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Table of Contents

Entrepreneurial Business and Economics Review

2025, Vol. 13, No. 2

10.15678/EBER.2025.130201

Development and validation of digital leadership skills scale

Nadire Cavus, Seyedali Aghamiri, Nuriye Sancar

ABSTRACT

Objective: The main aim of this study is to construct a digital leadership skills scale (DLS scale) to measure digital leadership skills. Moreover, by integrating the constructed scale into the existing model in the literature, we aimed to investigate the influence of the DLS scale on organisational factors, digital transformation, and enterprises' financial performance.

Research Design & Methods: We used the quantitative research method to construct the DLS scale and to test the proposed model based on a sample of 701 active employees in enterprises. In the first stage of the study, we conducted the comprehensive validity and reliability analysis including content validity, construct validity based on explanatory factor analysis, reliability analysis via Cronbach's alpha, Spearman-Brown coefficient, and retest reliability with Intraclass correlation and Pearson correlation coefficients, confirmatory factor analysis, and item analysis during the development process of the DLS scale. In the second stage, we integrated the digital leadership skills scale into the existing model as a factor and examined the overall compatibility and harmony of the integrated DLS scale items with the existing model. In the third stage of the study, we tested the proposed model with a linear regression analysis model.

Findings: The comprehensive validity and reliability analysis results showed that the constructed DLS scale is valid and reliable. Moreover, exploratory factor analysis (EFA), confirmatory factor analysis (CFA), reliability, item analysis, convergent, and discriminant validity analysis results indicated that the constructed DLS scale was harmoniously integrated with the existing model in the literature. Moreover, simple linear regression analysis results indicated that the constructed digital leadership skills scale influences organisational factors, digital transformation (DT), and enterprises' financial performance.

Implications & Recommendations: With the constructed scale, it will be possible for enterprises undergoing digital transformation to measure their digital leadership skills. Moreover, by integrating this constructed DLS scale into the model that enterprises will use during their digital transformation process, they can enhance the effect of digital transformation on financial performance as well. In other words, using this proposed model, enterprises can gain useful insights into the process of digital transformation and make well-informed choices about the integration of DLS into their digital transformation plans.

Contribution & Value Added: In this study, we constructed a novel scale to determine the digital leadership skills of the leaders who will lead the digital transformation process in enterprises. Moreover, we introduced to the literature a different model that can evaluate the effects of digital leadership skills on organisational factors, DT, and financial performance of enterprises in the digitalization process in enterprises by proposing a model that includes the constructed scale.

Article type:	research article
Keywords:	digital leadership skills; digital transformation; enterprises; financial performance; organisational factors
JEL codes:	C8, O3

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INTRODUCTION

Globalization has put great pressure on businesses in recent years, forcing them to digitalize and increase their productivity to compete with their competitors in the world. Digital transformation (DT)

is critical for companies seeking to preserve or increase their market share in the digital age. Digital transformation is a term that expresses the changes related to the use of digital technology in all areas of a person's life (Kääriäinen *et al.*, 2021). Leadership refers to having the ability to direct, motivate, and manage employees in an organisation to achieve the organisation's mission and goals (Winston & Patterson, 2006). 'Digital leadership' pertains to individuals in leadership positions who execute various leadership processes electronically (El Sawy *et al*., 2016). An effective digital leader will contribute to formulating the digital business strategy, leading to exceptional business success (Araujo *et al*., 2021). As Klein (2020) indicates, digital leaders are expected to be adaptable to organisational structures. Consequently, the presence of digital leadership in the DT process is crucial to align technology with strategic goals, improve adaptability, and ensure effective change management. The absence of a digital leader in the DT process will result in inefficient implementation and waste of resources, resulting in a slower and more effective digital transformation and a digital transformation process with little competitive power in the potential market. However, a standard digital leadership model is lacking. While most existing research is visionary and predicts the necessities for digital leadership based on predicted technological, economic, and organisational variations, limited research documents adjustments in leadership based on implemented cases. There has been little research on the topic in the organisational literature; this study summarizes the main characteristics of leadership in the digital transformation era. As a result, more scientific research on digital leadership qualities and impact is required in the future. Scholars should design new studies in this context to establish a quantifiable scale of digital leadership (Araujo *et al*., 2021).

Existing studies in the literature highlight the critical role of digital leadership in the digital transformation process. However, the existing literature lacks sufficient information on the extent of digital leadership abilities. While much has been written about general leadership and digital transformation separately, there is a lack of comprehensive, validated tools to assess digital leadership skills specifically. This scale contributes to the literature by providing a reliable measure that can serve to explore how digital leadership influences organisational success and transformation, offering both a theoretical framework and a practical tool for further studies. The main research aim is to construct a novel measurement tool called the digital leadership skills scale (DLS scale), specifically developed to evaluate proficiency in digital leadership abilities. This is of significant importance since the existing body of literature lacks a comprehensive scale for this purpose, and the results of this study may help fill this knowledge gap. Then, integrate this constructed scale as a model factor developed by Teng *et al.* (2022) and investigate its general compatibility. Moreover, in the study, we used the DLS scale to identify the digital leadership skills influencing digital transformation, organisational factors, and financial performance, respectively, and to illustrate the relationships between these factors in the proposed model. Thus, as a result of the study, we developed a scientific model that can be used in future studies to determine the effect of the digital leadership skills scale in the DT process of enterprises on financial performance. Using this proposed model, enterprises can gain valuable insights into the digital transformation process and explore how each factor influences the integration of digital leadership skills (DLS) into their digital transformation strategy. The process involved comprehensive validity and reliability analyses, integration of the scale into an existing model, and testing the proposed model using linear regression analysis. The key research questions addressed in this study were: Is the developed DLS scale reliable and valid for the measurement of the digital leadership skills of individuals in leadership positions? How do digital leadership skills influence digital transformation, organisational factors, and financial performance, what is the impact of digital transformation on financial performance, and how do organizational factors influence digital transformation? The article is organized as follows: the literature review and hypotheses development, methodology, results, discussion, and conclusion sections.

LITERATURE REVIEW AND HYPOTHESES DEVELOPMENT

Teng *et al.* (2022) examined the correlation between digital transformation and the performance of enterprises undergoing this transformation. The study found that employees' digital skills, digital technologies, and digital transformation strategies within organisations have a positive correlation with digital

transformation and that digital transformation significantly impacts the financial performance of organisations. To summarize their findings, the researchers proposed a conceptual model, as shown in Figure 1.

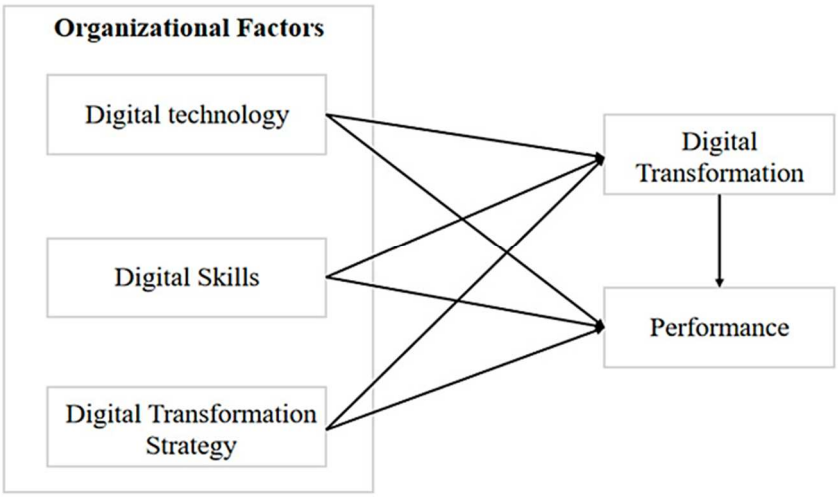

Figure 1. Conceptual model
Source: Teng *et al.*, 2022.

We analysed relevant studies to determine the most crucial competencies for a digital leader in today's world. We used the terms 'characteristics,' 'skills,' and 'traits' interchangeably to represent the multifaceted nature of the investigated concept. While these terms have distinct meanings-characteristics include both inherent and learned attributes, skills refer to acquired capabilities, and traits denote stable personality features. Here they are considered inter-connected elements that together define the construct under study in this study. Klein (2020) used a content analysis of a literature review. This study found 23 characteristics of digital leaders which are classified into three factors. The top skills in the 'digital business' dimension were 'innovative visionary,' 'networking intelligence,' and 'digital intelligence.' 'adaptable' and 'agile' were the top skills in the 'general mindset' factor. Lastly, the top skills for the 'social attitude' dimension were 'motivating coach' and 'social intelligence.' Figure 2 summarises these characteristics.

