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ORIGINAL

ESG Information Disclosure and Path Selection of New Energy Enterprises in the Context of Digital Economy

Divulgación de información de ESG y selección de ruta de nuevas empresas de energía en el contexto de la economía Digital

Qin Shuheng[1]

[1]The University of Melbourne. Melbourne, Australia 71000.

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Corresponding Author: Qin Shuheng

ABSTRACT

In the context of accelerating global digital transformation, Environmental, Social, and Governance (ESG) information disclosure has become a crucial measure of transparency, sustainability, and corporate responsibility. However, new energy enterprises often face challenges such as inconsistent disclosure standards, technological limitations, and a lack of strategic direction, especially when adapting to the evolving digital economy. This research aims to evaluate the current state of ESG information disclosure among new energy enterprises and identify optimal paths for improving transparency and effectiveness through digital tools and data-driven strategies. Data were collected through structured surveys from selected new energy enterprises. A series of statistical methods was then applied to analyze the data. Descriptive statistics (DS) provided an overview of current disclosure practices, while Pearson correlation analysis (PCA) assessed the relationship between DML and ESG disclosure quality. Multiple regression analysis (MRA) was used to identify key predictors of high-quality disclosure. The results demonstrated a significant positive correlation between digital integration and the effectiveness of ESG reporting. Businesses that used cloud computing and Artificial Intelligence (AI) more frequently disclosed information that was more relevant, consistent, and responsive to stakeholders. The research concludes that digital advancement is a critical enabler of effective ESG disclosure and recommends the implementation of standardized digital frameworks to support strategic decision-making and regulatory compliance in the new energy sector.

Keywords: Information Disclosure; Digital Economy; Path Selection; Environmental Social Governance (ESG); Energy Enterprises.

RESUMEN

En el contexto de la aceleración de la transformación digital global, la divulgación de información ambiental, Social y de gobernanza (ESG) se ha convertido en una medida crucial de transparencia, sostenibilidad y responsabilidad corporativa. Sin embargo, las nuevas empresas de energía a menudo se enfrentan a desafíos tales como normas de divulgación inconsistentes, limitaciones tecnológicas, y una falta de dirección estratégica, especialmente cuando se adaptan a la evolución de la economía digital. Esta investigación tiene como objetivo evaluar el estado actual de la divulgación de información de ESG entre las nuevas empresas de energía e identificar caminos óptipara mejorar la transparencia y la eficacia a través de herramientas digitales y estrategias basadas en datos. Los datos se recogieron a través de encuestas estructuradas de nuevas empresas de energía seleccionadas. Luego se aplicó una serie de métodos estadísticos para analizar los datos. La estadística descriptiva (DS) proporcionó una visión general de las prácticas de divulgación actuales,

mientras que el análisis de correlación de Pearson (PCA) evaluó la relación entre la calidad de divulgación DML y ESG. Se utilizó el análisis de regresión múltiple (arm) para identificar factores predicclave de divulgación de alta calidad. Los resultados demostraron una correlación positiva significativa entre la integración digital y la eficacia del informe ESG. Las empresas que utilizan la computación en la nube y la inteligencia Artificial (ia) con más frecuencia revelaron información que era más relevante, coherente y sensible a las partes interesadas. La investigación llega a la conclusión de que el avance digital es un factor fundamental para la divulgación efectiva de las ESG y recomienda la implementación de marcos digitales estandaripara apoyar la toma de decisiones estratégicas y el cumplimiento normativo en el sector de las nuevas energías.

Palabras clave: Divulgación de Información; Economía Digital; Selección del Camino; La Gobernanza Social Ambiental (Gae); Empresas Energéticas.

INTRODUCTION

In the Digital Economy Age, ESG information disclosure has become a strategic focus of new energy enterprises aiming at sustainable development and international competitiveness.[1] The shift to low-carbon energy systems, the escalating demands of stakeholders, and more severe regulatory frameworks are forcing companies in the new energy sector to practice transparent and comprehensive ESG reporting.[2] As much as the digital economy is transforming the nature of information flows and data management systems, it offers chances to improve the effectiveness, precision, and promptness of ESG disclosures.[3] The new energy companies find themselves in a special position in this transformation because of their inherent compatibility with sustainability goals.

With the help of digital technologies, including AI, cloud computing, block chain, and big data analytics, these enterprises can improve ESG data gathering, real-time tracking, and multi-platform sharing.[4] Besides, digital technology makes engagement easier with stakeholders since it enhances access to ESG information, hence supporting trust, brand reputation, and long-term investment opportunities. The digital economy requires choosing a path to ESG disclosure, which is associated with strategic coordination with corporate objectives, compliance with regulations, technological base, and stakeholder requirements.[5] It involves incorporating ESG metrics in planning tools for enterprise resources as well as decision-making. The comparability and reliability of information worldwide within the industry are guaranteed because of the standardization of the formats of disclosure and aligning them with the global frameworks.[6] Figure 1 displays the ESG dimensions in digital pathways of new energy enterprises.

