The Impact of Digitalisation on Energy Efficiency in European SMEs: A Comparative Analysis Using DESI and Sustainability Measures

Cătălin-Alexandru VERDEȘ [1]
Alexandra-Andreea MIRONESCU [2]
Mădălina MAZĂRE [3]

DOI: 10.24818/mer/2025.01-16

ABSTRACT
This research examines the relationship between the level of digitalisation of SMEs and the uptake of energy-saving measures in various European countries. Using data from the Digital Economy and Society Index (DESI) 2023 and a 2024 survey conducted by the European Commission, the study examines the percentage of SMEs with a basic level of digitalisation and the percentage of those implementing energy efficiency measures. Pearson correlation analysis was applied to assess whether digitalisation influences energy savings in SMEs.

KEYWORDS: *Digitalisation, SMEs, energy efficiency, sustainability, Europe*

JEL CLASSIFICATION: *L26, O33, Q56, M15, Q42*

1. INTRODUCTION

Energy efficiency has permanently been in the core focus of world development's aim to be investigated with priority. If we consider very sudden political, social, geographical, and educational climatic changes, we come to consider also the ways in which we can adapt to these changes if we also consider digital changes, we need to analyse both the positive and the negative impact of these changes in overall structure. In the context of digitisation, we started to use more devices both to communicate in the personal environment and to communicate in the professional environment, both to work and to spend free time, we use this digital equipment both to work faster and more efficiently at work and to develop our personal activities in our personal home in a much more efficient way and a way to ensure more free time for more innovative development.

The scope of this paper is to study the link between the energy efficiency in European small and medium enterprises and digitalisation, using correlation analysis through SPSS software, following the structure: literature review, methodology, objectives, and hypotheses, data set and conditions, statistical analysis, result and discussions and conclusions.

We can ascertain that the primary impact of digitisation is the development of a co-dependence on digital devices, or the lack of organic development of the ability to solve certain tasks without the assistance of a digital device, working only on the basis of energy, and which must be permanently connected to an outlet or another form of energy. In this context, the main problem that arises is educating the young generations to use these devices for personal and professional gainful purposes. The studies (Hanifah et al., 2024) brought to the fore the need to educate children from one generation to another, from a younger and younger age from a beginner level of education based on technology, pedagogy, and content

[1] Bucharest University of Economic Studies, Romania, verdes.catalin@outlook.com, corresponding author
[2] Bucharest University of Economic Studies, Romania, alexandramironescu84@yahoo.ro
[3] Bucharest University of Economic Studies, Romania, madalina.mazare@man.ase.ro

knowledge (TPACK) to cover technology-based online platforms such as Quizizz, Kahoot, and Google, starting even with pre-service teachers, the central goal being the rational use of energy, with tools for inclusive assessment, instruction, and practice.

Climate changes of a great intensity, which are taking place all over the globe, make us understand that we are in a complex process of global energy transition. The studies (Ameso, 2024) show that we depend on the efficient use of the energy that is made available to us things that can be achieved precisely through the increasingly digitalisation of all activities that do not require human intervention.

Improving the quality of life depends on an intervention clearly superior to the human factor and for universal health coverage (UHC) and the actualisation of the health-related sustainable development goals (SDGs) in order to avoid disruptions to health work.
Thus, human global health is already established as a major field, strongly impacted by digitisation, incessantly sustained in which medical treatments and prevention and medical monitoring can no longer be considered without the involvement of digitised resources, as huge transnational medical performance units require energy in the most efficient way possible to support all equipment and all communication at a high-performance level as required by global health assurance.

The analysis of the studies carried out on regional economic landscapes (Buyukyazici, 2024) brought to the fore the need for digital education in all fields of activity regardless of the global region, study level, profession or environment. The nuanced interplay between digital skills and the path-dependent factors, relatedness and complexity, revealed a very high energy consumption in the absence of proper education to ensure a rational use of energy.

Cooperation, coordination, communication, and inviting partners to symbiotic mutualism, has been identified (Aidi et al., 2024) as a potential transnational solution, because it was taken into account that the development of digitalisation with a strong impact on energy rationalisation does not take into account borders but requires permanent collaboration. Thus, collaborative governance can empower SMEs to reach the optimal level of energy rationalisation, and to reinvest in innovations that transcend geographical and temporal boundaries.

