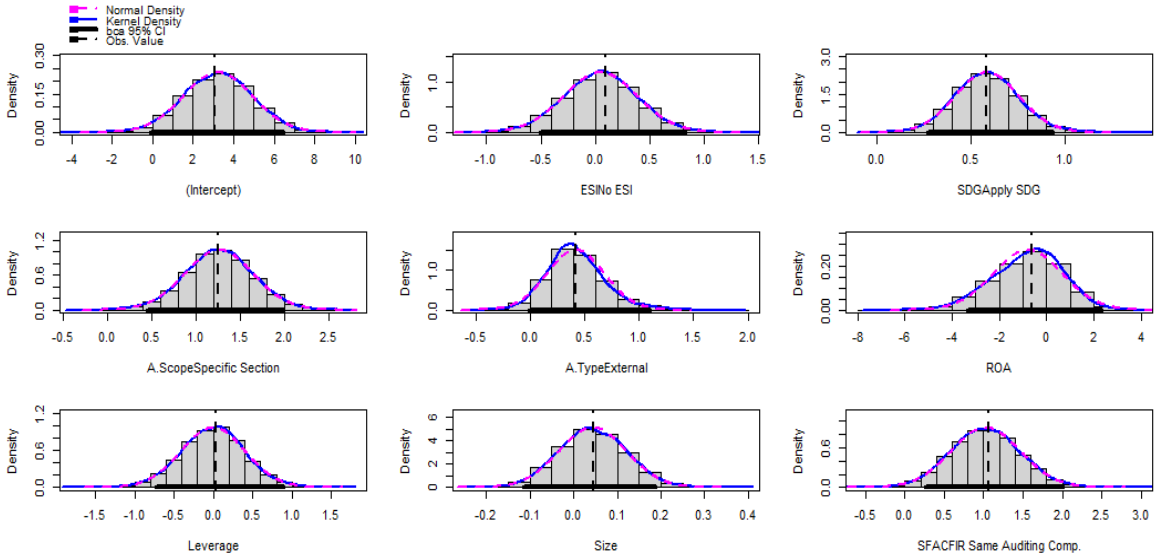

Figure 10. Distribution of Coefficients Estimates of the Bootstrapped Regression. Source: authors.

Importantly, Figure 10 further supports the findings of Table 9. The estimates for the variables SDG, A.Scope, and SFACFIR do not cross zero, again indicating that these variables truly represent the population parameters.

Finally, since this study aligns with the pragmatist philosophy and the research objective seeks to determine the assurance practices applied to sustainability reports in the mining–hydrocarbons, construction, and manufacturing sectors in Colombia in 2021, as

well as to establish a model to measure the reliability of these reports, this research values the applicability of the OLS measurement model presented thus far. Estimated marginal means using the emmeans package by [53] were used to compute best and worst-case scenarios for ESI and non-ESI companies. The best case scenario is the scenario that companies and governments in Colombia and LATAM countries must seek to achieve maximum reliability of sustainability reports by companies.

Desired Scenario for Companies and Governments:

- Assurance Scope: Specific Section;
- Assurance Type: External;
- SDG: Apply SDG in Sustainability Reports;
- Leverage: 1.0845;
- Visibility: Visible in Colir Index (ESG Index);
- SFACFIR: Same Auditing Company.

Worst Scenario for Companies and Governments:

- Assurance Scope: Without Specific Section;
- Assurance Type: Internal;
- SDG: Not Apply SDG in Sustainability Reports;
- Leverage: 0.011;
- Visibility: No Visible in Colir Index (ESG Index);
- SFACFIR: Not the Same Auditing Company.

The results for the estimated marginal means for both scenarios are depicted in Table 10. As shown in Table 10, based on the OLS model, the estimated marginal mean for the reliability of sustainability reports for ESI companies is 8.14 in the best-case scenario and 3.82 in the worst-case scenario. On the other hand, non-ESI companies obtained an estimated marginal mean for the reliability of sustainability reports of 8.26 in the best-case scenario and 3.94 in the worst-case scenario.

Table 10. Estimated Marginal Means (EMMEANS) for Best- and Worst-Case Scenarios.

