Acta Montanistica Slovaca
ISSN 1335-1788
actamont.tuke.sk

Sustainability as a driver of digitalization: a Czech study

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How to cite this article:
Sedlák, J. and Krajčík, V. (2025). Sustainability as a driver of digitalization: a Czech study. *Acta Montanistica Slovaca,* Volume 30 (1), 154-169

DOI:
https://doi.org/10.46544/AMS.v30i1.12

Abstract
Many previous studies have addressed the relationship between sustainability and digitalization. However, the impact of the EU Corporate Sustainability Reporting Directive (CSRD), which mandates extensive data disclosure, on corporate digitalization remains underexplored. This paper examines whether the CSRD acts as a driver of digitalization through correlation analysis and multivariate regression on a sample of Czech energy sector companies likely to fall under the CSRD in 2025. Due to the chosen selection criteria, the sample also includes companies with ties to the energy sector, such as representatives from the metallurgical and mining industries. Sustainability is represented by the quality of non-financial information (NFI) disclosed, assessed through the lens of the CSRD, while the level of digitalization is assessed through digitization indexes constructed based on the textual analysis of the annual reports and the asset-based approach. The findings show a weak but positive correlation between the quality of NFI and the level of digitalization, although this correlation is not statistically significant, which does not fully support previous researchers' findings. Thus, the methodological limitations are discussed in detail, and further research is recommended. Alternative methods of assessment of the level of digitalization, such as questionnaire surveys, can help provide a more comprehensive understanding of the sustainability-digitalization nexus. The theoretical contribution of this paper lies in offering a new perspective on methods for evaluating digitalization levels and linking digitalization progress to CSR development within the EU context. Practically, this paper highlights the relationship between digitalization and CSRD, providing valuable insights for companies and policymakers.

Keywords
CSR, CSRD, digitalization, ESG, non-financial reporting, sustainability, energy sector, metallurgical and mining industries.

Introduction

In 1987, the United Nations Brundtland Commission defined sustainability as "meeting the needs of the present without compromising the ability of future generations to meet their own needs." (United Nations, n.d.). Since then, the focus on sustainability has steadily increased to its current form. The United Nations General Assembly adopted Resolution 70/1, Transforming our World: the 2030 Agenda for Sustainable Development, on 25 September 2015 (United Nations, n.d.). This document lays out the 17 Sustainable Development Goals (SDGs), which aim to end poverty and hunger, protect human rights and human dignity, protect the planet from degradation, foster peace (European Environment Agency, n.d.), and minimize issues regarding human health (Imo & Ekechukwu, 2024). In parallel, the European Union introduced the European Green Deal strategy to support sustainable practices of businesses from different industries (Streimikiene, 2023; Streimikiene & Kyriakopoulos, 2024) and their digital transformation (Civelek et al., 2023a) in 2020. These sustainable practices have not only improved the sustainable development of various industries (Papcunová et al., 2024) and countries' economies (Matijová et al., 2023) but also have improved technology (Kuděj et al., 2023), innovation (Civelek et al., 2023b; Mtengwane, 2024), and financial performance of enterprises (Keelson & Padi, 2024) and the quality of life for individuals (Alsharif et al., 2024). These practices have also stimulated creativity (Civelek et al., 2024) and environmentally responsible behaviors of entrepreneurs (Fenitra et al., 2024).

On the other hand, one of the key tools for achieving SDGs is corporate social responsibility (CSR), represented by non-financial information. This has been highlighted by many researchers in previous studies (Gavurova et al., 2022). Aguado-Correa et al. (2023) state that non-financial information and its contribution to achieving the various SDGs is becoming very important in a business world where it is not enough to be economically sustainable without being ethically, environmentally, and socially sustainable. This was also confirmed by Krawczyk (2021), who stated that non-financial reporting (NFR) is essential to demonstrate progress towards the SDGs. In other words, the NFR level reflects the level of environmental, social, and governance (ESG) performance, i.e., behaviour of the companies in the CSR field. The European Commission has defined CSR as the responsibility of enterprises for their impact on society, and, therefore, it should be company-led. Companies can become socially responsible by integrating social, environmental, ethical, consumer, and human rights concerns into their business strategy and operations and by following the law (European Commission, n.d.). The legal framework for CSR in the European Union (EU) has been in place since 2014, with the introduction of the EU Non-Financial Reporting Directive (NFRD), which is further developed by the proposed Corporate Sustainability Reporting Directive (CSRD) in 2021 with effect from 5 January 2023.

The global focus on sustainability, reinforced by frameworks such as the United Nations SDGs and the statutory requirements for non-financial corporate reporting in the ESG area (CSRD), is not only shaping societal priorities but also fundamentally influencing the way organizations and industries operate. As the demand for more sustainable practices and related reporting continues to grow, businesses are increasingly seeking innovative tools and strategies to meet these expectations. One of the crucial tools in this context is certainly digitalization, which, among other things, helps meet the need for comprehensive, comparable, and transparent non-financial reporting, leading to the introduction of advanced digital tools.

Unlike sustainability, there is no consensus on the definition of digitalization. One of the most comprehensive and general definitions is that proposed by the EU agency Eurofound, which defines digitalization as "the ongoing integration of digital technologies and digital data across the economy and society" (Eurofound, n.d.). A similar but more precise definition is proposed by Veber et al. (2018), who understand digitalization as "a general term for the contemporary trend of mass deployment of both technical means (the Internet, microsensors, fast transmission networks, large data storage, fast computers capable of processing demanding programs, but also advanced automation and robotization) and software tools (for storing and retrieving large volumes of data, for their analysis and evaluation conclusions, for preparing routine decisions and control signals, feedback and control operations, etc.) all hardware, software, and communication interconnected and secured against any loss and cyber-attacks".