2. LITERATURE REVIEW

By studying the macroeconomic features with digitalisation as a moderating variable, with emphasis on SMEs medium and large companies (Ulises & José, 2024), it was found that digitalisation has a moderating effect in the relationship between human factor management and productivity. If we consider this demonstrated link between digitisation and productivity, we must take it for granted that educating human resources to use digitised devices is a key in success to contributing better to business performance. Most studies analyse that various electronics can also work in total darkness while the workforce needs plugged-in energy additional equipment’s or indoors assisted lighting. Nevertheless, in terms of efficient use of energy, the human workforce can be assisted by electronic devices, in the professional sector in order to consume less energy during a period of time when no energy is consumed by household consumers, or the electronic equipment they use in their personal home can be programmed to run different programmes at regionally designated low-power times, automatically and independently of human presence at home, using smart kits and sensors compatible with virtual assistants.

By exploring the practice for leading the expansion of the access to and application of digital technologies in education at the municipality level (Reis-Andersson, 2024), it is found to be necessary that for a coherent process to digital transformation the impact of digitisation, a very advanced form of educating the human resource to which these devices are intended to be used must also be taken into account, stating with K-12 education. The main users of these resources and their implicit dependence are the very young generations who have become accustomed to the use of these digital devices in their personal lives considering them a tool that is indispensable.

Establishing a period of 4-6 years in which a student or student will become active on the labour market, we also take into account the fact that that person will know how to use and work only with digital devices, not being familiar with devices in physical format or printed on paper because he did not use them even during his studies, so integration at work will be much easier because these systems are already available. Through the same analysis, we can also see that the disruptive impact of digitalisation can occur when a much too ageing human resource does not have the ability to fully understand the operation of digital devices. This two-way analysis taken into account by small and medium enterprises brings to the fore the need for a logical progressive order for digitalisation to grow in an organic way together with human resources and to make the intercorrelation between social ecosystems.

Studies by Rosyidiana and Narsa (2024) have gone much further in comparing digitalisation, literation, and innovation on the financial performance across Micro, Small, and Medium-Sized Enterprises (MSMEs) fostering an innovative culture within their businesses. A calculation is made in the analysis of the type: the more educated the human resource and the more digitised the company is, the more efficiently the energy is consumed. Most studies show a dependency account between the education of the workforce, of household users, and the rational consumption of energy through the use of digital devices. But an inverse codependency is also created in which the use of the digital device reduces the development of human creativity, while the devices are taught by AI to develop on their own, and the human brain regresses through the lack of challenges in solving lucrative problems.

Digitisation is becoming a current part of our lives and is raising new generations that use smart vehicles, smart communication devices, smart houses to live in, smart workplaces, pushing the boundaries of already contouring the notion" smart city", that has found a prominent place in urban visions, policies, planning, and infrastructure development (Felt, 2024). Digital implementation in small and medium enterprises can be considered as a pre-test in the development of smart cities, what is used and developed on a micro scale within a commercial company can be implemented at the level of a city at the level of a country and even at the level of an entire continent. Following these discrepancies between different educated generations, between different equipped companies, between different cities, and even between countries, the implementation of an international digitisation system cannot be extrapolated from the lack of legal implementation procedures.

A disruptive development without classical predecessor, it is not desirable as long as there is no regulated market for the use of digital devices, as long as there is no regulated market for the simultaneous use of human resources and digital appliances, as long as there is no strong experience analysed and documented to help the human resource in the problems that arise in the exclusive use of digital devices. This is the reason why there is a lot of study on this field of impact of digitisation, precisely to make available to end users some legal rules and procedures considered and analysed both at the level of countries and at the level of cross-border associations. As the impact of digitalisation on corporate sustainability, grounded in digital economy strategies and sustainable development principles (Kang et al., 2024) must be analysed monitored and legally regulated at national and international levels.

Both technological innovation and legal regulations ensure the sustainability of the implementation of digital innovations and the rational use of limited energy. A chaotic and unregulated development can have both positive and negative impacts, it can develop vast creative work environments, or it can lead to a deterioration of global health. In this regard digitalisation and datafication may be hampering the energy efficiency use but it can also lead to tailored solutions, and maintaining long-term system sustainability (Sulastri et al., 2024) of public and private parties' ecosystem.

The key to sustainable development is reducing disparities. But disparities cannot be accounted for without being categorised and monitored by advanced systems that can handle large amounts of data. Disparities can only be reduced by aligning to certain types of common uses or common education, or any type of global alignment to standards, mainly by understanding why standards exist and why standards must be respected. End users must voluntarily join these systems to be used conscientiously, constantly, without mediation, and without deviating from the initial purpose of use for which they were created and put into use.