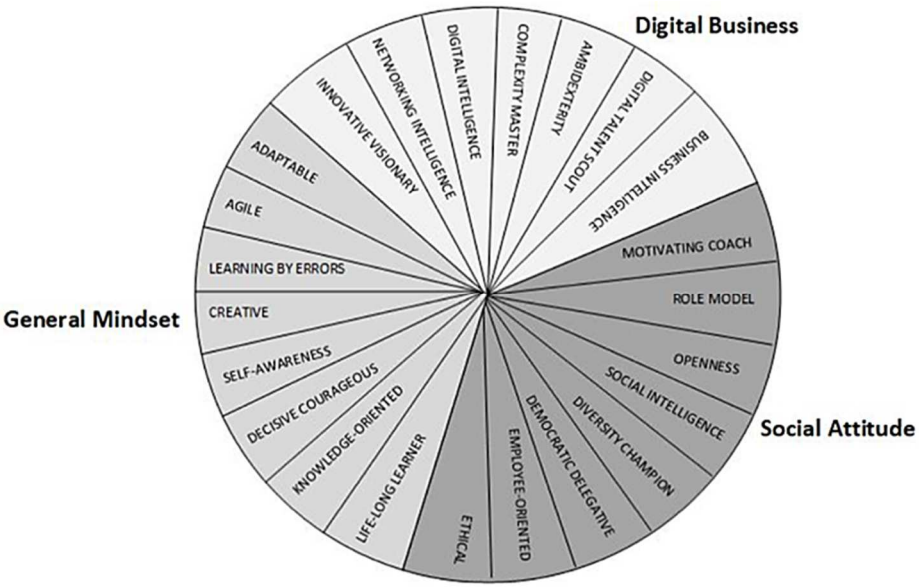

Figure 2. Digital leadership characteristics
Source: Klein, 2020.

In the digital age, technologies are constantly and rapidly changing. Determining which digital skills the leader who will lead digital transformation processes is not easy but essential. Due to a lack of research in this area, it could be difficult to determine which of the 23 acknowledged abilities a digital leader (DL) must have to efficiently lead the organisation through a DT (Klein, 2020). For this reason, some researchers explored the subject to identify some of the most crucial skills of a DL to fill this gap. Promsri (2019) identified six traits as the primary abilities that a DL must possess, which are mentioned in Table 1. On the other hand, Senadjki *et al.* (2024) stated that capabilities, experience, predictability, and vision are important for digital leaders. Interestingly, the top talents listed by Promsri (2019) and Klein (2020) have a high degree of overlap. The aim of our study is most directly related to Promsri's (2019) identification of these six characteristics as the most important abilities of a digital leader such as digital knowledge literacy, innovative vision, customer focus, agility, risk-taking, collaboration, and emphasis on their significance. As a result, we considered the top six digital leader characteristics shown in Table 1 as the basis of the digital leadership skills scale (DLS scale).

Table 1. Digital leader top six skills

Digital Leadership (DL) Characteristics	Description
Digital knowledge and literacy	DL's digital knowledge and the ability to comprehend the digital technologies which impact digital transformation (DT) in an organization.
Innovative visionary	DL's ability to have a clearly defined and stated vision and purpose for DT, and the ability to communicate that vision to employees at all levels in the organization, fostering an entrepreneurial mentality.
Customer focus	DL's requirement is to understand customers' true needs and address them while implementing the DT.
Agility	DL's capability to be flexible, agile, and adaptive for tackling the rapidly changing environment in the digital era.
Risk-taking and experimental atmosphere creation	DL enables employees throughout the organization to experiment with new products, services, and changes while embracing failure and mistakes and learning from them, also actively looking for fresh opportunities.
Emotional intelligence and collaboration	DL needs to equip themselves with high emotional intelligence which enables self-awareness, empathy, communication skills, collaborative skills, and cultural awareness. These skills encourage employees and teams to collaborate in an open and positive environment across boundaries to ensure a successful DT.

Source: Promsri (2019).

The literature defines emotional intelligence as an individual's ability to affect oneself and others to achieve goals and reach set targets (Salovey & Mayer, 1990). Emotional intelligence enhances digital leadership through effective communication and conflict management, self-awareness and decision-making, empathy, and managing relationships (Alsalminy & Omrane, 2023). Moreover, Rockstuhl *et al*. (2011) highlighted that emotional intelligence was a more significant indicator of digital leadership effectiveness in domestic settings. As a result, emotional intelligence coupled with digital leadership skills play an active role in increasing the financial performance of enterprises in the digital transformation process.

On the other hand, previous research emphasized the significance of digital transformation (Wang & Xia, 2024), the vital role of leadership (Araujo *et al.*, 2021), and, in particular, the unquestionable role of digital leaders in the success of digital transformation in the contemporary day (Persson & Manas, 2021). Moreover, the most important abilities of a digital leader have been highlighted (Klein, 2020; Porfírio *et al.*, 2021; Promsri, 2019). Digital leadership has been highlighted as one of the most understudied themes in the context of digital transformation, and more research is needed to go deeper into this topic (Malik, 2024). As a result, the main purpose of this study is to reveal that an organization's digital leadership skills are very important in influencing organisational characteristics. This, in turn, positively affects the organisation's digital transformation, which ultimately leads to enhanced financial performance. In this Table, while 'capability' refers to the potential and capacity to change and adapt in response to the evolving digital environment, such as in the case of agility and

risk-taking, 'ability' implies the present skill or competence in carrying out tasks related to digital leadership (e.g., digital knowledge, innovative vision).

Nowadays, researchers are becoming more interested in the broad and ongoing field of DT research (Vaska *et al.,* 2020; Verhoef *et al.,* 2021). However, the literature appears to lag behind the real world, with fewer studies focusing on how organisations are digitally altered (Fernández-Rovira *et al.*, 2021; Li, 2018; Warner & Wager, 2019). It has been observed that the models utilized by businesses during the digital transformation process consider client experience (Heinze *et al.*, 2018; Ramantoko *et al.*, 2018) and the competencies and attitudes of the leadership (Chonsawat & Sopadang, 2020). However, it has been noted that they do not include digital leadership skills in their DT models. Caputo *et al.* (2021) stated that it has been determined that it requires the implementation of technology as well as the redefining of important components of the business model.

On the other hand, DT requires a digital leader (Euler, 2015), and DL is critical to the success of any firm's DT (El Sawy *et al.*, 2016). The extent and manner in which leadership influences the transformation process within organisations (Singh *et al.*, 2020), as well as the importance of the company's mission to mobilize employees for DT (Porfírio *et al.*, 2021), remain subject to further examination. In addition, for businesses digitalizing their business models is essential (Scuotto *et al.*, 2021). However, achieving this is not straightforward. For instance, these models often overlook crucial leadership skills such as leadership guidance and prioritisation. This oversight creates uncertainty regarding the potential gains and outcomes of digital transformation (Gruber, 2019; Rafael *et al.*, 2020). Consequently, according to these perspectives, we hypothesised:

H1: Digital leadership skills positively influence digital transformation.

He *et al.* (2023) emphasized the function of leadership in enabling creative people and offering organized assistance support in crisis management through guiding digitalization. Moreover, Dalvi *et al.* (2013) noted the significant positive relationships between leadership, organisational change, and organisational development. Moreover, Ko *et al.* (2021) concluded that decision-makers, namely leaders, are the driving forces of digital transformation (DT) within organizations. Through these valuable research outputs, we created the following hypothesis:

H2: Digital leadership skills positively influence financial performance.

Successful digital transformation depends on considering both technological and organisational factors (Appio *et al.*, 2021). Although the concept of performance in enterprises requires a complex procedure, it depends on organisational factors and thus organisational factors should be included in the DT process (Gnizy, 2019). In the proposed model, organisational factors in enterprises consist of digital technology, digital transformation strategy, and employee digital skills. The issues of managing digital projects and accompanying infrastructure are addressed by a digital transformation strategy (DTS) (Henfridisson & Bygstad, 2013). Its objectives are to manage an organization's path toward the intended (digitally changed) future condition and to plan, prioritize, and carry out its digital transformation (DT) initiatives (Matt *et al.*, 2015). According to Wessel *et al.* (2021), digital technologies are a versatile phenomenon that enables an organization to conduct digital operations and is a key factor in digital transformation. However, Lipsmeier *et al.* (2020) and Tabrizi *et al.* (2019) also emphasize the integration of digital technology into the company's digital strategy. On the other hand, Holopainen *et al.* (2022) and Suuronen *et al.* (2022) have highlighted that digital technologies also ensure that employees within the company are strategically prepared to transition to digital operations. Therefore, Zhao *et al.* (2023) have emphasized the significant role of digital literacy among employees in the corporate digital transformation process. Thus, we put forward the subsequent hypothesis:

H3: Digital leadership skills positively influence organisational factors.