The interconnection between these two megatrends, namely sustainability and digitalization, has been addressed by numerous researchers in previous studies (Duran et al., 2024). However, little is known about the impact of the new CSRD and related European Sustainability Reporting Standards (ESRS) reporting standards on digitalization. However, it is the CSRD that is obliging companies in the EU to report extensively on sustainability using the ESRS for this non-financial reporting, which requires a huge amount of different data and introducing XBRL (eXtensible Business Reporting Language). This should potentially cause a significant shift towards digitalization for companies that will fall under this directive. The aim of this paper is to clarify whether this new CSR directive can be considered a real driver of the digitalization of companies.

In order to achieve this aim, this paper will build on the results of the author's previous study (Sedlak&Veber, 2024), hereafter referred to author's previous research, using the findings on the level of quality of non-financial information disclosed by all companies in the energy sector in the Czech Republic that have the potential to fall under the mandatory CSRD NFR from 2025 (hereafter referred to as the "selected companies"), whereby the

quality of NFI was assessed through the prism of CSRD, combined with research questions focused on the assessment of the level of digitalization and the relationship between the level of quality of NFI and the level of digitalization of the selected companies. As regards the selected companies, it is worth mentioning that, given the selection criteria chosen, the sample also includes companies with links to the energy sector, such as representatives of the metallurgical and mining industries.

The global focus on sustainability, reinforced by frameworks such as the United Nations SDGs and the statutory requirements for non-financial corporate reporting in the ESG area (CSRD), is not only shaping societal priorities but also fundamentally influencing the way organizations and industries operate. As the demand for more sustainable practices and related reporting continues to grow, businesses are increasingly seeking innovative tools and strategies to meet these expectations. One of the crucial tools in this context is certainly digitalization, which, among other things, helps meet the need for comprehensive, comparable, and transparent non-financial reporting, leading to the introduction of advanced digital tools.

Numerous studies have demonstrated the growing role of digital technologies in enhancing transparency, knowledge dissemination, and media literacy, which are essential components in supporting sustainable decision-making and the effective implementation of CSR strategies (Moravec et al., 2025; Gavurova et al., 2024a). Digitalization also contributes to improving institutional performance in sensitive sectors such as healthcare, where integrating and evaluating digital solutions play a key role in efficiency and accountability (Smolanka et al., 2024). Moreover, the spread of disinformation and the need for its management have driven the development of fuzzy logic-based assessment tools to ensure the quality of digital environments, further highlighting the intersection of sustainability and digital responsibility (Gavurova et al., 2024b).

In cross-border contexts, digital tools have enabled the application of fuzzy multicriteria evaluation models that account for social, economic, and environmental factors, particularly in regions facing resource-based challenges (Skare et al., 2023). Furthermore, hybrid digital models are being increasingly utilized to support sustainable regional development and public health policies, demonstrating the broader potential of digitalization for advancing sustainability goals (Kelemen et al., 2022).

The remainder of the paper is structured as follows: Section Material and Methods provides a review of the relevant literature and theoretical background, defines the research questions and hypotheses, justifies the focus on the selected sample of companies, explains how they were selected, and outlines the methodology used in the study. The Results section presents the findings, while the Discussion section analyzes them in the context of existing research. Finally, the Conclusions section provides an overview of the key findings, contributions, and recommendations for future research.

Material and Methods

Material

Given the aim of this paper and the fact that this paper builds on the author's previous research in terms of the quality of NFI, the literature review will focus on the relationship between sustainability and digitalization and on methods for assessing the level of digitalization in companies.

The interplay between sustainability and digitalization has been a focal point of investigation in many previous studies. There is even growing interest in the relationship between digitalization and environmental, social, and governance (ESG) performance, as emphasized by Gu (2024). The results of his study show that digitalization and ESG performance have a significant positive two-way mechanism; digitalization enhances ESG performance, while ESG performance promotes digitalization. However, the study by Pérez-Martínez et al. (2023) argues that while synergies between sustainability and digitalization arise in aspects related to economic and social sustainability, there are trade-offs in areas related to environmental protection due to their negative associations with existing economic development models. This also confirms the findings of the study by Fang et al. (2023). They found that digitalization enables companies to reduce agency costs and increase governance scores (G), as well as makes it easier for companies to improve goodwill and further increase social scores (S). However, they did not find that digitization improves companies' environmental (E) scores. A similar result was reached by Chwilkowska-Kubala et al. (2021), who concluded that corporate social practices have a positive effect on the level of digitalization. A positive relationship between firms' digital transformation and their ESG performance was also confirmed by the study of Lu et al. (2024). A more general conclusion was reached by Wang & Tang (2024), who concluded that substantial digital innovation can stimulate higher ESG performance. A positive link between digital technologies and sustainability can also be found in Folgado-Fernández et al. (2023), who came to the conclusion that using virtual reality applications in national parks can increase sustainability. A study by Khatami et al. (2024) in the tourism industry revealed that digital platforms, devices, and apps can enhance social sustainability. A study by Streimikiene (2023) shows a similar conclusion in the same tourism sector in the Visegrad countries. The greatest progress achieved in the field of sustainable tourism development is explained by the best results in the field of digitalization. Devkota et al. (2023) also confirm the link between digitalization and sustainability. The authors consider digital marketing as an important tool to promote sustainable practices in

tourism. Also, the findings of Santos et al. (2024) indirectly confirm the positive impact of digital technologies on sustainability, seeing hybrid events, i.e., events with simultaneous physical and online participation, as reducing environmental impacts. The link between digitalization and sustainability is also seen by Alsharif et al. (2024) in a study focusing on smart tourism. Poliakova et al. (2024) cite the level of digitalization of companies as a factor that may affect their level of sustainability.