Relatively new studies (Aurazo & Gasmi, 2024) have brought it to the fore that digitalisation payments have facilitated financial inclusion. Created to reduce your carbon footprint, digitised payments have also brought with them a new characteristic of deliveries imposed to a certain area. When payments are made in a digitised manner also the circuit of money changes. The transparency with which digital payments are exercised helps people see how much they spend on certain products, how much a physical delivery would cost more than delivering or picking up the product from a certain point where it is delivered wholesale, in bulk, or in an easy-box.

Although the main goal of the final buyer is not to reduce the carbon footprint, less money spending on delivery, it will coordinate their choice towards a much cheaper delivery, also reducing the carbon footprint. Consumer behaviour analysis and intervention during the purchase process can result in a reduction of the carbon footprint and a rationalisation of energy use by the simple fact that the consumer chooses a much cheaper delivery method. Thus, the positive impact of the digitisation of the trade in products and services (Iordache et al, 2023) is recognised by the moment when decision-making transparency is available for each end user, who will see the direct financial benefits and will easily choose a much cheaper delivery which at the level of national and international legal regulation transforms into the reduction of the carbon footprint and the efficient use of energy resources, as a direct effect of SMEs promoting the use of digital payments.

The reduction of cash also reduces the transport made from consumers to branches, to the headquarters of the companies, and then to the bank for counting and depositing the cash, thus reducing the costs of SMEs and the use of fossil fuels. That is precisely why it is required that all activities that are run at national and international level to consider the intercorrelation between SMEs activities and key leadership findings, as each of the actions carried out by a digital device or by a human factor has its own energy use and carbon footprint, that need to be monitored and reduced according to the global energy strategies. Thus, digitisation has a considerable impact on collaborative governance, as leadership and sustainability have been researched and examined concurrently (Boeske, 2023), in order to lay the foundations of an international law to regulate this market where innovation transcends the legal institutional capacity to analyse and set rules for a field that develops organically.

The requested analysis of the impact of digitisation cannot keep up with the implementation of laws that must be respected by the end user, who at the same time must study the use of these digital devices to improve their own life or professional life as well as to bring improvements to the environment of the institution itself. By the time a law or regulation is written and implemented, innovation has already exceeded the level required by that regulation several

times over. But at the same time as we obtain the benefits of innovation, we also notice an environment in constant degradation, so we must consider developing ourselves in tandem with the needs and capacities to sustain the environment at a global level for the global health of both mankind and the geographic planet.

An unregulated development of innovation in the field of digitisation can also lead to an exaggerated consumption of energy that cannot be supported by the planet's resources, that is why specialists in the field impose international regulations transposed into national regulations, which are transcribed at the level of each end user.

As Kim and Coonan (2023) show, the increasing threats of climate change, resource depletion, and human rights crises have led to a closer look at sustainability education. It is much easier to reduce human resources when it is explained and understood the impact it has on the environment, not of the institution, but for each person who does a certain action has a certain carbon footprint, thus all the digital tools we use they use a certain amount of energy that must be obtained and consumed in a sustainable manner.

The understanding of the concept of substances must be taught in schools from a very early age to be in agreement with the energy consumption that the planet can support. Those who will finish the school taught in a way to support energy sustainability will understand that in the workplace they must use digital resources in such a way as to respect these international and national regulations, but at the same time they will be at the feeling of the planet to support the long-term sustainable development at the level of the needs they have both at the company level and at the personal level both in the work environment and in the personal environment.

In conditions where the environment is degrading due to the improper use of energy resources, early education is very important because resources must be consumed properly to ensure new paths for innovation and a new path to rational use of energy education. Nevertheless, sustainable development requires several stakeholders, including SMEs, to take action (Lespinasse-Camargo et al., 2024), because sustainable development is not of a purely theoretical nature. It is not just a law that must be followed at scriptural level, it is a type of strategy to implement at the level of each company to ensure its own long-term organic development.

A recent bibliometric review of papers on sustainability published (Ellili, 2024) brings us to the table of discussion, an increasingly experienced important growth in research papers and citations. This shows us that there is a very high interest in the rational use of energy and in the development in an optimal direction of innovations, as well as the use of digital devices in such a way as to help the human resource to develop and to have a bidirectional collaboration of support. The existence of a very large number of works that study the impact of sustainability and digitisation shows that humanity is very interested in development in an organic manner, but still supported by the imposed development of small and medium-sized organisations as well as national and international organisations of public institutions and private.