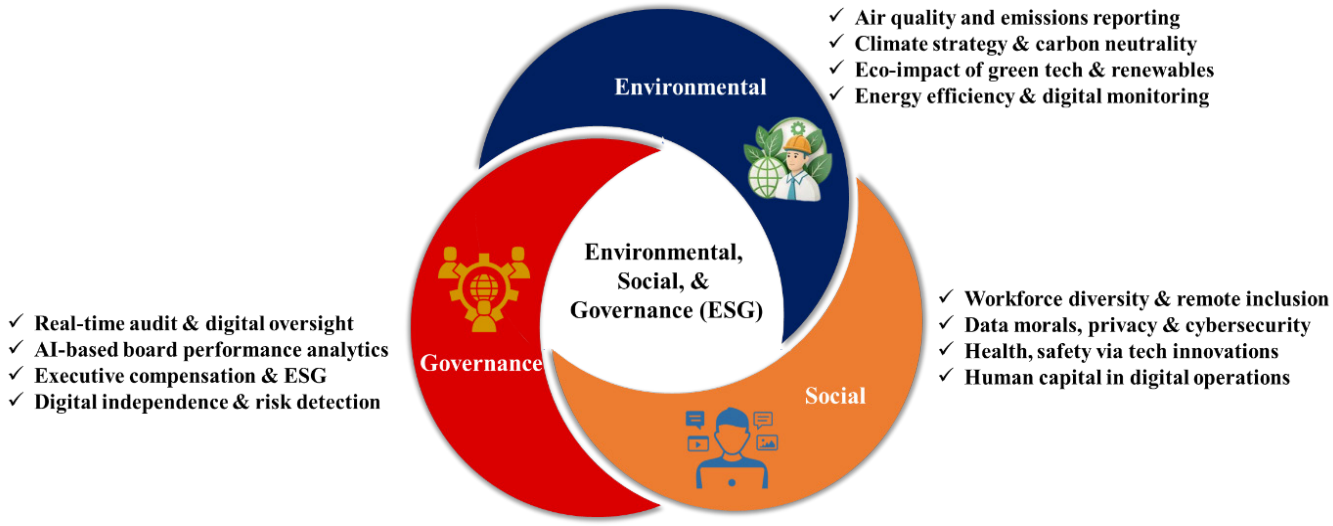

Figure 1. ESG Dimensions in Digital Pathways of New Energy Enterprises

The conventional ESG reporting processes are based on annual sustainability reporting, manual data input, and third-party verification reports that are static. Such approaches are not real-time, are time-consuming, and in many cases do not offer interactive or customizable views to the various stakeholder groups.[7] Traditional disclosure solutions are not flexible, cannot be monitored in real-time, or cannot be automated. They often suffer from data inconsistency, delayed updates, and limited transparency. Such constraints hinder stakeholder

engagement, make benchmarking difficult, and reduce the practical value of ESG information for decision-making in dynamic and fast-evolving business environments. The aim is to assess the existing ESG disclosure practices of new energy enterprises and explore effective, digitally-enabled pathways to enhance transparency, data accuracy, and stakeholder engagement through data-driven decision-making and advanced technologies frameworks.

Related Works

A-share businesses from to were used as the research sample used to examine how the digital transformation affected mining enterprises' environmental governance.[8] Digital transformation significantly enhances environmental governance, mainly through increased media supervision, with stronger effects observed in large-scale, mature-growth mining enterprises and non-state-owned enterprises. Enterprise resilience is influenced by environmental regulations, ESG performance, and technology innovation using structural equation modeling and survey data was explored by [9]. Findings reveal that environmental regulation and ESG integration drive technological innovation, fostering sustainable practices and significantly enhancing enterprise resilience in the face of crises.

The corporate transformation toward Industry 4.0 (CTTI4.0) and its effect on financial results were disclosed by the corporations in their annual reports and were examined by [10]. The results demonstrate sectoral variations in disclosure tactics and show that CTTI4.0 disclosure has a favorable impact on economic performance, with ESG practices enhancing their link. A comprehensive bibliometric analysis of ESG-related literature to identify research hotspots, key contributors, and emerging trends from 2004 to 2021 was conducted by [11]. The analysis reveals major research areas such as ESG factors, CSR linkage, and ESG investing, and highlights emerging trends in ESG disclosure, ratings, and capital market impact.

The role of Industry 4.0 technologies in enhancing the accuracy, availability, and transparency of ESG data for sustainability evaluation was explored by [12]. It concluded that AI, Internal of Things (IoT), blockchain, and big data significantly improve ESG reporting accuracy, addressing data limitations and supporting informed ESG investment and decision-making. Digital transformation's spatial spillover impacts on ESG performance in various nations from 2008 to 2020 utilizing the spatial Durbin framework was investigated by [13]. The findings demonstrate the way digital transformation improves ESG performance, with notable spatial spillovers, especially via digital public services and technological innovation, albeit with a modest direct impact.