The interconnection between sustainability and digitalization is also exemplified by a relatively recent phenomenon pertaining to digital responsibility: Corporate Digital Responsibility (CDR). This concept was defined in 2021 by an international group of academics, corporate practitioners, and published authors as "a set of practices and behaviors that facilitate an organization's utilization of data and digital technologies in a manner that is socially, economically, technologically, and environmentally responsible" (Corporate Digital Responsibility, 2021). In the context of purely academic discourse, the term CDR was introduced by Lobschat et al. (2021), who defined it as a set of shared values and norms that govern an organization's activities with respect to four main processes related to digital technology and data. These processes are as follows: technology creation and data collection, operations and decision-making, control and impact assessment, and technology and data improvement. Furthermore, they elucidated the managerial implications of fostering CDR-compliant behaviors within an organizational culture context and delineated avenues for future research, particularly regarding pertinent antecedents and consequences.

The significance of the topic is also underlined by the researchers' suggestions for additional surveys in the given research field. For example, as Skare et al. (2024) state, future research should include larger samples, expanded regional considerations, inter- and intra-sectoral data, as well as additional investigation at micro, meso, macro, and global levels. Wang & Esperanca (2023) recommends an international comparative study on this topic. Further research on the correlations between digital transformation and sustainability goals is recommended by Esses et al. (2021).

The main finding regarding methods for assessing the level of digitalization in companies is fully in line with what is repeatedly reported in previous studies (for instance, Zhao & Cai, 2023), and that is the fact that three main ways of measuring digitalization are used within academia.

The first way is to create a digitization index based on the frequency of digital-related words in the annual report or other company reports or websites. There are, of course, different ways of calculating the digitization index and even labeling it. Xue et al. (2022) introduce the Degree of Digital Transformation, which calculates the frequency of technology-related sub-indicators appearing in the report, which they sum and further add 1 to make the natural logarithm a measure of the degree of digital transformation of enterprises. A more sophisticated approach is presented by L. Fang & Li (2024), whose construction of a firm-year-level digitization index involves three steps: (1) using a comprehensive digitization-related dictionary as a reference for textual analysis; (2) matching digitization-related dictionaries from firm annual reports; and (3) constructing the index using entropy weighting. A different approach is presented by Fang et al. (2023), who calculate the keyword frequency based on the digitized thesaurus and obtain the digitization index for each year of the company from the following equation: the number of digitization keywords divided by the number of all words in the Management Discussion and Analysis section of the annual report multiplied by 100. Zhao & Cai (2023) then further divide this method of determining the digitization index based on how the data is processed, either by manually collating company reports or by processing the text using text analysis software tools. Overall, this method, creating a digitization index based on the frequency of digital-related words in the annual report, is used in 83% of studies analyzed. Phyton is the most used software tool for textual analysis. For this method, the question naturally arises: Can annual reports be considered a relevant source for determining the state of a company's digitalization? However, researchers have considered this question. According to Zhao & Cai (2023), the annual reports have the nature of the annual summary review and future outlook, so it is of certain research significance and feasibility to use the methods of text analysis and word frequency statistics on the annual reports of listed companies to measure the digital transformation of firms. This has been confirmed, for example, by (M. Fang et al., 2023), who claim that digitization is a highlight of companies' performance, and companies strongly desire to disclose it in their annual reports to gain favor with investors. Li & Tian (2023) then directly argue that it is scientific to quantify the level of digitalization in terms of the statistics of the frequency of words involving "digital enterprise transformation" in annual reports, basing this claim on the view of F. Li et al., (2013) who say that the usage of words in the annual reports reflects the company's strategic deployment and future planning.

The second approach to the assessment of the company's digital maturity is creating the digitization index based on the evaluation of the digital technology-related investment. This approach is used by Ren et al. (2023), who used the logarithm of the sum of the company's intangible assets and fixed asset investments, which are taken as digital investments, where digital investments include "software", "network", "client", "management system", "intelligent platform" etc. and fixed asset investments which include "computer server". For completeness, it should be mentioned that Fang et al. (2023) also used a digitization index based on ICT investment in their study. However, only as a robustness test to the primary method based on the frequency of digital-related words in the annual report. A study using this approach to the digitization index can also be considered by Higón & Bonvin

(2024). However, in line with their assertion that "digitalization is a complex phenomenon that a single indicator can hardly capture", they propose a comprehensive four-dimensional index, with digital-related investments (ICT investments and training costs) representing only part of the variables.

The third method is when the data of the company's digital transformation is obtained through a questionnaire survey. Schöggl et al. (2023) employed the questioner with closed-ended questions, with response options displayed on a five-point Likert-type scale (ranging from "not considered" to "implemented company-wide"), and several additional open-ended questions designed to allow companies to add any additional information about digital technologies. Similarly, Kamisalic et al. (2020) introduced a questionnaire with about 50 closed questions, with predefined response options depending on the nature of the question.

Methods

This section will define the research questions and related hypotheses, justify the focus on the selected sample of enterprises, propose a method for assessing the level of digitization, and suggest a method for selecting a mathematical method to determine the relationship between the quality of NFR (NFI) and the level of digitization for the sample of enterprises.

In terms of research questions, in line with the defined aim of this paper, it is necessary to answer the question of the relationship between the quality of non-financial reporting and the level of digitalization of the selected companies.

The following hypotheses are defined in relation to this research question: the null hypothesis H0 and the alternative hypothesis H1.

H0: There is no association between the quality of non-financial reporting and the level of digitalization.

H1: Higher quality of non-financial reporting is associated with a higher level of digitalization.

The alternative hypothesis was defined based on a literature search that yielded findings in the form of conclusions from studies by previous researchers that revealed a positive relationship between firms' digital transformation and their ESG performance.