Scenario	ESI (Factor Variable)	EMMEANS	SE	df	Lower CL	Upper CL
Best Case	ESI companies	8.14	0.672	85	6.81	9.48
Worst Case	ESI companies	3.82	0.466	85	2.90	4.75
Best Case	Non-ESI companies	8.26	0.616	85	7.04	9.49
Worst Case	Non-ESI companies	3.94	0.521	85	2.91	4.98

Note: Confidence level used: 0.95. Source: authors.

4. Conclusions

The presentation of the sustainability report is not yet mandatory in Colombia and even less so is its assurance. However, the Financial Superintendence and the Superintendence of Companies in Colombia have issued standards and recommendations for companies to disclose information on social, environmental, and climate-related matters.

Ref. [54], which aims to standardize and improve the disclosure of sustainability information and its relevance to investors. The Superintendence of Companies issued [55], which aims to improve transparency and accountability in the presentation of financial and non-financial information.

These circulars refer to the presentation of sustainability information, but there are still no pronouncements regarding its assurance, so it is an issue under development both in Colombia and the global context.

Given the above, the assurance of sustainability information is a topic of interest for conducting research and practical developments in the area of audit and assurance. This research focuses on studying the assurance practices of the sustainability reports of the largest Colombian companies according to the financial information reported to the Superintendence of Companies in 2021, the supervisory entity.

The entities included in the research are companies from the non-financial sectors of the construction, mining–hydrocarbons, and manufacturing macro-sectors, as they are environmentally sensitive industries, and the impacts they can generate on the economy, the environment, and society.

Based on the analysis of the assurance practices for sustainability reports and the study of the variables to measure the reliability of the reports, this study can conclude the following:

From the review of the assurance methods applied to the sustainability reporting of the mining–hydrocarbons, construction, and manufacturing sector in Colombia in 2021, it is evident that 67% of the companies studied apply internal assurance that does not specify the scope and level of assurance. On the contrary, 33% of the companies analyzed apply external assurance with scope to a specific section and a limited level, which shows that the assurance of integrated information in Colombia is at an early stage of development. This is a challenge for Colombian companies that present and gather information, given that advances in assurance methods are required to improve the reliability of information and to strengthen relations with stakeholders. Advances in assurance methods require a projection to a combined assurance that establishes synergies between internal and external assurance to deliver a verified report with a total scope and a reasonable level of security assurance that allows for a high degree of reliability in the sustainability report.

The proposed reliability measurement model allows us to understand how each variable of the reliability concept has an effect on the final measurement, as well as the reliability of the sustainability reporting of large Colombian companies that, without being obliged to present sustainability reports, do so to legitimize their practices and results before the stakeholders, as well as to provide useful information for decision making.

The results confirm a level of reliability of Colombian information in 2021 (with an average of 5.02 on a scale of 0 to 10) and, in particular, a high level of environmental certifications (average value of 8.42) and a low level of correspondence between the company that audits the financial statements is the same company that audits the sustainability report (average of 0.95). Further analysis confirms the assumptions about a relationship between the type and level of assurance, as well as a positive relationship between the scope and type of assurance. Secondly, it is also confirmed that the COLIR index has a positive effect on the reliability study variable, with a positive relationship, and that the variable "auditing company of the financial statements is the same company that audits the sustainability report" has a positive effect on the reliability study variable, with a positive relationship.

These conclusions are preliminary, as this study has the following limitations:

1. The geographic area where the research was conducted only addresses Colombia;
2. Only three industries were analyzed: construction; mining–hydrocarbons; and manufacturing, which belong to the non-financial sector;
3. The time horizon analyzed was the sustainability reports for the year 2021 only;
4. Access to information was limited, as only public information on the companies' websites was obtained. There is no information system where users can access information on the sustainability management of companies;
5. The theoretical/empirical model of reliability is also a limitation.

As mentioned in the previous paragraph, the results of the model are not universally applicable, but they can contribute to the development of measuring the reliability of sustainability reports. Applying this model in other contexts will allow for comparisons and contrasts between different latitudes, defining the best assurance practices and contributing to the standardization of these practices. This can increase the reliability of information for the decision-making of stakeholders.