The factors influencing sustainable business models, focusing on non-financial aspects like ESG and innovation, through a comprehensive international meta-analysis, were examined by [14]. The findings reveal that innovation positively impacts sustainable business models globally, while social capital shows a moderate positive influence; ESG factor standardization remains a key challenge. The impact of ESG disclosure more especially, ESG factors on non-financial firms' financial results in the Levant region between 2012 and 2019 were investigated by [15]. ESG performance positively affects financial indicators, while governance influences ROA only. Figure 2 shows the structure of the conceptual framework.

Research gap

Although ESG information disclosure is increasingly recognized as essential for corporate transparency and sustainability, many enterprises particularly in the new energy sector struggle with inconsistent standards, limited technological capabilities, and unclear strategies for integration within the digital economy. Previous studies highlight the role of digital transformation, Industry 4.0 technologies, and regulatory frameworks in shaping ESG practices and corporate performance, yet gaps remain in understanding sector-specific challenges and best practices. This research aims to evaluate the impact of digital transformation on ESG disclosure quality in new energy enterprises and to propose strategic, data-driven pathways to enhance sustainability reporting, stakeholder engagement, and regulatory compliance.

Hypothesis development

H1: digital maturity Level (DML) has a positive effect on ESG disclosure quality in new energy enterprises.

New energy companies that adopt advanced digital tools (e.g., cloud computing, big data, AI) are more likely to produce timely, accurate, and comprehensive ESG reports.

H2: top management support (TMS) positively influences ESG disclosure quality.

Leadership commitment to sustainability and digital transformation enhances transparency and accountability in ESG reporting.

H3: regulatory pressure (RP) has a positive effect on ESG disclosure quality.

Businesses are more inclined to raise the level and uniformity of their ESG disclosures when they are subject to stricter regulatory constraints.

H4: stakeholder engagement Level (SEL) positively affects ESG disclosure quality.

Firms that actively engage with stakeholders (investors and customers) tend to provide more relevant and responsive ESG information.

H5: technological infrastructure (TI) positively impacts ESG disclosure quality.

Well-developed IT infrastructure enables efficient data collection, analysis, and dissemination, thereby improving the effectiveness of ESG reporting. Figure 2 illustrates the conceptual framework developed.