Moreover, studies (Serzante & Khudozhnyk, 2023) aimed to identify the most appropriate sustainable evaluation methods for enterprises, outlines that the interest is shared both by small and medium-sized enterprises and at national and international level for maintaining the global health of both the environment and human resources, but with an emphasis also placed on a stable economic health as well as a geographical security of energy resources from which to benefit companies at cross-border level.

Studies revealed that Asia and Europe were the regions that have been most studied, with a focus on the secondary sector of enterprises, but with empathy towards the environment is again

a central point of early education that is emphasised to create an educated human resource at work in the responsible and conscientious use of digital devices to protect the limited resources that the environment provides.

The focus point in future analyses is placed on appropriate methodology for public institutions, companies, and academics to gather all the knowledge and authority at their disposal to educate the human resource in promoting the development of innovation and creativity in the use of digital devices respecting the impact on the environment and the individual and constant reduction of the carbon footprint. It must be constantly kept under the magnifying glass, that digitisation can have both a constructive and a disruptive impact, and as long awareness has been raised upon this double impact, pathways can be created to regulate this organically growing independent field in a sustainable monitored manner.

3. METHODOLOGY

In this study, the chosen methodology aims to analyse the relationship between the level of digitisation of small and medium-sized enterprises (SMEs) in Europe and the adoption of energy saving measures. The methodology is based on a quantitative approach, using statistical analysis to identify possible correlations between the studied variables.

3.1. Objectives and Hypotheses

The main objective of this research is to explore and assess the relationship between the level of digitisation of small and medium-sized enterprises (SMEs) and the adoption of energy saving measures in different European countries. In the context of the transition toward a green and digital economy, encouraged by the European Union, this research aims to determine whether and to what extent SMEs that have adopted a basic or advanced level of digitisation are more likely to implement effective energy saving measures.

- **Hypothesis 1 (H1):** Countries with a higher level of digitalisation among SMEs also have a higher percentage of SMEs adopting energy saving measures. This suggests that digitalisation supports sustainability by optimising resource consumption.
- **Hypothesis 2 (H0):** There is no significant relationship between the level of digitalisation of SMEs and the adoption of energy saving measures. This could indicate that the uptake of energy saving measures is not influenced by the digitalisation of SMEs, but may depend on other factors (e.g., environmental regulations, access to green finance, etc.).

3.2 Data Set and Conditions

3.2.1 Indicator 1: SMEs Digitisation Level (Tabel 1)

Data Source: Data for this indicator comes from the **Digital Intensity Index (DII v3)**, included in the **Digital Economy and Society Index (DESI) 2023**. This index measures the adoption of core digital technologies by SMEs, taking into account a set of 12 core digitisation technologies such as cloud computing, social media, high-speed internet, and others. SMEs using at least four of these technologies are considered to have a basic level of digital intensity.

Indicator Definition and Dimension: The level of digitisation is defined as the percentage of SMEs that have reached a basic level of digital intensity. This level indicates that the SME has adopted at least four of the selected digital technologies. The indicator focuses on SMEs with 10-249 employees, excluding the financial sector.

Reference Period: The year 2023 is the reference period for this indicator, being the most recent available dataset on digitalisation in SMEs.

Unit of Measurement: The indicator is expressed as the percentage of all SMEs in each country that have reached the baseline level of digitisation.

Limitations:

- The indicator measures only a baseline level of digitisation without detailing the degree of advancement in the use of complex digital technologies.
- Variations in access to technology and infrastructure between countries can also influence outcomes, particularly in countries with uneven digital development.