On the other hand, this model can be the starting point for the construction of more robust models, including other variables, that contribute to the measurement of the reliability of sustainability information. This can enable international organizations, governments, assurance service providers, companies, and stakeholders to access relevant and

reliable information for the management corresponding to each actor within the sustainability ecosystem.

Additionally, future research can address different latitudes, including the financial sector, given its higher regulation due to public interest, and also develop a longitudinal study to observe and analyze the changes, advances, and impacts of assurance of sustainability information. Future studies can measure the before and after a jurisdiction determines the mandatory assurance of information.

Furthermore, this study can contribute to the development of standards in this area and update existing ones in different jurisdictions. The variables defined in the model can be considered as the fundamental basis for determining whether a sustainability report is reliable for decision-making. This is because the model has considered a full scope of assurance, applying combined assurance with a reasonable level of security, as well as the correspondence between financial statement auditors and sustainability report auditors.

These results offer implications and scientific contributions mainly for the proposal of a model for the measurement of reliability in sustainability reports applicable in any geographical context and in any period of time. Although the potential arrival of the International Standard on Sustainability Assurance (ISSA) 5000 by the International Auditing and Assurance Board (IAASB), currently under consultation, promises to significantly enhance the landscape of sustainability assurance practices acting as a catalyst for mandatory sustainability reporting in Latin America, the reliability of sustainability reporting is the subject of study by the bodies that issue auditing and assurance standards (IFAC). Thus, few studies have delved into this concept, and there is a lack of works that analyze the development of the reliability of sustainability reports. This measurement tool will allow not only researchers but also assurance providers, standard-setting bodies, and companies to obtain a measure of reliability and variables. Likewise, this study has relevance in the Colombian context, where the development of the presentation of sustainability reports in companies classified as large according to their revenue is evident. Secondly, the defined variables have a significant relationship with the measurement of reliability, which provides information on both the current situation and future trends in the assurance of sustainability reporting. Other implications and contributions refer to the professional and managerial sphere: the definition of an empirical measurement model based on theoretical/scientific pillars and the results of its first application to the Colombian context offer opportunities for the implementation of a combined assurance that integrates internal and external assurance with a greater scope and a reasonable level of assurance.

5. Limitations

The current study has several limitations: 1. the analysis was conducted over a single year; 2. the spatial factor was limited to Colombia; 3. the availability and access to sustainability reports and financial statements were restricted; 4. the analysis focused only on the construction, mining–hydrocarbons, and manufacturing industries within the non-financial sector; and 5. the theoretical/empirical model on reliability, though developed from scientific contributions and consolidated theories, could be further expanded upon in future work, despite the variables being correctly correlated and linked in the initial practical application.

Future research could take several directions to build upon the current study:

Firstly, the reliability measurement model could be improved, deepened, and implemented further, both from theoretical and empirical perspectives. Secondly, the research methods could be enhanced by applying more robust statistical models such as quantile regression and mixed data analysis to analyze the data. Thirdly, the theoretical framework could be expanded by developing the variable of combined assurance in more depth.

Fourthly, the analysis could be broadened to include other macro-sectors of the economy, such as trade, services, agriculture, and the financial sector. Fifthly, the researchers envision interesting future contributions to measuring reliability through the model itself

in countries other than Colombia over longer periods of time and adopting international comparisons.

Lastly, a study on the reliability of sustainability reports could be conducted, including not only large companies but also small and medium-sized enterprises (SMEs), to enable comparisons and contrasts of the different industries and company sizes according to the economic, cultural, and social contexts.