Leaders with digital skills positively affect the production, development, and ultimately the overall performance of the organisation, as they positively affect the development of employees' skills and strategic plans of businesses (Ladkin & Patrick, 2022). Persson and Manas (2021) highlighted that the leader's successful application of digital leadership skills is a necessity for the digital transformation of enterprises and is an important factor in increasing the company's financial performance at the end of

the DT process. We created the following hypothesis to determine the impact of the digital leadership role on improving financial performance in the DT process in enterprises.

H4: Organisational factors positively influence digital transformation.

Business outcomes are positively impacted by digital transformation (Hai, 2021). According to recent research, business financial performance is influenced by digital transformation (Mubarak, 2019). Furthermore, enterprise performance benefits from enterprise digital transformation (Wang & Xia, 2024). According to Wang *et al.* (2020), digital transformation consistently enhances organisational performance and positively influences both short- and long-term financial outcomes. Peng and Tao (2022) emphasized that digital transformation in enterprises increases input-output efficiency, leading to overall productivity growth. Jacobs *et al.* (2016) argue that digital transformation positively impacts the financial performance of the business. Based on these opinions, we created the subsequent hypothesis.

H5: Digital transformation positively influences financial performance.

RESEARCH METHODOLOGY

Study Design

We aimed to create a new scale, the digital leadership skills scale (DLS scale), designed to measure digital leadership skills. Subsequently, we wanted to integrate these scale items into the scale developed by Teng *et al.* (2022) as a sub-dimension and examine its overall compatibility with the previously developed model for the research on the correlation between DT and enterprises' financial performance.

Therefore, the initial phase involved the development of the DLS scale, a new measurement designed to assess digital leadership skills. As Figure 3 shows, in the subsequent phase, we integrated the items from the DLS scale as a sub-dimension into the scale developed by Teng *et al.* (2022) as shown in Figure 1. Then, we examined the overall compatibility and harmony of the integrated DLS scale items with the previously developed scale for DT.

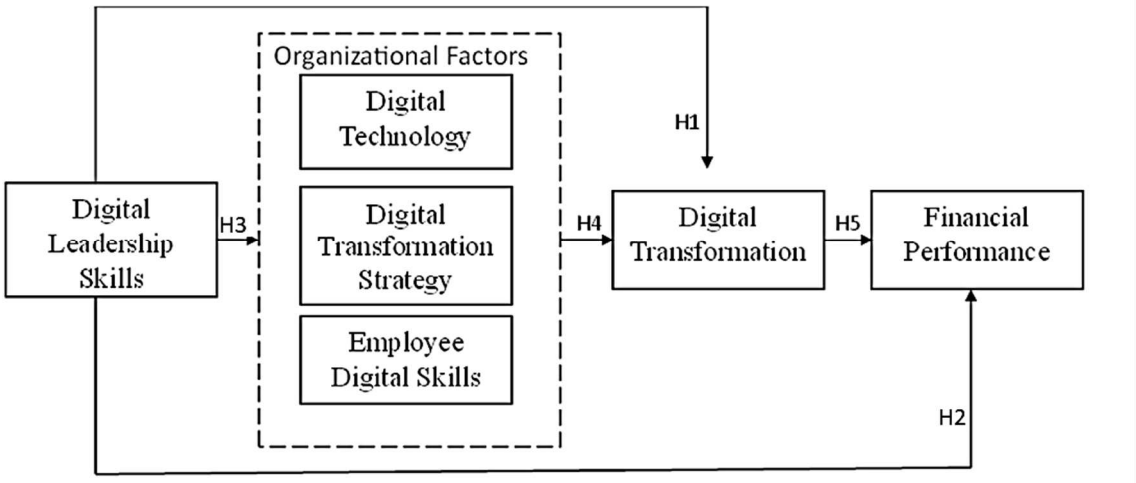

Figure 3. Proposed model
Source: own elaboration.

Participants: We selected employees active in an organization by purposeful sampling method. The online survey yielded 701 responses. The study received ethical approval from NEU Scientific Research Ethics Committee for this study (NEU/AS/2023/185).

From Table 2 we may see that participants represented different genders, different generations, different working experiences, different company sizes, different industries, different education levels, and different regions. The regions consisted of the following countries: Europe (Cyprus, Germany, Sweden, Turkey), America (Canada), Asia (Iran, UAE – United Arab Emirates), and others. There were no missing

observations in the data. Mahalanobis distance was utilized for the analysis of multivariate outlier observations. Based on Mahalanobis distance results, we found no outlier data points in the dataset.

Table 2. Demographic information of the participants

Demographic	Variable	Frequency (for first set n1=351)	%	Frequency (for second set n2=350)	%	Frequency (for all observations n=701)	%
Gender	Male	201	57.26%	275	78.57%	**476**	67.9%
	Female	149	42.45%	75	21.43%	224	32.0%
	Other	1	0.28%	0	0.00%	1	0.1%
What is your birth year?	Baby Boomer (1946-1964)	3	0.86%	2	0.57%	5	0.7%
	Generation X (1965-1980)	21	6.00%	14	3.99%	35	5.0%
	Generation Y or Millennials (1981-1996)	241	68.86%	168	47.86%	409	58.3%
	Generation Z (1997-2004)	86	24.57%	166	47.29%	252	35.9%
Years of working experience	1-3 Years	39	11.14%	30	8.55%	69	9.8%
	4-5 Years	75	21.43%	89	25.36%	164	23.4%
	6-10 Years	154	44.00%	143	40.74%	297	42.4%
	> 10 Years	83	23.71%	88	25.07%	171	24.4%
Company size	< 10 Employees	38	10.86%	33	9.40%	71	10.1%
	10-50 Employees	189	54.00%	213	60.68%	402	57.3%
	51-250 Employees	64	18.29%	50	14.25%	114	16.3%
	> 250 Employees	60	17.14%	54	15.38%	114	16.3%
Industry	Information and communications echnology	203	57.83%	275	78.57%	478	68.2%
	Education	71	20.23%	27	7.71%	98	14.0%
	Retail	23	6.55%	10	2.86%	33	4.7%
	Food	19	5.41%	13	3.71%	32	4.6%
	Banking	12	3.42%	6	1.71%	18	2.6%
	Health and medicine	11	3.13%	8	2.29%	19	2.7%
	Other	12	3.42%	11	3.14%	23	3.3%
Education Level	PhD / Post-Doc	43	12.29%	34	9.69%	77	11.0%
	Master's Degree	89	25.43%	125	35.61%	214	30.5%
	Bachelor's Degree	212	60.57%	180	51.28%	392	55.9%
	Associate's Degree	2	0.57%	1	0.28%	3	0.4%
	High School Diploma	5	1.43%	10	2.85%	15	2.1%
Region	Europe	194	55.27%	151	43.14%	345	49.22%
	America	99	28.21%	125	35.71%	224	31.95%
	Asia	55	15.67%	67	19.14%	122	17.40%
	Others	3	0.85%	7	2.00%	10	1.43%

Source: own study.

After an initial questionnaire administration, we conducted a retest of the DLS scale was conducted on a randomly selected group of 90 participants two weeks later to assess the test-retest reliability. This retest aimed to determine the consistency and stability of participants' responses over time. The decision to provide a two-week interval in the process of evaluating test-retest reliability was specifically chosen to minimize any memory effects on participant responses. A two-week period allows for a more stable assessment by reducing the influence of short-term emotional or situational changes on participants' responses. The literature suggests that a two-week period is sufficient and appropriate for reliability assessments, providing an effective timeframe to evaluate the stability of measurements without significant changes in participants' overall condition (Neuhaus *et al.*, 2023; Cavus & Sancar,

2023; Streiner *et al.*, 2014). Furthermore, we subjected the dataset to both EFA and CFA following its division into two distinct subsets. To elaborate, we separated the dataset comprising 701 cases into two groups. We used the first set of 351 case for exploratory factors for the scale development. Furthermore, we used a second set of 350 cases for confirmatory analysis, which validated the scale's structure and features. According to the literature, a sample would be split with one half being used to build a model and the other to test and validate the results from the first part (Anderson & Gerbing, 1988; Fokkema & Greiff, 2017). Splitting the sample into two for EFA and CFA strengthens the procedure of evaluating the consistency, applicability, and accuracy of the determined model. Thus, a more reliable basis is provided for the validity of the scale and test the robustness of the model. Demographic differences exist between the two data sets for EFA and CFA, such as gender, birth cohorts, work experience, company size, industry, and education. These differences can provide an opportunity to test the adaptability and robustness of the scale across various demographic and contextual groups and contribute to its potential for broader applicability.