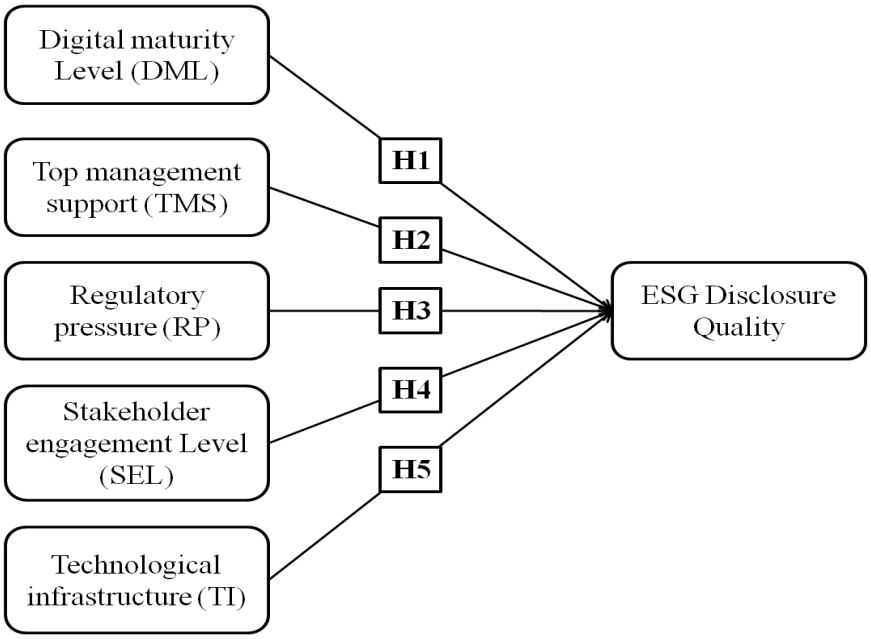

Figure 2. Conceptual Framework of hypothesis development

METHOD

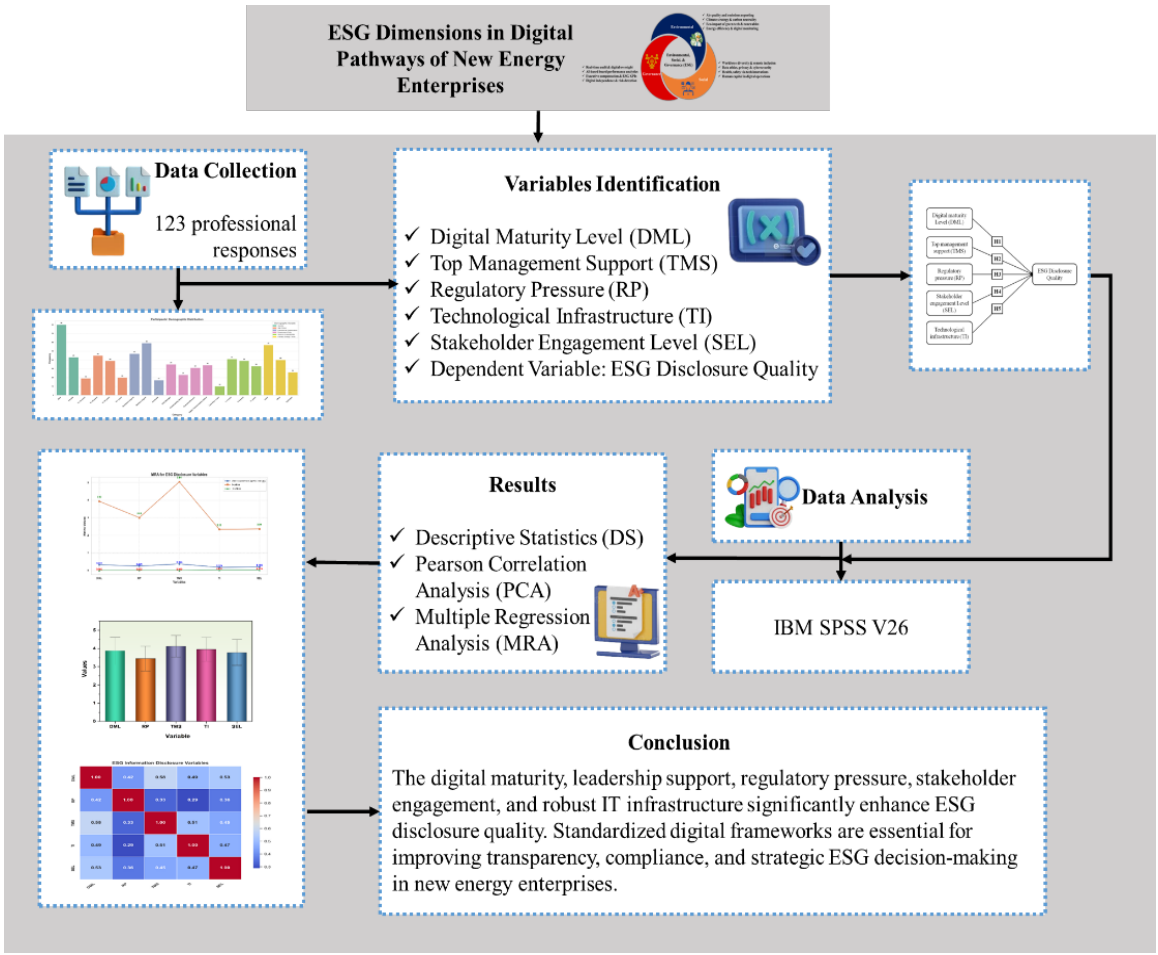

Figure 3. Overall Flow for the ESG Information Disclosure

This paper adopts a quantitative research design to examine the influencing factors of ESG information disclosure of new energy enterprises in the context of the digital economy. Data were collected from a random sample of 123 professionals. The structured survey instrument captured responses related to DML, RP, TMS, TI, and SEL, with the effectiveness of ESG disclosure as the variable of dependence. The survey data were supplemented by a new energy enterprise. SPSS was used for statistical analysis, including multiple regressions, Pearson correlation, and DS, to assess variable relationships and predictive strength. The methodology ensured broad representation across industry sub-sectors and digital maturity levels. Figure 3 shows the overall flow for the ESG Information disclosure and Path Selection.

Data Collection

Table 1. Participants' Demographic Variables

Demographic Variable	Category	Frequency (n=123)	Percentage (%)
Gender	Male	80	65,0
	Female	43	35,0
AgeGroup	21-30 years	19	15,4
	31-40 years	45	36,6
	41-50 years	39	31,7
	51+ years	20	16,3
Educational Qualification	Bachelor's Degree	47	38,2
	Master's Degree	59	48,0
	Doctorate	17	13,8
Respondent Role	ESG Manager	35	28,5
	ESG Manager	23	18,7
	Sustainability Officer	31	25,2
	Digital Transformation Officer	34	27,6
Years in Current Role	Lessthan 1 year	10	8,1
	1-3 years	41	33,3
	4-6 years	39	31,7
	7+ years	33	26,8
Primary Energy Focus	Solar	57	46,3
	Wind	40	32,6
	Hydrogen	26	21,1