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References

1. Kumar, P.; Firoz, M. Does Accounting-Based Financial Performance Value Environmental, Social and Governance (ESG) Disclosures? A Detailed Note on a Corporate Sustainability Perspective. *Australas. Bus. Account. Financ. J.* **2022**, *16*, 41–72. [CrossRef]
2. de Silva Lokuwaduge, C.S.; Smark, C.; Mir, M. The Surge of Environmental Social and Governance Reporting and Sustainable Development Goals: Some Normative Thoughts. *Australas. Bus. Account. Financ. J.* **2022**, *16*, 3–11. [CrossRef]
3. Rodriguez de Ramirez, M.d.C. Integrated Information. The Road Traveled Final Report. 2017. Available online: http://bibliotecadigital.econ.uba.ar/download/libros/RodriguezdeRamirez_Informacion-integrada-el-camino-recorrido-informe-final-2018.pdf (accessed on 20 June 2024).
4. Institute of Directors Southern Africa. King IV Report on Corporate Governance for South Africa. 2016. Available online: https://cdn.ymaws.com/www.iodsa.co.za/resource/collection/684B68A7-B768-465C-8214-E3A007F15A5A/IoDSA_King_IV_Report_-_WebVersion.pdf (accessed on 20 June 2024).
5. Integrated Reporting Committee (IRC) of South Africa. Preparing an Integrated Report: A Starter's Guide (Updated). 2018. Available online: https://integratedreportingsa.org/ircsa/wp-content/uploads/2018/08/IRC_Starters_Guide_20180820_12663_LN.pdf (accessed on 20 June 2024).
6. Richard, G.; Odendaal, E. Integrated Reporting Assurance Practices—A Study of South African Firms. *Int. J. Discl. Gov.* **2020**, *17*, 245–266. [CrossRef]
7. Goicoechea, E.; Gómez-Bezares, F.; Ugarte, J.V. Integrated Reporting Assurance: Perceptions of Auditors and Users in Spain. *Sustainability* **2019**, *11*, 713. [CrossRef]
8. Channuntapipat, C.; Samsonova-Taddei, A.; Turley, S. Exploring Diversity in Sustainability Assurance Practice. *Account. Audit. Account. J.* **2019**, *32*, 556–580. [CrossRef]
9. Cabrera Narváez, A. The Integrated Report in Colombia: An Evaluation of the Situation and the Factors That Drive Its Implementation in the Period 2013–2018. Cabrera Narváez, Andrés. 2021. Available online: https://repositorio.unal.edu.co/bitstream/handle/unal/80110/Tesis%20Andr%C3%A9s%20Cabrera%20Narv%C3%A1ez%20(2021).pdf?sequence=4&isAllowed=y (accessed on 20 June 2024).
10. Lee, S.W.A.; Rodrigs, M.; Nathan, T.M.; Rashid, M.A.; Al-Mamun, A. The Relationship Between the Quality of Sustainability Reporting and Corporate Financial Performance: A Cross-Sectional and Longitudinal Study. *Australas. Bus. Account. Financ. J.* **2023**, *17*, 38–60. [CrossRef]
11. Jensen, M.C.; Meckling, W.H. Theory of the Firm: Managerial Behavior, Agency Costs and Ownership Structure. *J. Financ. Econ.* **1976**, *3*, 305–360. [CrossRef]
12. Suchman, M.C. Managing Legitimacy: Strategic and Institutional Approaches. *Acad. Manag. Rev.* **1995**, *20*, 571–610. [CrossRef]