Statistical analysis: In the study, we used a comprehensive set of analysis methods to ensure the validity and reliability of the developed DLS scale and the proposed model integrated with the DLS scale. First, we assessed the normality of items through Skewness and Kurtosis indices, which lay in the acceptable bounds as the Skewness ranging between −2 and 2 and Kurtosis values of the items varying along −7 and 7, respectively. First, we examined the content validity for the scale. Next, we analysed the dataset's suitability for factor analysis using the Barlett Sphericity Test and the Kaiser-Meyer Olkin (KMO) coefficient. Later, we utilised an exploratory factor analysis (EFA) via principal component analysis with oblimin rotation to investigate the construct validity of the scale. We evaluated reliability using the Spearman–Brown coefficient, Cronbach's alpha (CrA), and retest reliability with Intraclass correlation and Pearson correlation coefficients. Moreover, item analysis included the computation of corrected item-total correlation and CrA (when individual items were eliminated). Subsequently, we employed a Student's *t*-test to determine whether the scale's items effectively differentiated between the bottom and top 27% of the participants. Furthermore, we utilised CFA to test the validation of the structure of the factors identified in EFA. In the next stage, in addition to the analyses conducted during the development of the DLS scale, such as EFA, CFA, reliability, and item analysis, we also assessed convergent and discriminant validity to examine the overall compatibility and harmony of the integrated DLS scale items with the Teng *et al.* (2022)'s model. Then, we used a simple linear regression model to test the developed hypothesis. We conducted data analysis with the R Studio version 4.3.2.

RESULTS AND DISCUSSION

Stage 1: Development of DLS Scale

DLS Scale Items Development Procedure

At first, we created a 14-item pool for leadership skills, considering that each skill is highly relevant to a digital leader's needed skills. We examined these items' content validity. Eight senior managers of information technology (IT) assessed the 14-item trial form as part of the qualitative stage who were experienced in the leadership roles of small, medium, and large enterprises and knowledgeable in the subject area. While two of these 8 IT experts were experts in IT project management, the others were experts in digital strategy, data analytics, cyber security, system analysis, and digital marketing, respectively. We conducted a quantitative part using the content validity ratio (CVR) and index (CVI) to analyse the scale's content validity in further detail. In this stage of the process, we asked specialists to rate every component on a scale of 1 to 3, denoting 'not essential,' 'helpful but not essential,' and 'essential.' We kept items that met Lawshe's criterion for CVR scores and removed those that did not. Lawshe's criterion, which considers the opinions of eight experts, determines a critical CVR value of 0.75 (Lawshe, 1975). Furthermore, we evaluated the clarity, simplicity, relevance, and ambiguity of the content validity index for item defined as 'I-CVI' and the scale content validity defined as 'S-CVI/Ave' via the four-point-scale (Polit *et al.*, 2007; Yaghmaie, 2003).

Values lying outside of this range were adjusted appropriately, and I-CVI scores at or above 0.78 were considered acceptable; we regarded scores below 0.7 as inappropriate (Polit *et al.*, 2007). S-CVI Ave indices as the mean value of all I-CVIs were greater than or equal to 0.9 and thus were adequate. Before as well as after item elimination, we determined the mean CVR and I-CVI indices of the full scale. We found eight items to be less appropriate for inclusion in the scale and were later removed, according to the content validity rates and indices that were acquired following the experts' feedback (A leader's digital intelligence positively affects the digital transformation strategy of your enterprise; A leader's social intelligence positively affects the digital transformation strategy of your enterprise; A leader's openness abilities positively affect the digital transformation strategy of your enterprise; A leader's democratic delegation skills positively affect the digital transformation strategy of your enterprise; A leader's focus on employee orientation positively affects the digital transformation strategy of your enterprise; A leader's lifelong learning abilities positively affect the digital transformation strategy of your enterprise; A leader's ambidexterity skills positively affect the digital transformation strategy of your enterprise; A leader's decisive courage positively affect the digital transformation strategy of your enterprise). As a result of the expert's opinion, we removed eight items. Consequently, we created a 6-item measure according to the suggestions and opinions of eight experts for the creation of the DLS scale. There were 7-point Likert scale items on this scale. This scale includes seven-point Likert scale items varying from 1 (strongly disagree) to 7 (strongly agree).

EFA Results of The DLS Scale

We unequivocally analysed the DLS scale's underlying factor structure using an EFA. Our sample size was sufficient for the analysis, as KMO was as 0.908. Moreover, due to Bartlett's sphericity test, we can conclude that the dataset exhibited the normal distribution and was appropriate for analysis ($\chi2(15)= 1420.398$, $p <0.001$). From the findings of factor analysis, the DLS scale was a one-factor scale with an eigenvalue of 4.244, explaining 70.729% of the total variance. Furthermore, the component matrix showed factor loadings varying from 0.801 to 0.899. As depicted in Table 3, we measured and illustrated the factor loadings and communalities of all six items of the DLS scale.

Table 3. Items, factor loadings, and communalities

Item No	Statement	Factor loading	Communalities
1	A leader's digital knowledge and the ability to comprehend digital technologies positively affect the digital transformation strategy of your enterprise.	0.801	0.641
2	A Leader's futuristic entrepreneurial mentality, and ability to clearly define and communicate the enterprise's vision to employees, positively affect the digital transformation strategy of your enterprise	0.899	0.809
3	A leader's understanding of customers' true needs and addressing them, positively affect the digital transformation strategy of your enterprise.	0.846	0.715
4	A leader's capability to be flexible, agile, and adaptive for tackling the rapidly changing environment, positively affects the digital transformation strategy of your enterprise.	0.839	0.704
5	A leader's ability to encourage employees to experiment with new products and services, and learn from their failures, positively affects the digital transformation strategy of your enterprise.	0.851	0.725
6	A leader's emotional intelligence, self-awareness, empathy, and communication skills, positively affect the digital transformation strategy of your enterprise.	0.806	0.650

Source: own study in R-studio.

CFA Results of the DLS Scale

We employed the second group (n2=350) to test the item-factor structure established in EFA through CFA. We examined the data to see if they fit the one-factor model using the maximum likelihood estimation approach. To evaluate the compatibility of the model, we utilised various fit indices. These fit indices include standardized root mean square residual (SRMR), normed Chi-

square(χ^2/df), root mean square error of approximation (RMSEA), incremental fit index (IFI), goodness-of-fit index (GFI), comparative fit index (CFI), adjusted goodness-of-fit index (AGFI), Bentler-Bonett normed fit index (NFI), and Bentler-Bonett non-normed fit index (NNFI) (Bollen, 1986; Bollen, 1989; Schermelleh-Engel *et al.*, 2003). In the context of these fit indices, values nearing 1 indicated a favourable fit, as the values approaching 0 for RMSEA and SRMR signify a strong fit (Tabachnick *et al.*, 2013). Table 4 presents detailed fit indices for the one-factor model.

Table 4. CFA results of the DLS scale

Index	Value	Excellent fit interval	Acceptable fit interval	Fit
χ^2	22.085	$0 \leq \chi^2 \leq 2\text{df}$	$2\text{df}<\chi^2 \leq 3\text{df}$ (df=9)	Acceptable
χ^2/df	2.453	$0 \leq \chi^2/\text{df} \leq 2$	$2 < \chi^2/\text{df} \leq 3$	Acceptable
RMSEA	0.064	$\text{RMSEA} \leq 0.05$	$0.05 < \text{RMSEA} \leq 0.08$	Acceptable
SRMR	0.018	$\text{SRMR} \leq 0.05$	$0.05 < \text{SRMR} \leq 0.10$	Excellent
NFI	0.984	$\text{NFI} \geq 0.95$	$0.90 \leq \text{NFI} < 0.95$	Excellent
TLI	0.985	$\text{TLI} \geq 0.97$	$0.95 \leq \text{TLI} < 0.97$	Excellent
IFI	0.991	$\text{IFI} \geq 0.95$	$0.90 \leq \text{IFI} < 0.95$	Excellent
CFI	0.991	$0.97 \leq \text{CFI} \leq 1.00$	$0.95 \leq \text{CFI} < 0.97$	Excellent
GFI	0.928	$0.95 \leq \text{GFI} \leq 1.00$	$0.90 \leq \text{GFI} < 0.95$	Acceptable
AGFI	0.904	$0.90 \leq \text{AGFI} \leq 1.00$	$0.85 \leq \text{AGFI} < 0.90$	Excellent

Source: own study.