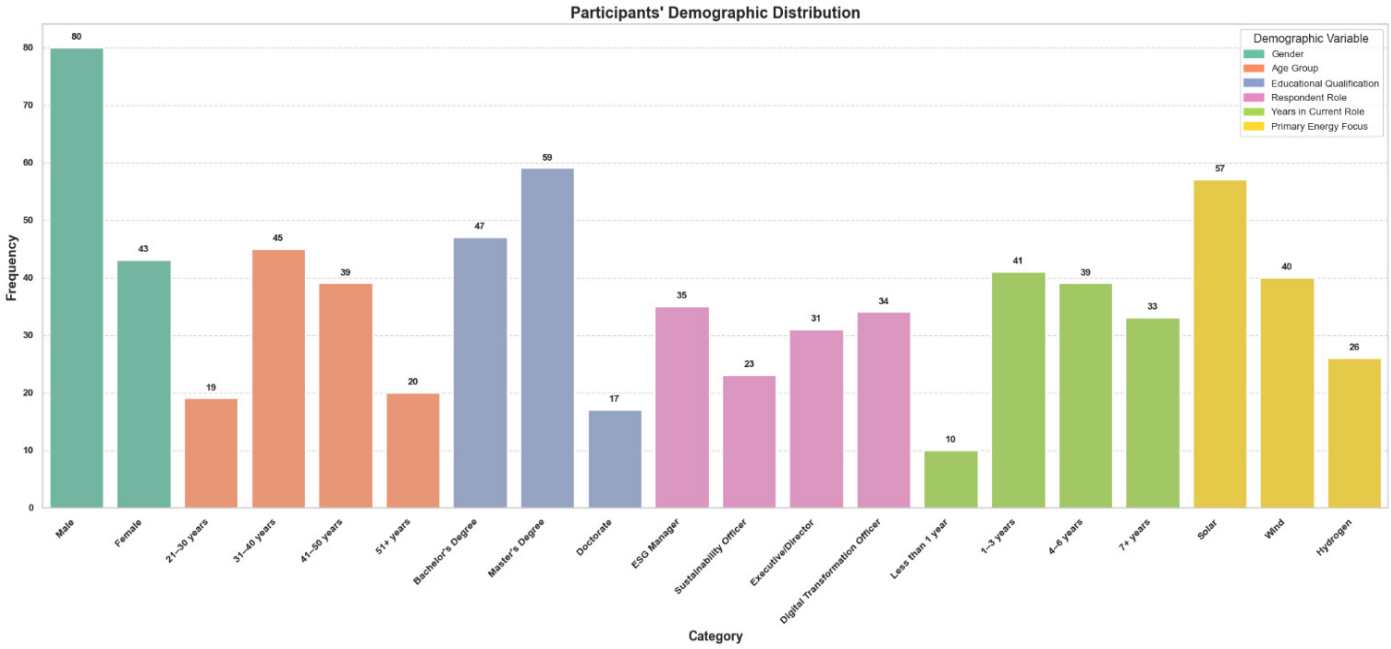

Figure 4. Demographic Characteristics of Respondents across Key Categories

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The data were collected from a random sample of 123 professionals employed in new energy enterprises across different regions. These participants were selected to ensure diversity in terms of organizational roles, industry sub-sectors, and DML. The sample included ESG managers, sustainability officers, and digital information officers involved in sustainability reporting and digital transformation initiatives. The dataset comprises variables such as DML, RP, TMS, TI, and SEL, along with the dependent variable, ESG disclosure quality. Respondents provided insights into how digital tools and organizational capabilities influence their ESG reporting practices. The participants' demographic variables are shown in table 1 and figure 4.

Structure of Questionnaires

DML: this section includes 3 questions. It examines combining contemporary technologies like big data analytics, cloud computing, and AI in ESG processes, enabling smarter decision-making, real-time data access, and improved ESG reporting effectiveness within new energy enterprises.

RP: this section includes 2 questions. It evaluates the extent to which external laws, policies, and compliance demands influence ESG disclosures. RP drives transparency, encourages standardization, and ensures enterprises align with national and global sustainability disclosure requirements.

TMS: this section includes 3 questions. It assesses leadership involvement in ESG strategies, focusing on how executives prioritize, fund, and monitor ESG initiatives. Strong management support reinforces ESG integration into core operations and promotes a culture of sustainability accountability.

TI: this section includes 2 questions. It explores the availability of digital tools like ESG platforms. These infrastructures support seamless data collection, integration, and automated reporting, playing a crucial part in raising the standard and uniformity of ESG disclosures.

SEL: this section includes 3 questions. It measures the frequency and quality of ESG-related interactions with stakeholders, including investors and customers. Effective engagement ensures disclosures are relevant, builds trust, and enhances responsiveness to external sustainability expectations. table 2 shows the sample questionnaires.