Regarding the selected companies, as mentioned in the section Introduction, the sample includes, in line with the author's previous study, all companies in the energy sector in the Czech Republic that have the potential to fall under the mandatory NFR CSRD from 2025. The reason for choosing a specific limited sample in the author's previous study was the fact that the energy sector is a key sector of the national economy in all EU countries and one of the largest contributors to environmental pollution and should, therefore, be our primary focus when talking about ESG or CSR. Regarding the regional focus on one specific EU country, this should not imply a significant limitation of generality for the EU, as the Czech Republic can be considered a representative average sample within the EU in terms of industrial development, energy mix, and legislative status. The relevance of focusing on the energy sector and its relation to digitalization is also confirmed by previous research, where, for instance (Krajcík, 2021), by following Han et al. (2011), sees a link between the digitalization of industry and energy resources and argues that all transformational changes related to the digitalization of industry affecting production and management should respect the intentions of energy policy, especially aimed at increasing energy efficiency. Although reference is made to the author's previous study, it is worth explaining how the sample was defined in terms of the selection of specific companies. As far as the author is aware, there is currently no publicly available list of these companies, and it was therefore necessary to develop a method of selecting these companies. According to the respective legislation, starting in 2025, the reporting requirements under the CSRD will apply to (i) large companies already subject to NFRD and (ii) all large companies that have more than 250 employees and a net turnover of more than EUR 40 million, or a total balance sheet exceeding EUR 20 million. The following approach was employed to define the sample of companies from the Czech energy sector. The holders of the licenses from the Czech Energy Regulatory Office were identified using the licenses finder tool, accessible via the following link: https://eru.gov.cz/vyhledavac-licenci. The licenses in question were granted in the fields of electricity production, electricity distribution, electricity transmission, gas production, gas transmission, gas storage, heat production, and heat transmission. However, the search in the fields of electricity production, electricity distribution, heat production, and heat distribution yielded an overwhelming number of results (approximately 30,000 companies). Consequently, it was necessary to limit the search further. The license finder allows the use of the filter based on installed power. The level of installed power was set at 10 MWe, with the assumption that the level of assets in the balance sheet was EUR 20 million or above and EUR 2 million per installed MW. This proposal was based on the cost of new installations, which ranged from EUR 0,5 million in the case of gas and solar PV to almost EUR 10 million per MW in the case of nuclear. Thus, the representation of individual sources in the energy mix was also estimated. The alternative approach, based on a net turnover of EUR 40 million and above, an average annual production rate (considering the average utilization as per sources), and an electricity price of approximately EUR 100 per MWh, would result in a filter of 90 MWe. Consequently, a filter of 10 MWe was employed to avoid the risk of omitting some companies. A similar approach was employed in the case of heat production, resulting in a filter of 200 MWt. This procedure resulted in the initial sample of 135

companies, in total, across the selected fields from the Czech energy sector, including companies from other sectors, such as the metallurgy and mining industry, with different core activities but providing, to a not insignificant extent, also energy-related services, in this paper thus considered also as companies from the Czech energy sector. To obtain the final sample, it was necessary to verify for these pre-selected companies whether they meet the conditions set out in the legal framework for companies to be covered by the CSRD from 2025, i.e., a minimum of 250 employees and a net turnover of at least EUR 40 million or a total balance sheet exceeding EUR 20 million. This verification was carried out using a freely accessible database of Czech firms available at https://www.informaceofirmach.cz/, where information on the number of employees and net turnover is available. In the case of a company with more than 250 employees but a net turnover of less than EUR 40 million, the balance sheet information from the annual report of the company concerned, available from the public register, was further verified. The procedure described above led to a final sample of 53 companies. However, considering the procedure of sample selection, it can be stated that, in this case, the sample is equal to the population.

To answer the research question and to confirm or reject the hypotheses, it is necessary to know the quality of non-financial reporting and the level of digitalization of the selected companies.

As already pointed out, the findings regarding the quality of non-financial reporting are fully taken from the authors' previous research. Thus, no methods for assessing the quality of non-financial reporting are the subject of this paper.

Regarding the method of assessing the level of digitalization, as the literature review shows, the most used method of assessing the level of digitalization in academia is the method using a digitization index based on the frequency of digital-related words in the annual report. In line with the process employed by previous researchers (for instance, L. Fang & Li, 2024), the construction of the digitization index in this paper will require three steps: (1) selection of comprehensive digitization-related keywords (and word stems) as a reference for textual analysis; (2) textual analysis or text mining selected keywords from the annual reports of the companies in the defined sample, and (3) construction of the appropriate digitization index.

Artificial intelligence will be used to select keywords, and word stems related to digitization due to its ability to process and generate contextually relevant terms efficiently. This will ensure comprehensive coverage and accuracy in identifying key terms for text analysis. Open-source tools such as Voyant Tools, AntConc, Orange Text Mining, etc., which provide efficient and affordable solutions for text data processing, will be used for text analysis, i.e., to determine the occurrence and frequency of selected keywords in the annual reports. Regarding the construction of the digitization index, following the approach of L. Fang & Li (2024), the digitization index is calculated as the ratio of the number of digital keywords to the number of all words in the annual report multiplied by 100, i.e.:

$$Digiin = \frac{Number\ of\ digitalization\ keywords}{Number\ of\ all\ words\ in\ anuall\ report} \times 100 \tag{1}$$

For the robustness test, an alternative method of measuring the level of digitalization based on the evaluation of investment in digital technologies will be employed. The control variable for *Digiin*, the *Digiin_cont*, will be constructed as the ratio of a company's digitalization-related assets, specifically considering available data in annual reports simplified to "software", to the company's total fixed assets multiplied by 100, i.e.:

$$Digiin\_cont = \frac{Software\ related\ assest\ [CZK]}{Total\ fixed\ assets\ [CZK]} \times 100 \tag{2}$$

The chosen method of calculating the digitization index fully determines the source of the data - the annual reports of the selected companies and the annual reports for 2022 will be used to make the data consistent with the author's previous research adopted in this paper.