These results align with the predefined threshold values provided in Table 4. The suggested one-factor model for the DLS scale appeared to have good support from all fit measures, suggesting an excellent fit and validity.

Reliability Evaluation of DLS Scale

The DLS scale has quite good internal consistency, as evidenced by a CrA of 0.917. Moreover, the Spearman-Brown split-halfreliability coefficient yielded a similarly high value of 0.896. Furthermore, 90 individuals completed the scale at a 2-week interval to assess test-retest reliability, and the results were evaluated using ICC and Pearson's r. The ICC value for the overall scores was remarkably high at 0.982 ($p<0.001$), while Pearson's r also demonstrated a strong correlation of 0.989 ($p<0.001$). The data highlights the consistency of DLS scores over about two weeks.

Item Analysis Results of the DLS Scale

To evaluate the items in the DLS scale, we conducted several analyses, including corrected item-total correlation, squared multiple correlations (SMC), CrA when individual items were removed, and a t-test comparing the upper 27% and lower 27% subgroups for all items. Table 5 presents the summary of mean, standard deviation (SD), and item analysis outcomes. The results of the corrected item-total correlation ranged from 0.714 to 0.845, while SMC values fell between 0.545 and 0.731 for all scale items. Notably, the corrected item-total correlation values for all items exceeded 0.300. Furthermore, when each item was removed individually, CrA values did not surpass the overall internal consistency coefficient of 0.917. We conducted Student's *t*-test to compare mean scores between the top 27% (n=95) and bottom 27% (n=95) sets for all items, all 6 items displayed significant differences between the two groups, with t-values ranging from 16.585 to 21.784. These results indicate that the scale's items effectively distinguish participants regarding digital leadership skills and collectively assess the same behaviour.

Stage 2: Integration DLS Scale to the Proposed Model as a Factor

At this stage, we collectively evaluated the items of the proposed model together with the items from the DLS scale for the proposed model. This evaluation aimed to integrate the valid and reliable DLS scale items into the comprehensive framework of the proposed model as a complementary sub-dimension. In summary, during this phase, we thoroughly examined the integrated DLS items within the broader context of the proposed model's overall consistency and alignment. In this section, in

addition to the analyses conducted during the development of the DLS scale, such as EFA, CFA, reliability, and item analysis, we also assessed discriminant and convergent validity and performed item analysis. The factor analysis preceded an individual examination of the reliability, convergent and discriminant validity, and total scale as well as the dimensions and scale items within each dimension. It is advised that each construct's composite reliability (CR) and CrA values are above 0.70 to demonstrate validity for convergent (Hair *et al.*, 1998). Moreover, each factor's average variance extracted (AVE) value needs to be greater than 0.5 (Fornell & Larcker, 1981). We tested the discriminant validity using the Fornell-Larcker criteria (Fornell & Larcker, 1981).

Table 5. Item analysis findings of the DLS scale

Item	$\bar{x}$ (s)	Corrected item-total correlation	SMC	CrA if item deleted	t (top 27%-bottom 27%)
1	6.34 (1.162)	0.714	0.571	0.909	18.741***
2	6.18 (1.167)	0.845	0.731	0.890	21.784***
3	6.27 (1.107)	0.771	0.596	0.901	18.479***
4	6.17 (1.099)	0.762	0.594	0.902	16.585***
5	6.28 (1.085)	0.778	0.611	0.900	19.257***
6	6.08 (1.115)	0.719	0.545	0.908	17.371***

Note: ***p<0.001.
Source: own study.

EFA Results

We applied the EFA on a set of 35 items across six scales to identify the relationships between them and group them into expected distinct factors based on their common variance. Moreover, the KMO of the sampling adequacy measure reported a value of 0.992 showing sample size adequacy. Moreover, due to Bartlett's sphericity test, we can conclude that the dataset exhibited a normal distribution and was appropriate for analysis ($\chi 2$ (528) = 8387.584, p <0.001). The results of the EFA revealed that two items, item number 17 (To what extent your enterprise uses artificial intelligence) and item number 24 (To what extent your enterprise uses cybersecurity technology), did not meet the acceptable range of factor loading, *i.e.*, they were less than 0.40. We removed these items from the study since they failed to demonstrate adequate performance during the analysis, despite being initially included under the scale of digital technology. We used the extraction method of PCA and the rotation method of Oblimin with Kaiser Normalization to derive these results. Following the removal of these two items, we refined the scale to comprise 33 items with 6 dimensions. The items within each sub-dimension demonstrated strong construct validity, aligning effectively with their respective sub-dimensions. Six dimensions together explained 69.562% of the variance in the proposed model. The revised scale demonstrated satisfactory factor loadings and communalities. The EFA successfully refined the original set of 35 items, resulting in a more robust scale comprising 33 items. This process allowed for a better understanding of the underlying factors within the data, thereby enhancing the reliability and validity of the scale for subsequent analyses. Furthermore, when we collectively assessed the proposed model's items with the DLS scale's items, we observed that the items were placed in the expected factors, and there was no structural disruption as shown in Table 6. In other words, when considered as a whole, the items were appropriately situated within the relevant sub-dimensions.

CFA Results

We assessed and confirmed the 6-factor model obtained from the EFA analysis using CFA with a sample of n2=350. To evaluate the model's fit, we employed various fit indices. The CFA results presented in Table 7 demonstrate that the proposed 6-factor model exhibits an excellent fit, confirming the 6-factor model obtained from the EFA analysis.

Discriminant-convergent Validity

Ensuring convergent validity requires that each dimension displays CR and CrA indices exceeding 0.70, with each factor's AVE being a minimum of 0.5 (Fornell & Larcker, 1981; Hair *et al.*, 1998). Our analysis

Table 6. EFA result of the proposed model

Item	Statement	Factor loading	Communalities
	Digital leadership skills (DLS)		
1	A leader's digital knowledge and the ability to comprehend digital technologies positively affect the digital transformation strategy of your enterprise.	0.702	0.670
2	A leader's futuristic entrepreneurial mentality, and ability to clearly define and communicate the enterprise's vision to employees positively affect the digital transformation strategy of your enterprise	0.916	0.819
3	A leader's understanding of customer's true needs and addressing them positively affect the digital transformation strategy of your enterprise.	0.806	0.719
4	A leader's capability to be flexible, agile and adaptive for tackling the rapidly changing environment positively affects the digital transformation strategy of your enterprise.	0.82	0.748
5	A leader's ability to encourage employees to experiment with new products and services and learn from their failures positively affect the digital transformation strategy of your enterprise.	0.839	0.735
6	A leader's emotional intelligence, self-awareness, empathy, and communication skills positively affect the digital transformation strategy of your enterprise.	0.868	0.731
	% of variance: 5.496 Eigenvalue: 1.814		
	Digital Transformation (DT)		
7	'Assess your organization's digital transformation maturity compared to peers.'	0.898	0.824
8	'Assessment of the use of digital technology.'	0.904	0.796
9	'Assess how widely your own digital technology is used.'	0.834	0.738
	% of variance: 6.491 Eigenvalue: 2.142		
	Digital Transformation Strategy (DTS)		
10	'Your company's digital transformation strategy can increase sales.'	0.645	0.681
11	'Your company's digital transformation strategy can improve competitiveness.'	0.696	0.749
12	'Your company's digital transformation strategy can fundamentally change business processes.'	0.883	0.699
13	'Your company's digital transformation strategy can improve customer experience and satisfaction.'	0.843	0.775
14	'Your company's digital transformation strategy can improve innovation capabilities.'	0.671	0.712
15	'Your company's digital transformation strategy can improve business decisions.'	0.683	0.605
16	'Your company's digital transformation strategy can improve efficiency.'	0.772	0.680
	% of variance: 38.641 Eigenvalue: 12.752		
	Digital Technology (DTech)		
18	'To what extent your enterprise uses blockchain technology.'	0.822	0.658
19	'To what extent your enterprise uses cloud technologies (cloud computing, edge algorithms, cloud-edge collaboration).'	0.687	0.641
20	'To what extent your enterprise uses big data and data analysis.'	0.635	0.606
21	'To what extent your enterprise uses mobile technology 4.5G-5G.'	0.712	0.655
22	'To what extent your enterprise uses the Internet of Things (IoT).'	0.693	0.743
23	'To what extent your enterprise uses social media (collaboration technology).'	0.689	0.463
	% of variance: 4.310 Eigenvalue: 1.422		
	Employee Digital Skills (EDS)		
25	'We advance continuous learning in digital technologies.'	0.695	0.726
26	'A balance between general digital skills and specialized digital roles is adequate.'	0.691	0.706
27	'We can assemble teams with the right mix of skills for each digital project.'	0.776	0.719
28	'Employees are compound talents who understand both business and digitalization.'	0.644	0.651
29	'My organization provides employees with resources or opportunities to acquire the right digital skills for digital transformation.'	0.745	0.716

	% of variance: 3.382 Eigenvalue: 1.116		
	Financial Performance (FP)		
30	'Digital transformation of your business can help increase sales.'	0.671	0.663
31	'Digital transformation of your business can help return on sales.'	0.768	0.694
32	'Digital transformation of your business can help increase gross profit.'	0.690	0.659
33	'Your enterprise's digital transformation can help increase net profit.'	0.725	0.662
34	'Digital transformation of your business can help return on equity.'	0.651	0.787
35	'Digital transformation of your business can help return on investment.'	0.741	0.615
	% of variance: 11.243 Eigenvalue: 3.710		

Source: own study.