Table 2. Sample Questionnaires

Variable	Number of Questions	Question(s)
DML	3	1. How extensively has your organization adopted digital technologies (e.g., cloud computing, AI)? 2. Which digital tools are most used in ESG reporting? 3. What would you say about the general degree of digital integration in your company?
RP	2	1. To what extent do regulatory requirements influence your ESG disclosure practices? 2. How frequently do you review ESG policies due to government updates?
TMS	3	1. Does your senior management actively promote ESG initiatives? 2. Are sufficient resources allocated to ESG compliance? 3. Is ESG performance regularly reviewed by top executives?
TI	2	1. Does your organization use dedicated ESG reporting platforms or tools? 2. How well does your IT system support real-time ESG data processing and reporting?
SEL	3	1. How often does your company engage with stakeholders about ESG topics? 2. Do you collect and use stakeholder feedback for ESG improvement? 3. What communication channels do you use for ESG stakeholder interactions?

Statistical Assessment

The analysis was performed using IBM SPSS 26 to ensure the robustness and reliability of results in evaluating ESG information disclosure among new energy enterprises. The data was compiled using DS, which offered information on the overall distribution, dispersion, and primary trends (mean, median) of important factors such as stakeholder engagement, digital maturity, and regulatory pressure. The degree and direction of the correlations between the variables that were independent and the quality of ESG disclosure were evaluated using PCA. This helped identify significant associations, such as the positive linkage between digital maturity and

disclosure effectiveness. MRA is utilized to evaluate the combined predictive power of independent variables on the dependent variable ESG disclosure quality. It enabled the identification of key determinants and quantified their contribution, offering valuable insights into which factors most significantly influence ESG transparency. The combination of these statistical tools predetermined the thoroughness of the acquisition of knowledge on the digital and organizational forces that define the practice of ESG reporting.

RESULTS

The results reveal that DML, RP, TMS, TI, and SEL significantly influence the outcomes across Descriptive Statistics (DS), Pearson Correlation Analysis (PCA), and Multiple Regression Analysis (MRA).

Descriptive Statistics(DS)

The DS presents the entire summary of major variables that affect the ESG information disclosure and the choice of digital path that new energy enterprises take. This summary highlights central tendencies and variability, offering foundational insights for further empirical analysis in the digital economy context. Common DS include mean (μ) standard deviation (σ), and variance (σ^2), as shown in equations (1 – 3).

$$\mu = \frac{1}{n}\sum_{i=1}^{n} x_i \quad (1)$$

$$\sigma = \sqrt{\frac{1}{n-1}\sum_{i=1}^{n}(x_i - \mu)^2} \quad (2)$$

$$\sigma^2 = \frac{1}{n-\downarrow}\sum_{i=1}^{n}(x_i - \mu)^2 \quad (3)$$

The DML has a mean of 3,87, media 4,00n, SD 0,74, with values ranging from 3,13 to 4,61. RP averages 3,45 (median 3,50), showing moderate variation (SD = 0,68). TMS is relatively high (mean 4,12, SD = 0,59). TI and SEL average 3,95 and 3,78, respectively, both with consistent medians of 4,00 and moderate dispersion. The mean shows the average value, the median indicates the midpoint, SD reflects variability, while the minimum and maximum represent the lowest and highest observed values in the data. Table 3 shows the DS of key digital transformation variables, and figure 5 displays the DS for digital transformation variables in ESG disclosure.

Table 3. DS of ESG in Key Digital Transformation Variables

Variable	Mean	Median	Standard Deviation(SD)	Minimum	Maximum
DML	3,87	4,00	0,74	3,13	4,61
RP	3,45	3,50	0,68	2,77	4,13
TMS	4,12	4,00	0,59	3,53	4,71
TI	3,95	4,00	0,65	3,30	4,60
SEL	3,78	4,00	0,71	3,07	4,49

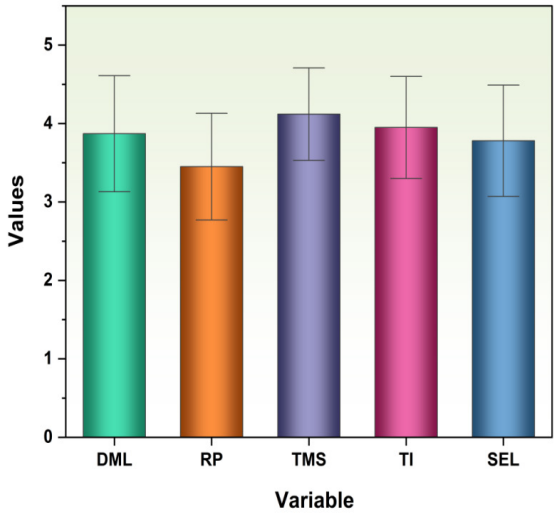

Figure 5. DS for Digital Transformation Variables in ESG Disclosure

Pearson Correlation Analysis(PCA)