Table 1. SMEs with at least a basic level of digital intensity

Country	Indicator	Unit of measure	Value	Reference Period
Austria	SMEs with at least a basic level of digital intensity	Percentage of enterprises	57.9%	2023
Belgium	SMEs with at least a basic level of digital intensity	Percentage of enterprises	74.5%	2023
Bulgaria	SMEs with at least a basic level of digital intensity	Percentage of enterprises	28.4%	2023
Cyprus	SMEs with at least a basic level of digital intensity	Percentage of enterprises	67.3%	2023
Czechia	SMEs with at least a basic level of digital intensity	Percentage of enterprises	49.3%	2023
Germany	SMEs with at least a basic level of digital intensity	Percentage of enterprises	61.4%	2023
Denmark	SMEs with at least a basic level of digital intensity	Percentage of enterprises	75.3%	2023
Estonia	SMEs with at least a basic level of digital intensity	Percentage of enterprises	55.9%	2023
Greece	SMEs with at least a basic level of digital intensity	Percentage of enterprises	43.3%	2023
Spain	SMEs with at least a basic level of digital intensity	Percentage of enterprises	60.5%	2023
Finland	SMEs with at least a basic level of digital intensity	Percentage of enterprises	85.6%	2023
France	SMEs with at least a basic level of digital intensity	Percentage of enterprises	52.0%	2023
Croatia	SMEs with at least a basic level of digital intensity	Percentage of enterprises	56.0%	2023
Hungary	SMEs with at least a basic level of digital intensity	Percentage of enterprises	53.2%	2023
Ireland	SMEs with at least a basic level of digital intensity	Percentage of enterprises	66.1%	2023
Italy	SMEs with at least a basic level of digital intensity	Percentage of enterprises	60.7%	2023
Lithuania	SMEs with at least a basic level of digital intensity	Percentage of enterprises	60.0%	2023
Luxembourg	SMEs with at least a basic level of digital intensity	Percentage of enterprises	57.8%	2023
Latvia	SMEs with at least a basic level of digital intensity	Percentage of enterprises	48.2%	2023
Malta	SMEs with at least a basic level of digital intensity	Percentage of enterprises	76.5%	2023
Netherlands	SMEs with at least a basic level of digital intensity	Percentage of enterprises	78.6%	2023
Poland	SMEs with at least a basic level of digital intensity	Percentage of enterprises	50.0%	2023
Portugal	SMEs with at least a basic level of digital intensity	Percentage of enterprises	53.6%	2023
Romania	SMEs with at least a basic level of digital intensity	Percentage of enterprises	26.8%	2023
Sweden	SMEs with at least a basic level of digital intensity	Percentage of enterprises	79.9%	2023
Slovenia	SMEs with at least a basic level of digital intensity	Percentage of enterprises	50.4%	2023
Slovakia	SMEs with at least a basic level of digital intensity	Percentage of enterprises	42.2%	2023

Source: Created by the author based on data provided by European Commission (2023a)

3.2.2 Indicator 2: Energy Saving in SMEs (Tabel 2)

Data Source: This indicator is based on data collected in a survey conducted by the **European Commission** between June 3 and June 28, 2024. The survey tracks the percentage of SMEs that have implemented energy saving measures as part of their resource efficiency initiatives. These measures may include adopting technologies that reduce energy consumption, optimising production processes or using alternative energy sources.

Indicator Definition and Scope: Energy savings is measured as the percentage of SMEs reporting the implementation of energy efficiency measures. This reflects SMEs' concern for sustainability and their ability to adopt green practices.

Reference Period: The reference period for this indicator is June 2024, providing an up-to-date picture of the energy saving measures adopted by SMEs in the current sustainability context.

Unit of measurement: Percentage of SMEs in each country that apply energy saving measures.

Limitations:

- There is a time difference between data collection on digitisation (2023) and energy saving (June 2024), but this difference is considered insignificant for the purpose of the correlation.