Table 7. CFA results for the proposed model

Index	Value	Fit
χ^2	823.290	Excellent
χ^2/df	1.715	Excellent
RMSEA	0.0409	Excellent
SRMR	0.0218	Excellent
NFI	0.9610	Excellent
NNFI	0.9817	Excellent
IFI	0.9834	Excellent
CFI	0.9833	Excellent
GFI	0.9159	Acceptable
AGFI	0.9130	Excellent

Source: own study.

reveals that all factors in the study exhibited AVE indices higher than 0.5, along with CR and CrA values exceeding 0.7 for each factor, as indicated in Table 8. WE assessed discriminant validity using the Fornell-Larcker criteria (Henseler *et al.*, 2015). Our findings, presented in Table 9, align with the Fornell-Larcker, as the AVE values' square root for each dimension passes over the correlation coefficients for each factor in the relevant columns and rows, confirming discriminant validity. Discriminant validity analysis is crucial to demonstrate that the factors of a scale are distinct from each other, each making a unique contribution. A scale must show that it measures different factors. On the other hand, convergent validity is employed to determine if a scale measures similar concepts or components across different factors. If different factors measure the same concept, this indicates that convergent validity is achieved. Therefore, the analysis results indicated that the DLS integrates with the proposed model, measuring similar concepts as a whole. Moreover, it confirmed that the factors of the scale were distinct from each other and each contributed uniquely.

Table 8. Convergent validity result for the proposed model

Dimension	CR	CrA	AVE
DLS	0.928	0.917	0.685
DT	0.911	0.854	0.773
DTS	0.897	0.815	0.558
DTech	0.857	0.811	0.502
EDS	0.836	0.798	0.506
FP	0.858	0.832	0.503

Source: own study.

Reliability Analysis Results

The proposed model demonstrated good internal consistency, as shown by CrA value of 0.942 for all 33 items. The proposed model's six dimensions each showed robust internal consistency (LS=0.917, DT=0.854, DTS=0.815, DTech=0.811, EDS=0.798, FP=0.832). When calculating the CrA value for the scale containing five dimensions without including the LS sub-dimension, we found it to be 0.851. This indi

Table 9. Discriminant validity results

Dimension	Fornell-Larcker Criteria					
	LS	DT	DTS	DTech	EDS	FP
LS	0.827	–	–	–	–	–
DT	0.612	0.879	–	–	–	–
DTS	0.619	0.515	0.747	–	–	–
DTech	0.658	0.596	0.509	0.709	–	–
EDS	0.641	0.630	0.683	0.703	0.711	–
FP	0.598	0.563	0.695	0.678	0.674	0.709

Source: own study.

cates that including the LS factor in the scale enhances the reliability of the proposed model. Furthermore, removing any particular item from either factor had no significant influence on CrA levels. Furthermore, the Spearman-Brown value of whole items on the DLS scale indicated a good value (r = 0.774). All dimensions for the proposed model dimensions also displayed favourable values, for the Spearman-Brown coefficient consistency (LS=0.857, DT=0.824, DTS=0.801, DTech=0.787, EDS=0.752, FP=0.804).

Item Analysis Results

For all factors, the item-total correlations were higher than 0.300. Moreover, the items' SMC varied from 0.485 to 0.778, all of which comfortably surpassed the 0.20 threshold in the context of item analysis as shown in Table 10 (Hooper *et al.*, 2008). Strong associations between items and their respective constructs were frequently demonstrated by those with robust item-total correlations and SMC values, which considerably improved the scale's overall validity and reliability. Furthermore, the CrA values of all items were not above the scale's total alpha value of 0.942 when we methodically removed individual elements from the scale and computed CrA. Notably, when we conducted this study for every subfactor separately, the pattern remained consistent. The item analysis yielded several important conclusions, which emphasize how crucial it is to keep all 33 items in the proposed model. These findings highlight how every item on the scale is consistent with the concept being studied and adds to the scale's general validity and reliability. In other words, when these scale items were integrated into the model developed by Teng *et al.* (2022), the DLS scale was separated from the factors in the model proposed by Teng *et al.* (2022) and was evaluated as a different sub-dimension harmoniously.

Stage 3: Hypothesis Evaluation

To evaluate the hypothesis in this study, we conducted Pearson's correlation analysis and simple linear regression analysis. Table 12 presents the analysis results. In our model, organisational factors have been considered as the total of digital technology, digital transformation strategy, and employee digital skills as in Teng's model.

Influence of DLS on DR: We can see that we have statistically verified H1 based on the simple regression results in Table 12, ($F(1.699)=115.290$; $R^2=0.142$, $p<0.01$). The regression model coefficient ($\beta=0.376$, $p<0.01$) showed that digital leadership skills have a statistically significant and positive influence on digital transformation.

Influence of DLS on FP: We have statistically verified H2 based on the simple regression results in Table 12$F(1.699)=551.627$; $R^2=0.441$, $p<0.01$). The regression model coefficient ($\beta=0.664$, $p<0.01$) showed that digital leadership skills have a statistically significant and positive influence on organisational factors.

Influence of DLS on OF: We have statistically verified H3 based on the simple regression results in Table 12 ($F(1.699)=570.279$; $R^2=0.449$, $p<0.01$). The regression model coefficient ($\beta=0.670$, $p<0.01$) showed that digital leadership skills have a statistically significant and positive influence on organisational factors.

Table 10. Item analysis for the proposed model

Item	$\bar{x}$ (s)	min-max	Corrected item-total correlation	SMC	CrA if item deleted	*t*-value (27% upper-27% lower)
			Factor 1. Leadership skills (LS)			
1	6.34 (1.162)	1-7	0.548	0.640	0.939	22.851***
2	6.18 (1.167)	1-7	0.526	0.778	0.939	21.456***
3	6.27 (1.107)	1-7	0.538	0.682	0.939	20.369***
4	6.17 (1.099)	1-7	0.572	0.691	0.939	23.562***
5	6.28 (1.085)	1-7	0.575	0.677	0.939	19.799***
6	6.08 (1.115)	1-7	0.553	0.652	0.939	20.456***
			Factor 2. Digital transformation (DT)			
7	5.29 (1.205)	1-7	0.498	0.678	0.940	17.325***
8	5.34 (1.234)	1-7	0.432	0.661	0.940	18.471***
9	5.54 (1.170)	1-7	0.465	0.602	0.940	14.955***
			Factor 3. Digital transformation strategy (DTS)			
10	5.60 (1.067)	1-7	0.614	0.683	0.939	15.698***
11	6.00 (1.207)	1-7	0.561	0.727	0.939	18.366***
12	5.54 (1.145)	1-7	0.495	0.608	0.940	17.474***
13	5.91 (1.130)	1-7	0.619	0.751	0.940	15.241***
14	6.06 (1.182)	1-7	0.622	0.711	0.940	18.470***
15	5.79 (1.182)	1-7	0.566	0.633	0.939	14.521***
16	5.91 (1.197)	1-7	0.636	0.683	0.939	19.911***
			Factor 4. Digital technology (Dtech)			
17	3.76(1.266)	1-7	0.211	0.184	0.953	1.856
18	2.96 (2.156)	1-5	0.437	0.575	0.941	17.802***
19	5.31 (1.447)	1-7	0.537	0.504	0.940	14.257***
20	5.05 (1.527)	1-7	0.595	0.644	0.940	18.332***
21	5.73 (1.619)	1-7	0.521	0.564	0.939	14.125***
22	4.27 (2.173)	1-7	0.483	0.650	0.940	19.226***
23	5.60 (1.363)	1-7	0.581	0.485	0.940	18.515***
24	4.32(1.798)	1-7	0.196	0.195	0.948	1.559
			Factor 5. Employee digital skills (EDS)			
25	5.63 (1.253)	1-7	0.707	0.673	0.940	17.846***
26	5.80 (1.331)	1-7	0.594	0.665	0.940	18.203***
27	5.37 (1.394)	1-7	0.649	0.715	0.939	14.255***
28	5.15 (1.534)	1-7	0.606	0.629	0.939	15.230***
29	5.41 (1.513)	1-7	0.673	0.675	0.940	19.655***
			Factor 6. Financial performance (FP)			
30	5.81 (1.090)	1-7	0.681	0.707	0.939	20.354***
31	5.77 (1.077)	1-7	0.707	0.713	0.939	15.277***
32	5.68 (1.078)	1-7	0.678	0.699	0.939	19.656***
33	5.60 (1.050)	1-7	0.650	0.684	0.939	22.542***
34	5.52 (1.180)	1-7	0.656	0.778	0.939	20.874***
35	5.55 (1.194)	1-7	0.662	0.673	0.939	20.412***

Note: *** p<0.001.
Source: own study.