To investigate the relationship between the level of digitization and the quality of non-financial information, this paper employs the Pearson correlation coefficient (r), calculated according to the following formula:

$$r = \frac{n\Sigma xy - \Sigma x\Sigma y}{\sqrt{(n\Sigma x^2 - (\Sigma x)^2)(n\Sigma y^2 - (\Sigma y)^2)}} \tag{3}$$

Where:

· n is the total number of elements in the sample (i.e., the number of companies)

· x is the independent variable in the dataset (*NFII*)

· y is the dependent variable in the data set (*Digiin* / *Digiin_cont*)

Multivariate regression analysis will also be used to understand the dynamics between CSR and digitalization further. The dependent variable will be the digitization index level (Digiin / Digiin_cont), and the independent variable will be the quality of non-financial information in six specific ESG domains based on the CSRD methodology. These independent variables include environmental issues (*ENV*), social issues (*SOC*), human rights issues (*HUM*), governance issues (*GOV*), employee issues (*EMP*), anti-corruption and anti-bribery issues (*COR*), and access to the Sustainable Development Goals (*SDGs*). The proposed regression model can be expressed as follows:

$$Digiin=\beta_0+\beta_1 ENV+\beta_2 SOC+\beta_3 HUM+\beta_4 GOV+\beta_5 COR+\beta_6 SDG+ \varepsilon \quad (4)$$

Where, in addition to the above-mentioned variables, β_0 is an intercept term, representing the baseline value of Digiin when all independent variables are zero, $\beta_{1\text{-}6}$ are regression coefficients, indicating the strength and direction of the relationship between *Digiin* and each independent variable, and ε represents an error term, capturing variability not explained by the independent variables. As already emphasized, the values of independent variables will be taken over from the author's previous research.

Results

The level of quality of NFI represented by the non-financial information index (*NFII*) and its subindexes (*ENV, SOC, HUM, GOV, EMP, COR, SDG*), disclosed by the selected companies, is fully taken from the authors' previous research and is summarized, in the form of descriptive statistic for *NFII* and its sub-indexes in Table 1 below.

Table 1: Result of the descriptive statistic_NFII

Index	Mean	SD	Min	Median	Max	Skew
ENV	2.434	0.772	0.000	2.000	4.000	-0.942
SOC	2.019	1.135	0.000	2.000	4.000	-0.612
HUM	1.302	1.488	0.000	0.000	4.000	0.402
GOV	1.679	1.384	0.000	2.000	4.000	-0.162
EMP	2.226	0.933	0.000	2.000	4.000	-0.919
COR	1.604	1.485	0.000	2.000	4.000	-0.045
SDG	1.321	1.516	0.000	0.000	4.000	0.357
NFII	12.585	7.774	0.000	10.000	28.000	0.290

Source: own elaboration

The average score of *NFII*, calculated using the defined sub-indexes, is 12.585 (i.e., 44.92% of the maximum value), while the median is 10.000 (i.e., 35.71% of the maximum value). The standard deviation is high (7.76), indicating a large variance, which is confirmed by the minimal (0.000) and maximal (28.000) values of *NFII*. The sample population has a positive skew in *NFII* values at 0.290, indicating an approximately symmetric distribution, with most of the data evenly distributed around the mean, with a marginally longer tail on the right side of the distribution. Such a low skewness value typically implies that the distribution is close to being normal and does not exhibit significant asymmetry. Two companies achieved a maximum of 28.000 points, and one company got 0 points.

The results regarding the level of digitalization of the selected companies are as follows.

As regards the selection of keywords related to digitalization, in line with the proposed approach, the following keywords (and word stems) were defined: *Information, Intel*, Internet*, IT, IoT, Cyber*, Online, "Industry 4.0", Smart, System*, Technol** and *Virtu**. These keywords and word stems lead to 72 words and collocations characteristic of digitalization, a sufficiently comprehensive group. The full list of these words and collocations is given in Table A1 in the Appendix.

The annual reports of the selected companies were collected from the public register. It should be mentioned here that not all reports are saved in a format suitable for direct use by the text analysis tool, and they had to be adapted to this using the online software tool PDF24 Tools with Optical Character Recognition (OCR). Text analysis was then performed to determine the occurrence and frequency of keywords and word bases. It is worth

noting here that both Voyant Tools and Chat GPT automated text analysis tools were found to have a high error rate by spot checking, and therefore, the text analysis was performed using the advanced search function in Acrobat Reader. It should also be noted that for some of the selected keywords or word bases (especially " System*, Technol*), the context of the individual collocations identified had to be carefully considered, and only those referring to digitization were counted. The online software tool WordCounter was then used to determine the total number of words.

After text analysis, a large difference in the number of words in the annual reports was found (min. 6,321, max. 197,863). To clean the result from the effect of word count, an additional digitization index, *Digiin_simp*, was added, which is calculated as the number of words and word stems related to digitalization divided by 100. The result of the calculated digitization index (*Digiin, Digiin_cont, Digiin_simp*) is presented using descriptive statistics in Table 2 below:

Table 2: Result of the descriptive statistic_Digitization index

Index	Mean	SD	Min	Median	Max	Skew
Digiin	0.051	0.076	0.000	0.024	0.389	2.445
Digiin_cont	0.554	0.892	0.000	0.194	4.199	2.702
Digiin_simp	0.224	0.474	0.000	0.040	2.920	3.996

Source: own elaboration

The Digiin index shows that the maximum number of words related to digital identified in one annual report is 292, while the minimum is 0, and was found in 8 annual reports. The standard deviations (SD) across all three indexes (*Digiin, Digiin_cont, Digiin_simp*) indicate relatively high variability, suggesting substantial differences in digitalization levels among companies. The positive skewness for all indexes reveals that the distributions are right-skewed, with the majority of companies clustered at lower levels of digitalization and a few outliers exhibiting significantly higher values. These patterns are consistent across the three measures, with no fundamental differences in the nature of the variability or skewness.