The PCA examines the linear relationships between key variables influencing ESG information disclosure and path selection in new energy enterprises within the digital economy, highlighting significant interdependencies that guide strategic planning, technological adoption, and SEL. The PCA coefficient (r) among variables X and Y, is shown in equation (4).

$$r = \frac{\sum_{i=1}^{n}(X_i-\bar{X})(Y_i-\bar{Y})}{\sqrt{\sum_{i=1}^{n}(X_i-\bar{X})^2}\sqrt{\sum_{i=1}^{n}(Y_i-\bar{Y})^2}} \quad (4)$$

The correlation matrix reveals that DML is strongly associated with TMS (0,58), followed by SEL (0,53) and TI (0,49). RP shows moderate correlations, highest with DML (0,42) and lowest with TI (0,29). TMS correlates well with TI (0,51), while SEL maintains consistent moderate relationships across all variables, especially with DML (0,53) and TI (0,47). Figure 6 illustrates the correlation matrix for digital economy ESG disclosure of information variables.

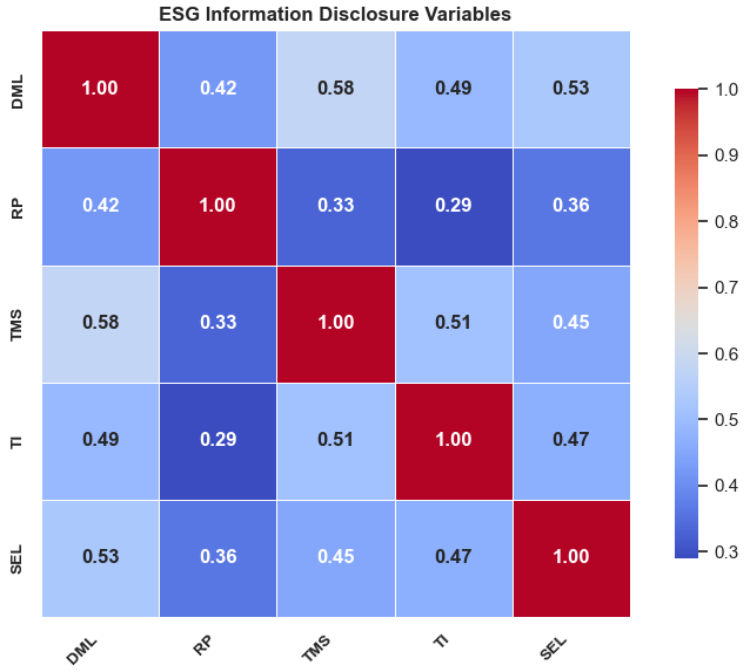

Figure 6. Correlation Matrix for Digital Economy ESG Disclosure of Information Variables

Multiple Regression Analysis (MRA)

The MRA examines how factors such as DML, RP, TMS, TI, and SEL significantly influence ESG information disclosure and strategic pathway choices among new energy enterprises within the evolving digital economy context. The general multiple linear regression, is shown in equation (5).

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \cdots + \beta_k X_k + \varepsilon \quad (5)$$

The regression analysis reveals that TMS has the strongest influence on ESG information disclosure (β = 0,365, p = 0,000), followed by DML (β = 0,318, p = 0,000). RP also shows a significant positive effect (β = 0,249, p = 0,003). TI (β = 0,174, p = 0,021) and SEL (β = 0,196, p = 0,020) are both statistically significant contributors. The standardized coefficient () shows the strength of each predictor's effect. Standard error indicates estimate variability. The t-value tests significance, while the p-value shows probability; a p-value < 0,05 implies an impact on the dependent variable that is statistically significant. Table 4 shows the MRA of ESG disclosure in the digital economy context, and figure 7 displays the MRA-based regression of ESG disclosure determinants in the digital economy.

Table 4. MRA of ESG Disclosure in Digital Economy Context

Variable	Standardized Coefficient (ß)	StandardError	t-value	p-value
DML	0,318	0,087	3,931	0,000
RP	0,249	0,092	3,000	0,003
TMS	0,365	0,079	5,038	0,000
TI	0,174	0,081	2,333	0,021
SEL	0,196	0,095	2,358	0,020