Influence of OF on DT: From a simple linear regression model for the influence of organisational factors on digital transformation, we have statistically confirmed H4 F(1.699)=237.'923; R^2=0.254, p<0.01). The regression model coefficient (β=0.504, p<0.01) showed that organisational factors are statistically significant and positively influence digital transformation.

Influence of DT on FP: From a simple linear regression model for the influence of digital transformation on financial performance, we have statistically confirmed H5 F(1.699)=140.262; R^2=0.254,

p<0.01). The regression model coefficient (β=0.409, p<0.01) showed that digital transformation significantly positively influences financial performance.

Table 11. Pearson correlation coefficients between the factors

Variables	DLS	OF	FP	DT
DLS	1			
OF	**0.670****	1		
FP	**0.664****	**0.809****	1	
DT	**0.376****	**0.504****	**0.409****	1

Note: **p<0.01; (n=701).
Source: own study.

CONCLUSIONS

Developments in the technological field have made digital transformation necessary. All businesses must initiate digital transformation processes immediately under digital leadership. Therefore, enterprises need to recognize the significance of digital leadership skills and include digital leaders in their digital transformation processes. However, the existing body of literature lacks a comprehensive scale to measure the digital leadership skills (DLS) of leaders. For this reason, we constructed a valid and reliable tool called the digital leadership skills scale (DLS scale). Therefore, the findings of this study are important as they have the potential to address this knowledge gap. Moreover, in the study, the developed scale has been used to identify the digital leadership skills influencing Digital transformation, organisational factors, and financial performance, respectively, and to illustrate the relationships between these factors in the proposed model. By using this proposed model, enterprises may get useful insights into the process of digital transformation and investigate the impact of each factor on the integration of DLS into their digital transformation plan.

Table 12. Simple linear regression analysis Results for testing hypothesis

Statistics	B	β	Std.Error	*t*	p	95% Confidence Interval	Decision
(DLS→ DT)							H1 supported
Constant	9.521		0.655	14.541	0.000	(8.235, 10.806)	
DLS	0.188	0.376	0.018	10.737	0.000	(0.154, 0.222)	
Model 1 summary: R^2=0.142; F(1.699)= 115.290; p=0.000							
(DLS→ FP)							H2 supported
Constant	10.824		0.978	11.070	0.000	(8.905, 12.744)	
DLS	0.614	0.664	0.026	23.487	0.000	(0.563, 0.666)	
Model 3 summary: R^2=0.441; F(1.699)= 551.627; p=0.000							
(DLS→ OF)							H3 supported
Constant	33.296		2.666	12.488	0.000	(28.062, 38.531)	
DLS	1.703	0.670	0.071	23.881	0.000	(1.563, 1.843)	
Model 2 summary: R^2=0.449; F(1.699)= 570.279;p=0.000							
(OF→ DT)							H4 supported
Constant	6.930		0.626	11.079	0.000	5.702, 8.159)	
OF	0.099	0.504	0.006	15.425	0.000	(0.087, 0.112)	
Model 4 summary: R^2=0.254; F(1.699)= 237.923; p=0.000							
(DT→ FP)							H5 supported
Constant	21.036			1.069	0.000	(18.938, 23.135)	
DT	0.757	0.409		0.064	0.000	(0.631, 0.882)	
Model 5 summary: R^2=0.167; F(1.699)= 140.262; p=0.000							

B: Unstandardised coefficient, β: Standardised coefficient.
Source: own study.

Theoretical Implications

The present study significantly contributes to the existing literature on the digital transformation of enterprises. Digital transformation is crucial for enterprises' survival and competitiveness (Westerman *et al.*, 2012), and effective implementation of digital transformation positively affects the financial performance of enterprises (Valdez-Juárez *et al.*, 2024). However, Fabian *et al.* (2021) stated that digital transformation has been achieved effectively by involving digital leaders and a positive relationship between digital transformation and financial performance has only emerged. A virtuous digital leader must have digital knowledge and literacy, innovative vision, net-working intelligence, digital intelligence (Klein, 2020), etc. However, a digital leader who is technologically weak will not be a role model for its employees in the enterprise's digital transformation process, will be inadequate in the technical and theoretical applications required for digital transformation, and will have a great impact on the failure of digital transformation within the enterprises. Eventually, the technologically strong digital leader ensures the success of an organisation's digital transformation (El Sawy *et al.*, 2016; Ko *et al.*, 2021; Tigre *et al.*, 2023).

Consequently, the importance of digital leadership skills in driving digital transformation and financial performance has been overlooked. Araujo *et al.* (2021) highlighted that there is a gap in the literature on digital leadership skills in the context of digital transformation. Moreover, they stated that more scientific research on the impact of digital leadership is required in the future and that a new study should be designed to establish a quantifiable scale of digital leadership. In this context, the digital leadership skills scale developed in our study addresses this gap in the literature. Moreover, we also contributed to the literature the proposed model that will guide businesses through the digital transformation process.

Practical Implications

As a result of the mandatory need for digitalization among businesses, many enterprises have initiated the digital transformation process under the leadership of digital leadership (Euler, 2015). However, studies in the literature identify a lack of advanced digital transformation models in enterprises. For this reason, we introduced the digital leadership skills scale (DLS scale) to the literature as a reliable tool to measure digital leadership skills in the context of digital transformation. Moreover, we integrated this scale into the existing model developed by Teng *et al.* (2022) and eliminated the lack of 'digital leadership skills' in the model. The developed DLS scale provides practitioners with a tool to systematically assess and develop their digital leadership skills. In this way, practitioners can conduct targeted training and development efforts in digital leadership more effectively. Moreover, the DLS scale enables leaders to track their progress over time, supporting continuous improvement in line with digital transformation goals. Moreover, the new model created will guide businesses in the digitalization process and will have a positive impact on their development in the current competitive business environment. By establishing connections with existing research in the literature and emphasizing the importance of digital leadership skills, this study has revealed the positive impact of these skills on the financial performance of businesses in their digitalization efforts. Therefore, the constructed DLS scale and proposed model make a valuable contribution to the related literature on leadership skills, digital transformation, and financial performance in enterprises' digital transformation processes.

In summary, the developed DLS scale provides enterprises with a tool to systematically assess and develop their leaders' digital leadership skills. The developed scale helps leaders identify their strengths and areas for improvement in enterprises by focusing on the core competencies required for digital transformation. In this way, practitioners can conduct targeted training and development efforts in digital leadership more effectively. Moreover, the DLS scale enables leaders to track their progress over time, supporting continuous improvement in line with enterprises' digital transformation goals.

Limitations and Future Research Direction

As with all scientific research, this study also has some limitations. The study was limited to the items in the developed new DLS scale used. Moreover, the model was limited to used factors. Since the

relationships examined and the model created are confined to these dimensions, we evaluated the research questions tested in the study within this scope.

For future work, we suggest integrating additional dimensions into the model and testing different relationships between these dimensions. Furthermore, scholars can apply the DLS scale developed in this study to different sectors within the digital transformation process, enabling a comparative analysis of the differences in digital leadership skills or commonalities between sectors. Moreover, scholars could apply structural equation modelling (SEM) as a different approach for analysing relationships in path models with latent variables, such as digital leadership skills. Using SEM may add robustness to the findings by allowing for a more comprehensive examination of the hypothesized relationships and mediating factors within the model. On the other hand, we recommend testing the scale's validity using more balanced samples in future research for EFA and CFA. This approach would allow a deeper understanding of how demographic and contextual factors such as gender, birth cohorts, work experience, company size, industry, and education influence the scale's validity.

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The contribution share of authors is equal and amounted to ⅓ for each of them. NC, SA – conceptualisation; NC, SA – literature writing; NS – methodology; NS, SA – calculations, NC, NS – discussion.