The results regarding the association between the quality of non-financial reporting and the level of digitalization in selected companies are represented by the Pearson correlation coefficient (r) values, shown in Table 3 below.

Table 3: Pearson correlation coefficient (r)

Correlation	Pearson correlation coefficient (r)
NFII and Digiin	0.303
NFII and Digiin_cont	0.048
NFII and Digiin_simp	0.390

Source: own elaboration

The correlation coefficient (*r*) between *NFII* and *Digiin* is 0.303, between *NFII* and *Digiin_cont* 0.048, and between *NFII* and *Digiin* 0.390. The results show that there is a positive correlation between the quality of NFI disclosure. However, using the guide that Evans (1996) suggests for the absolute value of *r*: (0.00 – 0.19 = very weak), (0.20 – 0.39 = weak), (0.40 – 0.59 = moderate), (0.60 – 0.79 = strong), and (0.80 – 1.00 = very strong), it must be specified that this is a weak correlation. This indicates that as the quality of non-financial information disclosed increases, there is a tendency for the level of digitalization to increase as well, although the strength of this association is not strong. To properly evaluate whether this correlation coefficient is statistically significant, a significance t-test for correlation was conducted based on the following formula:

$$t = r\sqrt{\frac{n-2}{1-r^2}} \tag{5}$$

Where:
• *r* is the correlation coefficient
• *n* is the number of pairs of data (= the number of companies)
The result for the respective correlation coefficient is shown in Table 4 below.

Table 4: t-values

Correlation	*t*-value
NFII and Digiin	2.274
NFII and Digiin_cont	0.345
NFII and Digiin_simp	3.022

Source: own elaboration

Based on the publicly available Student's *t* table for two-tailed tests, for 51 degrees of freedom at a 95% confidence level, the critical *t*-value is ±2.01. Since the calculated *t*-statistic for all correlations does not exceed the critical value, the null hypothesis (H0) - stating that there is no association between the quality of non-financial reporting and the level of digitalization - cannot be rejected. Thus, although there is a weak positive trend, the evidence, considering all the methods chosen to assess the level of digitalization in the interest of the robustness of the approach, is insufficient to confirm a statistically significant association.

As outlined in the section Data and Methods, multivariate regression analysis was used to gain deeper insights into the dynamics between CSR and digitalization. Regression models were created based on the established digitization indexes. The aim of this analysis was to explore the relationships between the independent variables representing different aspects of the environment (*ENV*), social factors (*SOC*), human resources (*HUM*), government support (*GOV*), employment (*EMP*), corruption (*COR*) and Sustainable Development Goals (*SDGs*) and the digital indices as the dependent variable. The results were analyzed in terms of regression statistics, analysis of variance and regression coefficients, and associated statistics. The summary of the main outcomes for all three regression models are shown in Table 5 below:

Table 5: Main outcomes from the regression models

Dependent variable	Multiple R	R-squared	Adjusted R-squared	Key coefficient	*p*-value	Significant variables
Digiin	0.437	0.191	0.065	β_3HUM (0.027)	0.183	none
Digiin_cont	0.304	0.093	-0.049	β_1ENV (-0.285)	0.509	none
Digiin_simp	0.461	0.213	0.090	β_1ENV (0.250)	0.243	none

Source: own elaboration

The regression analyses conducted for the three models based on dependent variables - *Digiin, Digiin_cont,* and *Digiin_simp* -reveal limited explanatory power and a general lack of statistically significant predictors. Across all three models, the R^2 values are low, ranging from 0.093 to 0.213, indicating that only a small proportion of the variance in the dependent variables is explained by the independent variables. Adjusted R^2 values are even lower, highlighting the weak predictive capacity when accounting for the number of predictors included in the models. None of the independent variables show consistent statistical significance across the models. In the *Digiin* model, which exhibits an R^2 of 0.191, no predictor variables are statistically significant. The *Digiin_cont* model, with the lowest R^2 of 0.093 and a negative adjusted R^2, also lacks significant predictors. While the *Digiin_simp* model demonstrates the highest R^2 of 0.213 and a Multiple R of 0.461, it similarly fails to yield significant results for any independent variables. No coefficients across any of the models exhibit *p*-values below the commonly accepted threshold of 0.05. This lack of significant relationships indicates that the chosen independent variables do not adequately explain the variation in the dependent variables. The full regression analysis results are presented in the Appendix in Tables 2, 3A, and 4A.

Discussion

Results related to the level of digitalization of the selected companies cannot be easily interpreted. There are no criteria related to the chosen evaluation method and no minimum and maximum values for evaluating the digitization index or the digital maturity of the companies. However, as can be seen from the descriptive statistics in Table 2, most of the companies in the sample show a lower level of digitalization. This is in line, although not fully commensurate in terms of company size, with (Krajcík, 2021), who concluded that awareness of economic digitalization in small and medium-sized enterprises (SMEs) in the Czech Republic is not the highest. However, the most recent study (Krajcík et al., 2023), also focusing on the digital transformation of SMEs, concluded that there is a positive trend towards digital transformation in this sector, as the management of more than 60% of the companies in the sample of companies surveyed in this study have already taken a strategic decision or are already implementing the first measures in the field of enterprise digitalization. A different perspective, more in line with

the results of this paper, is offered by Wiegand & Wynn (2023), who argue that the use of digital technologies to support sustainability goals within the EU is currently limited.