Table 2. Energy Saving Indicator Data

Country	Indicator	Unit of measure	Value	Reference Period
Austria	Saving energies	Percentage of enterprises	63%	3 June – 28 June 2024
Belgium	Saving energies	Percentage of enterprises	77%	3 June – 28 June 2024
Bulgaria	Saving energies	Percentage of enterprises	61%	3 June – 28 June 2024
Cyprus	Saving energies	Percentage of enterprises	57%	3 June – 28 June 2024
Czechia	Saving energies	Percentage of enterprises	65%	3 June – 28 June 2024
Germany	Saving energies	Percentage of enterprises	66%	3 June – 28 June 2024
Denmark	Saving energies	Percentage of enterprises	76%	3 June – 28 June 2024
Estonia	Saving energies	Percentage of enterprises	52%	3 June – 28 June 2024
Greece	Saving energies	Percentage of enterprises	67%	3 June – 28 June 2024
Spain	Saving energies	Percentage of enterprises	84%	3 June – 28 June 2024
Finland	Saving energies	Percentage of enterprises	65%	3 June – 28 June 2024
France	Saving energies	Percentage of enterprises	76%	3 June – 28 June 2024
Croatia	Saving energies	Percentage of enterprises	52%	3 June – 28 June 2024
Hungary	Saving energies	Percentage of enterprises	66%	3 June – 28 June 2024
Ireland	Saving energies	Percentage of enterprises	40%	3 June – 28 June 2024
Italy	Saving energies	Percentage of enterprises	58%	3 June – 28 June 2024
Lithuania	Saving energies	Percentage of enterprises	72%	3 June – 28 June 2024
Luxembourg	Saving energies	Percentage of enterprises	57%	3 June – 28 June 2024
Latvia	Saving energies	Percentage of enterprises	52%	3 June – 28 June 2024
Malta	Saving energies	Percentage of enterprises	36%	3 June – 28 June 2024
Netherlands	Saving energies	Percentage of enterprises	58%	3 June – 28 June 2024
Poland	Saving energies	Percentage of enterprises	64%	3 June – 28 June 2024
Portugal	Saving energies	Percentage of enterprises	42%	3 June – 28 June 2024
Romania	Saving energies	Percentage of enterprises	54%	3 June – 28 June 2024
Sweden	Saving energies	Percentage of enterprises	69%	3 June – 28 June 2024
Slovenia	Saving energies	Percentage of enterprises	43%	3 June – 28 June 2024
Slovakia	Saving energies	Percentage of enterprises	82%	3 June – 28 June 2024

Source: Created by the author based on data provided by European Commission. (2023b)

3.3 Statistical Analysis

- **Descriptive Analysis**: We will conduct a descriptive analysis to observe the basic characteristics of the two variables - level of digitisation and energy saving - in all countries included in the study.
- **Normality Test**: We will perform Kolmogorov-Smirnov and Shapiro-Wilk tests to check the normal distribution of the data. This step helps us to decide the appropriate type of correlation.
- **Correlation Analysis**: If the data are normally distributed, we will use the Pearson correlation to evaluate the relationship between the level of digitisation and energy saving. Otherwise, we will use a non-parametric method.

- **Interpretation of Results**: Based on the correlation result, we draw conclusions on the influence of digitisation on sustainability in SMEs in Europe.

4. RESULTS AND DISCUSSIONS

Table 3. presents the results of the descriptive analysis for: the percentage of SMEs that have reached a basic level of digitisation and the energy saving indicator. For the digitisation level, the median value is 57.8% and the mean value is 58.2%, indicating a symmetric distribution, where the majority of SMEs in the sample have a basic level of digitisation around these values. For the energy saving indicator, the median is 63% and the mean is 61.26%, suggesting a slightly higher trend in the adoption of energy efficiency measures compared to the level of digitalisation.

The standard deviations for the two variables are 14.49% for digitisation and 12.53% for energy saving, indicating a moderate in-sample variation for both variables, but slightly lower for energy saving measures. These values show that the percentages vary significantly across countries, reflecting regional differences in the adoption of digital technologies and energy efficiency practices in SMEs.

The Kolmogorov-Smirnov and Shapiro-Wilk tests of normality have p-values greater than 0.05 for both variables (0.200 and 0.543 for digitisation, and 0.200 and 0.777 for energy saving, respectively). These results suggest that the data do not deviate significantly from normality, which justifies the use of Pearson correlation to explore the relationship between the two variables.

In terms of extreme values, the level of digitisation ranges from a minimum of 26.8% to a maximum of 85.6%, while energy saving ranges from 36% to 84%. This range indicates considerable diversity between countries in both the adoption of digital technologies and the implementation of energy efficiency measures. Overall, the table shows a relatively balanced distribution of data for both variables and suggests variability between countries, thus providing a solid basis for applying the Pearson correlation and for interpreting the relationship between digitalisation and sustainability in SMEs.

Table 3. SMEs with at least a basic level of digital intensity and Energy Saving Indicator Data.

	Indicator	SMEs with at least a basic level of digital intensity	Energy Saving Indicator
1	Median	57.8%	63%
2	Mean	58.2%	61,26%
3	Std. Deviation	14,49%	12,53%
4	Skewness	-0.164	-0.184
5	Std. Error of Skewness	0.448	0.448
6	Kurtosis	-0.077	-0.406
7	Std. Error of Kurtosis	0.872	0.872
8	Kolmogorov-Smirnov p	0.200	0.200
9	Shapiro-Wilk p	0.543	0.777
10	Minimum	26.8%	36%
11	Maximum	85.6%	84%

Source: Authors' own research with SPSS Statistics 26

4.1 Hypothesis

Table 4 presents the results of the Pearson analysis between the two variables SMEs with at least a basic level of digital intensity and the energy saving indicator. The Pearson correlation coefficient between these two variables is **0.029**, which indicates a very weak correlation, almost non-existent, between the level of digitalisation and energy saving in the SMEs in the sample analysed.