13. Shocker, A.D.; Sethi, S.P. An Approach to Incorporating Societal Preferences in Developing Corporate Action Strategies. *Calif. Manag. Rev.* **1973**, *15*, 97–105. [CrossRef]
14. Freeman, R. *Strategic Management: A Stakeholder Approach*; United States of America By Cambridge University Press: NewYork, NY, USA, 1984.
15. Pereda, J.T. Evolution and Current Situation of Accounting Thought. *Legis Int. J. Account. Audit.* **2004**, 43–128.
16. Elkington, J. Triple Bottom Line Revolution-Reporting for the Third Millennium. *Aust. CPA* **1999**, *69*, 75.
17. Maroun, W. A Conceptual Model for Understanding Corporate Social Responsibility Assurance Practice. *J. Bus. Ethics* **2020**, *161*, 187–209. [CrossRef]
18. Maroun, W. Does External Assurance Contribute to Higher Quality Integrated Reports? *J. Account. Public Policy* **2019**, *38*, 106670. [CrossRef]
19. Farooq, M.B.; de Villiers, C. How Sustainability Assurance Engagement Scopes Are Determined, and Its Impact on Capture and Credibility Enhancement. *Account. Audit. Account. J.* **2019**, *33*, 417–445. [CrossRef]
20. Quick, R.; Inwinkl, P. Assurance on CSR Reports: Impact on the Credibility Perceptions of Non-Financial Information by Bank Directors. *Meditari Account. Res.* **2020**, *28*, 833–862. [CrossRef]
21. IAASB. Supporting Credibility and Trust in Emerging Forms of External Reporting: Ten Key Challenges for Assurance Engagements. 2018. Available online: https://www.iaasb.org/publications/supporting-credibility-and-trust-emerging-forms-external-reporting-ten-key-challenges-assurance (accessed on 19 July 2023).
22. IAASB. Handbook of International Quality Control, Auditing, Review, Other Assurance, and Related Services Pronouncements. 2021. Available online: https://www.ifac.org/system/files/publications/files/IAASB-2020-Handbook-Volume-2.pdf (accessed on 17 July 2023).
23. Oneto, A.; Rojas, C. Guidelines for a Latin American Corporate Governance Code. Caracas 2024. Available online: https://scioteca.caf.com/handle/123456789/2239 (accessed on 20 June 2024).
24. Akisik, O.; Gal, G. Integrated Reports, External Assurance and Financial Performance. *Sustain. Account. Manag. Policy J.* **2019**, *11*, 317–350. [CrossRef]
25. Committee of Sponsoring Organizations of the Treadway Commission. *Enterprise Risk Management: Integrating with Strategy and Performance*; Committee of Sponsoring Organizations of the Treadway Commission: Washington, DC, USA, 2017.
26. COSO. *Internal Control-Integrated Framework*; COSO: Washington, DC, USA, 2013.
27. Richard, G.; Odendaal, E. Credibility-Enhancing Mechanisms, Other than External Assurance, in Integrated Reporting. *J. Manag. Gov.* **2021**, *25*, 61–93. [CrossRef]
28. Feder, M.; Weißenberger, B.E. Towards a Holistic View of CSR-Related Management Control Systems in German Companies: Determinants and Corporate Performance Effects. *J. Clean. Prod.* **2021**, *294*, 126084. [CrossRef]
29. Maroun, W. Corporate Governance and the Use of External Assurance for Integrated Reports. *Corp. Gov. Int. Rev.* **2022**, *30*, 584–607. [CrossRef]
30. Alzeban, A. The Relationship between Internal Control and Internal Audit Recommendations. *Span. J. Financ. Account./Rev. Española De Financ. Y Contab.* **2019**, *48*, 341–362. [CrossRef]
31. de Silva Lokuwaduge, C.S.; De Silva, K.M. ESG Risk Disclosure and the Risk of Green Washing. *Australas. Bus. Account. Financ. J.* **2022**, *16*, 146–159. [CrossRef]
32. Hoang, H.; Phang, S.-Y. How Does Combined Assurance Affect the Reliability of Integrated Reports and Investors' Judgments? *Eur. Account. Rev.* **2021**, *30*, 175–195. [CrossRef]
33. Phang, S.; Hoang, H. Does Positive CSR Increase Willingness to Invest in a Company Based on Performance? The Incremental Role of Combined Assurance. *Account. Financ.* **2021**, *61*, 5631–5654. [CrossRef]
34. Donkor, A.; Djajadikerta, H.G.; Mat Roni, S. Impacts of Combined Assurance on Integrated, Sustainability and Financial Reporting Qualities: Evidence from Listed Companies in South Africa. *Int. J. Audit.* **2021**, *25*, 475–507. [CrossRef]
35. Maroun, W.; Prinsloo, A. Drivers of Combined Assurance in a Sustainable Development Context: Evidence from Integrated Reports. *Bus. Strategy Environ.* **2020**, *29*, 3702–3719. [CrossRef]
36. Prinsloo, A.; Maroun, W. An Exploratory Study on the Components and Quality of Combined Assurance in an Integrated or a Sustainability Reporting Setting. *Sustain. Account. Manag. Policy J.* **2021**, *12*, 1–29. [CrossRef]
37. Zhou, S.; Simnett, R.; Hoang, H. Evaluating Combined Assurance as a New Credibility Enhancement Technique. *Audit. J. Pract. Theory* **2019**, *38*, 235–259. [CrossRef]
38. Kaushik, V.; Walsh, C.A. Pragmatism as a Research Paradigm and Its Implications for Social Work Research. *Soc Sci* **2019**, *8*, 255. [CrossRef]
39. Riffe, D.; Lacy, S.; Watson, B.R.; Fico, F. *Analyzing Media Messages*; Routledge: New York, NY, USA, 2019. [CrossRef]
40. Campbell, D. Intra- and Intersectoral Effects in Environmental Disclosures: Evidence for Legitimacy Theory? *Bus. Strategy Environ.* **2003**, *12*, 357–371. [CrossRef]
41. Krippendorff, K.H. *Content Analysis: An Introduction to Its Methodology*, 3rd ed.; Sage: Los Ángeles, CA, USA, 2013.
42. Balluchi, F.; Lazzini, A.; Torelli, R. Credibility of Environmental Issues in Non-Financial Mandatory Disclosure: Measurement and Determinants. *J. Clean. Prod.* **2021**, *288*, 125744. [CrossRef]
43. BVC. Colombian Securities Exchange's Colir Index. Available online: https://www.bvc.com.co/indices/colir (accessed on 20 June 2024).