A different situation is in the case of the research question "*What is the relationship between the quality of non-financial reporting and the level of digitalization of the selected companies*?" as this topic is the subject of many studies. Some researchers see a clear positive relationship between digital transformation and CSR in the positive impact of digital transformation on green technology innovation (L. Fang & Li, 2024; Xue et al., 2022). Zhao & Cai (2023) proved that the digital transformation of heavy polluters significantly contributes to ESG performance. M. Fang et al. (2023) identified two channels through which digitization improves ESG performance: first, digitization reduces agency costs; second, digitization improves goodwill. However, they did not find that digitization significantly improves environmental performance. Cai et al. (2023) found that enterprise digital transformation can significantly improve ESG performance, alleviate the financial constraints of the enterprise, and increase analyst attention. A positive relationship between firms' digital transformation and their ESG performance is also confirmed by Lu et al. (2024). The result of the study by Merlet & Pénard (2022) demonstrated that craft companies with the highest level of skills and digital tools tend to exhibit the most responsible practices, both environmentally and socially. In contrast, companies lagging in digital advancement show lower commitment to CSR practices. (Skare et al., 2024) claimed that digitalization has a positive and statistically significant impact on sustainability development measured by the sustainable development goals (SDG). Less strong but similar conclusions on the same topic were reached by Pérez-Martínez et al. (2023), who found strong positive associations between the level of digitalization and social and economic goals and negative associations associated with environmental goals. Considering the above, it can be concluded that most researchers agree on the existence of a positive correlation between ESG or CSR and the level of digitalization of companies.

When comparing the results of this paper with the findings of previous research, it becomes clear that the conclusions of earlier studies were not fully corroborated. The analysis conducted on the selected sample of companies did not establish a statistically significant association between ESG or CSR performance - represented by the quality of non-financial reporting - and the level of digitalization. However, a different pattern emerges when focusing specifically on the Digiin_simp index, derived from a straightforward count of relevant keywords and word stems in annual reports. This alternative approach reveals a weak to moderate, yet statistically significant, correlation between the quality of non-financial reporting and the level of digitalization. This result aligns more closely with the findings of previous studies, which have generally suggested a positive association between ESG or CSR performance and digitalization.

Therefore, it is important to recognize the limitations of the methods used in this study to assess the level of digitalization. The primary method used to assess the level of digitization in this study, where the digitization index (*Digiin*) is calculated as the ratio of the number of digital keywords to the number of all words in the annual report multiplied by 100, may have limitations when there are large differences in length. The control method represented by *Digiin_cont* may, in turn, be burdened by simplifying the understanding of digitalization-related assets to the item "software", which is nevertheless the only standard item that can be attributed to digitalization in all the annual reports of the selected companies. Furthermore, the appropriateness of this method could be considered in light of the significantly different depreciation periods of software and other assets. The residual value of software may not always correlate with the extent of digitalization; on the contrary, it may significantly distort it in relation to the chosen method and the extent of other assets of capital-heavy companies.

Thus, if we were to accept the fact that ESG or CSR performance is positively associated with the level of digitalization, as has been shown by previous researchers, the only appropriate method for measuring the level of digitalization for the selected sample of companies would be the *Digiin_simpl* index, which consists of simply determining the number of words related to digitalization in annual reports. However, this would need to be confirmed by a robustness test, which, in line with another approach used to measure the level of digitalization, could be based on a questionnaire survey.

Conclusions

This article aimed to clarify whether the new CSR Directive can be considered a real driver for the digitalization of companies. In order to achieve this objective, it was necessary to (i) build on the author's previous research in terms of using knowledge on the level of quality of non-financial information disclosed by all companies in the energy sector in the country that have the potential to fall under the mandatory CSRD NFR from 2025 (selected companies), (ii) assess the level of digitalization of these selected companies, including the selection of data collection and processing methods, and (iii) analyze the relationship between the quality of non-financial reporting and the level of digitalization of the selected companies. The result of this process is translated into the following findings:

(i) *The selected sample of companies shows a low level of digitalization, except for a few companies*.

More precisely, looking at descriptive statistics, the median is only 6.2% (or 4.6% or 1.3%, depending on the method chosen to construct the digitization index) of the maximum value, with 8 companies out of 53 reaching 0%.

(ii) *The analysis conducted on a sample of companies did not demonstrate a statistically significant relationship between ESG and CSR performance - represented by the quality of non-financial reporting - and the level of digitalization. Therefore, the new CSR directive cannot yet be considered a driving force for digitalization, at least as far as the sample of companies surveyed is concerned.*

Considering the above-mentioned, it can be concluded that the aim of this paper has been fulfilled in its entirety.

Nonetheless, certain limitations warrant attention. As outlined in the section Results, this paper raises concerns about the general applicability of the methods used to evaluate the level of digitalization, particularly those based on textual analysis of annual reports and the asset-based ratio derived from financial data within these reports. These concerns are especially pertinent if the findings of previous researchers regarding the correlation between ESG performance and digitalization are assumed to hold general validity. To address this issue further, the application of a third method recommended by previous researchers - the questionnaire survey - could be the focus of future research.

Another limitation lies in the relatively small size and specific composition of the sample. This limitation, however, could be mitigated in future studies by targeting samples with larger or different compositions. Moreover, longitudinal research could provide a more robust understanding of the dynamics between ESG performance and digitalization over time.

As part of the conclusion, it is important to emphasize that the findings presented in this paper do not imply any criticism of the current state of affairs. While many companies in the sample appear insufficiently mature in terms of digitalization, it should be noted, as previously discussed, that the methods for evaluating the level of digitalization are inherently limited. Additionally, it is crucial to consider that the selected sample comprises companies that will fall under the new CSR directive starting in 2025. Therefore, any observed deficiencies in ESG or CSR performance - represented by the quality of non-financial reporting - that may influence the level of digitalization or vice versa should not be interpreted as indicative of non-compliance.