Furthermore, the statistical significance value (Sig. 2-tailed) is **0.886**, which is well above the 0.05 threshold. This result indicates that there is no statistically significant correlation between the two variables, suggesting that any observed association is likely due to chance and does not represent a significant relationship between digitisation and energy saving measures.

Table 4. Correlations

			SMEs with at least a basic level of digital intensity	**Saving Energies**
Pearson Correlation	SMEs with at least a basic level of digital intensity	Pearson Correlation	1.000	0.029
		Sig. (2-tailed)	.	.886
		N	27	27
	Saving Energies	Pearson Correlation	0.029	1.000
		Sig. (2-tailed)	.886	.
		N	27	27

Source: Authors' own research with SPSS Statistics 26

The results obtained are relevant in the context of the hypotheses formulated:

- **Hypothesis 1 (H1)** assumed that countries with a higher level of digitalization of SMEs also have a higher percentage of SMEs adopting energy saving measures, suggesting that digitalisation supports sustainability. The correlation results reject this hypothesis as there is no significant relationship between digitalisation and energy saving. The very small and statistically insignificant correlation coefficient indicates that the level of digitalisation of SMEs is not associated with their energy efficiency measures.
- **Hypothesis 2 (H0)**, that there is no significant relationship between digitisation and energy saving, is supported by the results of the analysis. The fact that the significance of the value is well above the 0.05 threshold confirms that there is no significant correlation between the two variables.

In conclusion, the results suggest that the adoption of basic digital technologies by SMEs does not have a notable influence on their energy saving measures. This may indicate that other variables, such as environmental regulations, government support or organisational culture, may play a more important role in SMEs' decision to adopt energy efficiency measures.

5. CONCLUSION

This research investigated the relationship between the level of digitalisation of small and medium-sized enterprises (SMEs) and the adoption of energy-saving measures in various European countries. The study was conducted through a statistical analysis of the data, using Pearson correlation to assess the relationship between the percentage of SMEs with a basic level of digitalisation and the percentage of SMEs implementing energy efficiency measures. The descriptive analysis showed a moderate variability in the level of digitalisation and

energy savings across countries, but the distribution of these data was relatively symmetric and normality conforming, allowing the Pearson correlation test to be applied.

The results obtained do not support the hypothesis that a higher level of digitisation is associated with a higher uptake of energy saving measures. The correlation coefficient of 0.029 and the p-value of 0.886 indicate an extremely weak and insignificant relationship between the two variables. Therefore, there is no statistical evidence to support that digitisation per se stimulates the adoption of energy sustainability practices in SMEs.

These findings support the null hypothesis (H0) that there is no significant relationship between the level of digitisation and energy saving measures. This suggests that while digitisation may have positive effects on SMEs' operational efficiency, it is not automatically a determining factor in their decision to adopt green measures. Factors that might play a more important role in promoting energy saving in SMEs include environmental regulations at national or European level, financial incentives for investments in green technologies, and a sustainability-oriented organisational culture.

Based on these results, recommendations for policy makers could target additional support measures for SMEs towards sustainability. For example, instead of focusing solely on digitalisation, support programmes could also integrate specific incentives for the adoption of green technologies and energy efficiency, tailored to the needs of SMEs. Therefore, research suggests that a sustainable business environment in SMEs requires a more comprehensive approach, including both support for digitisation and active promotion of green measures.

REFERENCES

Aidi, A., Avianti, I., Koeswayo, P. S., Poulus, S., & Mariam, S. (2024). The effect of an inclusive approach to collaborative governance and its impact on digitizing the quality of public services. *Cogent Business & Management*, *11*(1). https://doi.org/10.1080/23311975.2024.2392324

Ameso, E. A. (2024). Digital entanglements: Medical drones in African healthcare systems. *Global Public Health*, *19*(1). https://doi.org/10.1080/17441692.2024.2405987

Aurazo, J., & Gasmi, F. (2024). Digital payment systems in emerging economies: Lessons from Kenya, India, Brazil, and Peru. *Information Economics and Policy*, *69*, 101113. https://doi.org/10.1016/j.infoecopol.2024.101113