44. Zina, O. *The Essential Guide to Doing Your Research Project*; Sage: Los Ángeles, CA, USA, 2017.
45. Drisko, J.; Maschi, T. *Content Analysis*; Oxford University Press: Oxford, UK, 2015. [CrossRef]
46. Fox, J.; Weisberg, S. *An R Companion to Applied Regression*, 3rd ed.; Sage Publications: Thousand Oaks, CA, USA, 2019.
47. Melnikovas, A. Towards an Explicit Research Methodology: Adapting Research Onion Model for Futures Studies. *J. Futures Stud.* **2018**, *23*, 29–44.
48. Superindencia de sociedades de Colombia. Report of the 1000 Largest Companies in the Country. 2021. Available online: https://siis.ia.supersociedades.gov.co/10MilEmpresas/index.html#/ (accessed on 20 June 2024).
49. Han, J.; Kamber, M.; Pei, J. Data Preprocessing. In *Data Mining Concepts and Techniques*, 3rd ed.; Morgan Kaufmann Publishers: Burlington, VT, USA, 2012.
50. Funder, D.C.; Ozer, D.J. Evaluating Effect Size in Psychological Research: Sense and Nonsense. *Adv. Methods Pract. Psychol. Sci.* **2019**, *2*, 156–168. [CrossRef]
51. Lüdecke, D.; Ben-Shachar, M.; Patil, I.; Waggoner, P.; Makowski, D. Performance: An R Package for Assessment, Comparison and Testing of Statistical Models. *J. Open Source Softw.* **2021**, *6*, 3139. [CrossRef]
52. Wickham, H. *Ggplot2*; Springer New York: New York, NY, USA, 2009. [CrossRef]
53. Lenth, R. *Estimated Marginal Means, Aka Least-Squares Means_. R Package*. 2024. Volume 1.10.2. Available online: https://rvlenth.github.io/emmeans/ (accessed on 10 April 2024).
54. Superintendencia Financiera de Colombia. Circular 031 of 2021 Instructions Regarding the Disclosure of Information on Social and Environmental Issues, Including Climate Related Issue. 2021. Available online: https://www.superfinanciera.gov.co/publicaciones/10104699/industrias-supervisadasfinanzas-sosteniblesdocumentos-tecnicos-y-normativa-10104699/ (accessed on 20 August 2024).
55. Superintendencia de Sociedades de Colombia. Circular Externa 100-000010 de 21 de Noviembre de 2023, by Means of Which Chapter XV Is Added to the Basic Legal Circular 100-000008 of July 12, 2022. 2023. Available online: https://www.supersociedades.gov.co/preview_search_result/-/asset_publisher/y8cpLFNLRnDt/document/id/6857030#:~:text=Por%20medio%20de%20la%20cual,12%20de%20julio%20de%202022.&text=Ep%C3%ADgrafe%20Consolidar%20ep%C3%ADgrafe%20del%20documento (accessed on 20 August 2024).