To take a fully objective view of sustainability and digitalization, it is important to recognize that while digitalization brings significant benefits in relation to CSR and the SDGs, where it is often directly driven by developments in these areas, it also presents a number of significant environmental challenges. The accelerated development of digital technologies is leading to a sharp increase in energy consumption, especially in data centers. This phenomenon cannot be considered a progressive step towards sustainability, especially when seen in the context of the current mix of primary energy sources. The process of manufacturing digital devices requires the extraction of precious minerals, leading to environmental degradation and adverse social impacts. In addition, the accelerated turnover of electronic devices leads to the generation of significant amounts of electronic waste (e-waste), which poses a significant environmental hazard. These problems need to be addressed to ensure a sustainable digital transformation.

Appendices

Table A1: Words and collocations related to digitalization defined based on keywords and word stems

information systems, information technology, information management, information flow, information-driven processes, information security, artificial intelligence (AI), intelligent systems, intelligent automation, data intelligence, business intelligence, intelligent networks, internet of things (IoT), internet-based systems, internet infrastructure, industrial internet, secure internet access, cloud, IT infrastructure, IT systems, IT management, IT security, IT-driven innovation, IT automation, IoT devices, IoT-enabled automation, IoT networks, smart IoT systems, industrial IoT, IoT security, cybersecurity, cyber risk management, cyber resilience, cyber-physical systems, cyber networks, cyber threats, online platforms, online services, real-time online systems, online collaboration tools, online education, online accessibility, Industry 4.0 technologies, Industry 4.0 systems, smart factories under Industry 4.0, Industry 4.0 and IoT integration, digital transformation in Industry 4.0, smart technologies, smart devices, smart cities, smart manufacturing, smart grids, smart homes, smart mobility, integrated systems, automated systems, system optimization, system resilience, real-time systems, system integration, emerging technologies, advanced technologies, technology-driven innovation, technology-enabled processes, disruptive technologies, technology integration, virtual reality, augmented reality, virtual collaboration tools, virtual environments, virtual systems, virtual training.

Source: own elaboration

Table 2A: Result of the descriptive statistic_Digiin

Regression statistic	
Multiple R	0.437
R-squared	0.191
Adjusted R-squared	0.065
Standard error	0.074
Observations	53

Analysis of variance

	Degrees of freedom	Sum of Squares	Mean Square	F-statistic	Significance F
Regression	7	0.057	0.008	1.519	0.185
Residual	45	0.243	0.005		
Total	52	0.301			

Regression Coefficients and associated statistics

	Coefficients	Standard Error of coefficients	t-statistic	p-value	Lower 95% Confidence Limit	Upper 95% Confidence Limit
Intercept	-0.019	0.044	-0.419	0.677	-0.108	0.071
$\beta_1 ENV$	0.011	0.034	0.312	0.757	-0.059	0.080
$\beta_2 SOC$	0.009	0.017	0.533	0.597	-0.025	0.042
$\beta_3 HUM$	0.027	0.020	1.352	0.183	-0.013	0.068
$\beta_4 GOV$	0.014	0.017	0.826	0.413	-0.020	0.047
$B_5 EMP$	0.008	0.035	0.243	0.809	-0.061	0.078
$B_6 COR$	-0.015	0.015	-1.015	0.316	-0.045	0.015
$B_7 SDG$	-0.024	0.015	-1.667	0.103	-0.054	0.005

Source: own elaboration

Table 3A: Result of the descriptive statistic_Digiin_cont

Regression statistic

Multiple R	0,304
R-squared	0,093
Adjusted R-squared	-0,049
Standard error	0,913
Observations	53

Analysis of variance

	Degrees of freedom	Sum of Squares	Mean Square	F-statistic	Significance F
Regression	7	3.830	0.547	0.656	0.707
Residual	45	37.529	0.834		
Total	52	41.359			

Regression Coefficients and associated statistics

	Coefficients	Standard Error of coefficients	t-statistic	p-value	Lower 95% Confidence Limit	Upper 95% Confidence Limit
Intercept	1.091	0.551	1.979	0.054	-0.020	2.201
$\beta_1 ENV$	-0.285	0.428	-0.665	0.509	-1.146	0.577
$\beta_2 SOC$	0.029	0.206	0.143	0.887	-0.385	0.443
$\beta_3 HUM$	-0.056	0.250	-0.223	0.824	-0.559	0.448
$\beta_4 GOV$	-0.186	0.208	-0.896	0.375	-0.604	0.232
$B_5 EMP$	-0.037	0.429	-0.086	0.932	-0.901	0.827
$B_6 COR$	0.244	0.183	1.334	0.189	-0.124	0.612
$B_7 SDG$	0.150	0.182	0.827	0.413	-0.216	0.516

Source: own elaboration

Table 4A: Result of the descriptive statistic_Digiin_simp

Regression statistic	
Multiple R	0.461
R-squared	0.213
Adjusted R-squared	0.090
Standard error	0.452
Observations	53

Analysis of variance

	Degrees of freedom	**Sum of Squares**	**Mean Square**	**F-statistic**	**Significance F**
Regression	7	2.479	0.354	1.735	0.125
Residual	45	9.186	0.204		
Total	52	11.665			

Regression Coefficients and associated statistics

	Coefficients	**Standard Error of coefficients**	**t-statistic**	**p-value**	**Lower 95% Confidence Limit**	**Upper 95% Confidence Limit**
Intercept	-0.391	0.273	-1.432	0.159	-0.940	0.159
$\beta_1 ENV$	0.250	0.212	1.183	0.243	-0.176	0.677
$\beta_2 SOC$	0.085	0.102	0.832	0.410	-0.120	0.289
$\beta_3 HUM$	0.142	0.124	1.144	0.259	-0.108	0.391
$\beta_4 GOV$	-0.007	0.103	-0.065	0.949	-0.214	0.200
$B_5 EMP$	-0.056	0.212	-0.262	0.795	-0.483	0.372
$B_6 COR$	-0.064	0.090	-0.710	0.481	-0.246	0.118
$B_7 SDG$	-0.092	0.090	-1.026	0.310	-0.273	0.089

Source: own elaboration

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