Boeske, J. (2023). Leadership towards Sustainability: A Review of Sustainable, Sustainability, and Environmental Leadership. *Sustainability*, *15*(16), 12626. https://doi.org/10.3390/su151612626

Buyukyazici D. (2024). Digital skills and industrial diversification of regions. *Regional Studies Regional Science*, *11*(1), 583-598. https://doi.org/10.1080/21681376.2024.2388075

Ellili, N. (2023). Bibliometric analysis of sustainability papers: Evidence from Environment, Development and sustainability. *Environment, Development and Sustainability*, *26*(4**)**, 8183-8209. https://doi.org/10.1007/s10668-023-03067-6

European Commission. (2023a). Shaping Europe's digital future. Retrieved November 04, 2024, from https://digital-decade-desi.digital strategy.ec.europa.eu/datasets/desi/charts/desi-indicators?indicator=desi_sme_di3_gelo&indicatorGroup=desi2023-3&breakdown=ent_sm_xfin&period=desi_2024&unit=pc_ent&country=AT,BE,BG,HR,CY,CZ,DK,EE,EU,FI,FR,DE,EL,HU,IE,IT,LV,LT,LU,MT,NL,PL,PT,RO,SK,SI,ES,SE

European Commission. (2023b). *SMEs, resource efficiency, and green markets*. Retrieved November 04, 2024, from https://europa.eu/eurobarometer/surveys/detail/3221

Felt, U., & Sepehr, P. (2024). Infrastructuring citizenry in Smart City Vienna: investigating participatory smartification between policy and practice. *Journal of Responsible Innovation, 11*(1). https://doi.org/10.1080/23299460.2024.2313303

Hanifah, U., Adam, Z. B., Faizin, M., Jannah, I. M., & Hanafi, Y. (2024). Accelerating the digitalisation of learning post-COVID-19 era to improve the pedagogical competence of pre-service Arabic teachers. *Cogent Education, 11*(1), 2413241. https://doi.org/10.1080/2331186X.2024.2413241

Iordache, A. M. M., Ionescu, A., Cârstea, V. G., Chung, H., Dumitru, N. R., & Glăvan, B. (2023). Scenarios to Improve E-Commerce SMEs Activity Based on Their Classification: A Case Study on Romania. *Sustainability, 15*(15), 11963. https://doi.org/10.3390/su151511963

Kang, Y., Yuan, T., & Tang, M. (2024). Digitalization's influence on corporate sustainability strategies in the context of new environmental law. *Finance Research Letters*, 70(15):106259. https://doi.org/10.1016/j.frl.2024.106259

Kim, E., & Coonan, T. (2023). Advancing Sustainability Education through a Cross-Disciplinary Online Course: Sustainability and Human Rights in the Business World. *Sustainability, 15*(6), 4759. https://doi.org/10.3390/su15064759

Lespinasse-Camargo, B., Pires Eustachio, J. H., Bonifacio, D., Macini, N., & Caldana, A. C. F. (2024). Corporate sustainability professionals: The landscape of sustainability job positions. *Business Ethics, the Environment and Responsibility, 33*(2), 184-200. https://doi.org/10.1111/beer.12644

Reis-Andersson, J. (2024). Leading the digitalization in K–12 education at the municipality level. *Cogent Education, 11*(1), 2368997. https://doi.org/10.1080/2331186X.2024.2368997

Rosyidiana, R. N., & Narsa, I. M. (2024). Micro, small, and medium-sized enterprises (MSMEs) during the post-pandemic economic recovery period: Digitalization, literation, innovation, and its impact on financial performance. *Cogent Business & Management, 11*(1), 2342488. https://doi.org/10.1080/23311975.2024.2342488

Serzante, M., & Khudozhnyk, A. (2023). Reviewing Sustainability Measurement Methods for Enterprises. *Sustainability, 15*(21), 15514. https://doi.org/10.3390/su152115514

Sulastri, R., Janssen, M., van de Poel, I., & Ding, A. (2024). Transforming towards inclusion-by-design: Information system design principles shaping data-driven financial inclusiveness. *Government Information Quarterly, 41*(4), 101979. https://doi.org/10.1016/j.giq.2024.101979

Ulises, K. R. J. & José, A. B. P. (2024). Impact of human factor management on company productivity: The moderating effect of digitalization moderating effect of digitalization. *Cogent Business & Management, 11*(1), 2371064. https://doi.org/10.1080/23311975.2024.2371064