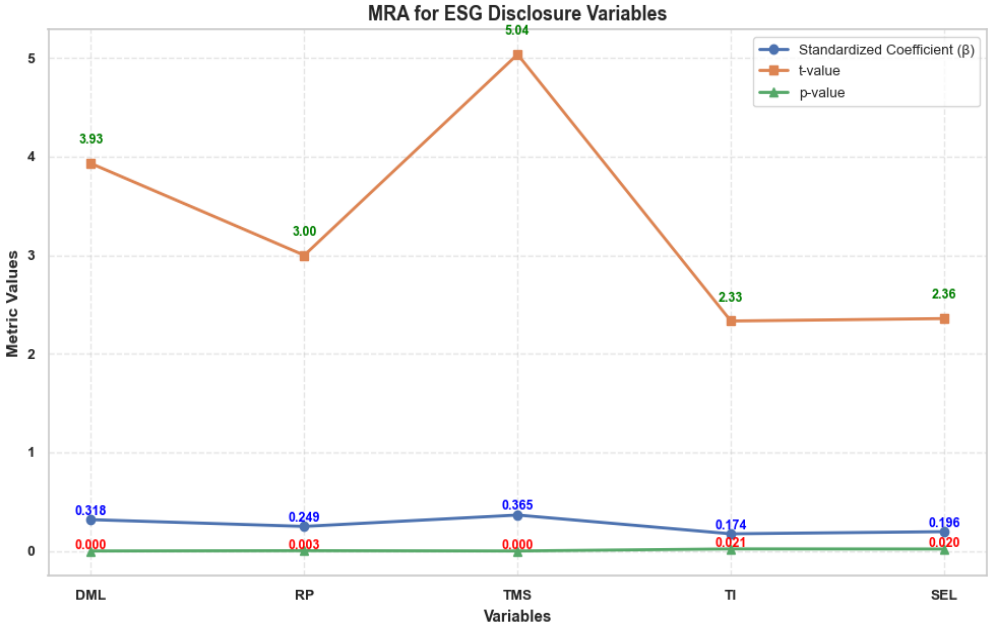

Figure 7. MRA-Based Regression of ESG Disclosure Determinants in Digital Economy

DISCUSSION

The new energy enterprises disclose ESG information within the digital economy. It examines digital transformation factors influencing ESG practices and identifies strategic paths these enterprises adopt to enhance transparency, regulatory compliance, and stakeholder engagement, thereby promoting sustainable development and corporate accountability in a digital era. The DS analysis reveals important insights into the digital transformation variables influencing ESG information disclosure. Among the five variables, TMS exhibits the highest mean value (4,12), indicating its strong presence across the sampled firms, while RP shows the lowest mean (3,45) and reflects variability in external forces. DML, TI, and SEL also display high central tendencies, with SD suggesting moderate consistency in responses. The PCA uncovers significant positive relationships among all variables. DML is strongly correlated with TMS (0,58), SEL (0,53), and TI (0,49), highlighting its foundational role in digital-driven ESG initiatives. TMS and TI share a strong relationship (0,51), suggesting that management support may foster technological enhancements. RP shows moderate correlations with DML (0,42) and SEL (0,36), indicating a moderate influence of regulatory dynamics on internal stakeholder engagement and maturity. The MRA confirms that all five variables significantly contribute to ESG information disclosure. TMS (ß = 0,365, p = 0,000) and DML (ß = 0,318, p = 0,000) are the most influential predictors. RP (ß = 0,249), TI (ß = 0,174), and SEL (ß = 0,196) also show positive and statistically significant impacts, demonstrating the multifaceted way in which digital transformation improves ESG transparency.

The analysis is limited by geographic concentration and potential bias in reported data, affecting broader applicability. Future efforts can explore long-term impacts of digital ESG practices, include diverse regional contexts, and assess industry-specific digital tools. Incorporating stakeholder views and advanced technologies like AI can enhance the effectiveness and transparency of ESG information disclosure pathways.

CONCLUSIONS

ESG Information Disclosure and Path Selection of New Energy Organizations in the Digital Economy explores the function of digital instruments in enhancing ESG transparency, guiding strategic decisions, improving stakeholder engagement, and supporting sustainable growth for new energy enterprises. Based on structured data collection from 123 professionals in the new energy sector, the investigation tested five hypotheses

linking DML, TMS, RP, SEL, and TI to ESG disclosure quality. DS highlighted current reporting practices. Pearson correlation revealed strong associations, especially between digital maturity and ESG quality, and multiple regressions confirmed all five factors as significant predictors. The results highlight the value of organizational dedication and digital tools in boosting ESG openness and directing the next strategic and legal advancements. In the DS analysis, TMS emerged as the strongest variable, with the highest mean (4,12) and the lowest SD (0,59), indicating consistently high leadership involvement in digital transformation. PCA, DML showed the strongest relationships with other variables, particularly with TMS (0,58), highlighting its central role in digital readiness. In the MRA, TMS again proved most influential, with the highest standardized coefficient β = 0,365, p = 0,000), significantly impacting ESG disclosure effectiveness.

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None.

CONFLICT OF INTEREST

Authors declare that there is no conflict of interest.

AUTHORSHIP CONTRIBUTION

Conceptualization: Shuheng Qin.
Data curation: Shuheng Qin.
Formal analysis: Shuheng Qin.
Drafting - original draft: Shuheng Qin.
Writing - proofreading and editing: Shuheng Qin.