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Beyond the crisis: Role and effects of corporate social responsibility during the COVID-19 Pandemic

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ABSTRACT

Objective: The article addresses the research gap in understanding corporate social responsibility (CSR) dynamics during the COVID-19 pandemic, presenting the outcomes of a national research initiative in Slovakia.

Research Design & Methods: The research delves into the social, economic, and environmental components of CSR, aiming to quantify their individual effects and uncover potential interconnections. Operationalising questions into variables allows for a rigorous examination of these dimensions, utilizing factor analysis with principal component analysis. With 190 organisations answering a questionnaire, the study provides quantitative and qualitative insights.

Findings: The results show that CSR has the most significant impact on strengthening corporate reputation across all three dimensions. CSR reinforced the importance of ethical and sustainable strategies during the pandemic, with organisations with an active CSR strategy performing better. The research confirmed that CSR is key to building corporate credibility and competitiveness.

Implications & Recommendations: Based on the information above and the article's content, we want to provide direction for further research. It is mainly about investigating the impact of the COVID-19 pandemic, especially after the post-COVID-19 period, in the most critical areas that evoke CSR and the business environment, such as corporate culture, human resources, and companies' financial and economic situations.

Contribution & Value Added: The presented research aimed to expand knowledge about the effects and impacts of social responsibility on organisations that implement socially responsible activities and the region and society in which they operate. We based the research on the processing of data from a nationwide survey. We processed a total of 190 valid questionnaires, which enabled the use of descriptive and inference statistics procedures.

Article type:	research article
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INTRODUCTION

Together with other social concerns (including corporate philanthropy and social enterprise), corporate social responsibility (CSR) has emerged as one of the major global business trends of the twenty-first century. Businesses now recognize their responsibility to society and its ideals and their role in addressing social, environmental, and economic challenges. Globally, scholars regard CSR as a specialized area of international business ethics, and its significance is increasing with the entry of multinational corporations. Even though the literature on CSR has covered the definition and extent of CSR in detail, there is still disagreement on how to define the term. Many of those businesses believe that CSR makes them more competitive in the marketplace (Gatti *et al.*, 2019). Cieślik *et al.* (2024) examine

how firms' decisions to sell in specific geographical markets (national, European, and non-European) differ based on their participation in different IBNs and domestic firms. We compared the market choices of multinational firms from large developed economies (*e.g.*, the US, Germany, the UK, and France) to those of Polish standalone firms and business groups. Kljucnikov *et al*. (2020) found that small and medium-sized businesses often lack a clear understanding and conscious acceptance of CSR as a norm rooted in their management philosophy rather than an exception caused by special circumstances. Since this idea is relatively new in the Slovak Republic, it is likely the cause of the over 50% of people who still do not understand what this term entails. Since the 1950s, CSR has been discussed in management literature, with increasing interest in recent years. However, businesses and society's interest in this idea has only increased recently. Several business scandals at the start of the new millennium have increased public awareness and highlighted the value of corporate social responsibility. This is underscored by the increasing mainstream concern for corporate social responsibility among many firms, in addition to gaining attention from academics. Since the idea has been evolving since the 1950s, one might assume that defining it would be quite simple. However, there is no widely accepted definition. There is a large range of definitions that we may find both extremely basic and highly complex. Many new, related, and complementary concepts and terms have emerged along with the growth and evolution of corporate social responsibility, but in actual use, they are frequently misconstrued as CSR. Although they are quite similar in nature, each term and concept has a distinct meaning (Moravčíková, 2016; Ubrežiová *et al*., 2022; Ubrežiová & Horská, 2011). On the other hand, the 1987 Brundtland Commission report 'Our Common Future' helped to establish the credibility of CSR in relation to sustainable development. Following the discussions on environmental preservation, particularly during the 1992 UN Earth Summit in Rio de Janeiro, the concept gained even more traction. Currently, there are numerous areas where the concepts of CSR and sustainable development overlap. The integration of the social, economic, and environmental dimensions is a component of both. Sustainability and CSR are major concerns on the agendas of international bodies and organisations, such as the EU 2020 Strategy, the UN Millennium Development Goals, the ILO Tripartite Declaration, and the OECD Guidelines for Multinational Enterprises (Moravčíková, 2016).

LITERATURE REVIEW

The significance of engaging in socially responsible behaviour is growing over time. In the 1970s, the American Chamber of Economic Development published two strategic papers entitled 'A new rational for corporate social policy' and 'Social responsibility of business corporations' (Latapí *et al.,* 2019). Wang *et al*. (2015) describe the positive relationships between CSR, firm performance, and brand loyalty. This practice demonstrates that CSR, as an intangible asset, improves the company's performance. The notion of social responsibility originated in the 1950s, and until recently, the business sector was the only target audience for this approach (Madzík, 2015).

As seen above, the idea of CSR is expanding to encompass a variety of concepts centred around societal advancement. Taking a step back from the ideological perspective of corporate social responsibility, we can see that various methodological or application approaches have been developed to focus on CSR from a practical standpoint systematically. The so-called triple-bottom-line concept is one of the most popular globally. It illustrates how social responsibility's social, economic, and environmental facets are interrelated (Norman & MacDonald, 2004). The triple bottom line remains a useful tool for systematic CSR analysis. Even now, it is possible to apply in-depth analyses that advance human knowledge on this significant and advantageous topic for society.

Stakeholder theory, corporate citizenship, sustainability, business ethics, and CSP were among them. Despite their close relationship, these ideas are different (Jaysawal & Saha, 2015). Significant events that shaped the 1990s saw the spread of globalization accelerate (Bolton, 2023). This decade has seen a rise in the importance of sustainability and the introduction of numerous new ideas related to it, particularly after Rio de Janeiro hosted the Earth Summit in 1992 (Latapí *et al*., 2019). Numerous writers have discussed CSR and sustainable economic development, which are based on opportunities for businesses to access markets for highly skilled labour, scientific discoveries, and new technologies

rather than the availability of raw materials or markets. This cannot be done without developing an innovative development model based on the concepts of corporate social responsibility (Ubrežiová *et al*., 2020). On the other hand, an analysis of the current approaches to evaluating investments and innovations shows that the key barrier to transitioning to sustainable investment is not considering environmental, social, and governance (ESG) factors (Sládková *et al.,* 2022).

Past studies demonstrate the critical importance of these two ideas for any business, as CSR and innovation practices support regular operations during the profound and drastic transformation of the economy (Rexhepi *et al*., 2013). The quantity of research on the connection between CSR and financial performance has skyrocketed recently. Still, not every study produced the same findings. There are two schools of thought in empirical research on the connection between financial efficiency and corporate social responsibility (McWilliams & Siegel, 2000).

We can assess CSR using specific quantitative indices. The non-profit, non-governmental Global Reporting Initiative (GRI) has been handling this kind of evaluation since 2002 under the auspices of the 'Sustainable Reporting Guidelines' program. Performance indicators, as suggested by GRI, describe how a company affects the economy, society, and living environment. These indicators are subject to change, or a company may choose to develop its own. However, the GRI basic principle, which guides the preparation of the annual report on CSR subjects, is immutable.

Global Reporting Initiative uses both quantitative and qualitative performance indicators. Quantitative numerical data are highly convenient because they are simple, comprehensible, and commensurable. However, there are instances in which they can also be imprecise and fail to discuss the true impact of an organisation on its surroundings, such as when describing a firm's existence in a complex social and economic system that defies quantitative expression. Subsequently, GRI suggests utilizing qualitative indicators as well, which are described as elaborate responses that offer a nuanced picture of the company's social, environmental, and economic performance.

The COVID-19 pandemic caused widespread lockdowns and other restrictive measures and had a major effect on the labour market and the economy (OECD, 2021). This suggests that the COVID-19 pandemic affected a number of sectors from the standpoint of the national economy. He and Harris (2020) provide a preliminary analysis of the ways in which the COVID-19 pandemic may impact the advancement of marketing and CSR. They contend that the pandemic offers companies a great chance to move toward more real and authentic CSR and help address pressing global social and environmental issues. Madzík *et al*. (2025) indicated in the article's research a significant increase in publications on human-centricity in production during the COVID-19 pandemic (2019-2022). Natural disasters and diseases have historically triggered industrial changes, making this unsurprising. Żur and Wałęga (2023) explicated how the activities of small and medium-sized Polish enterprises were impacted by internationalization and innovation orientation as factors of employee learning and development adaptation during the COVID-19 pandemic. According to Tomcikova *et al*. (2021), organisations should be ready to adapt quickly to change and have their action plans ready because the new coronavirus situation affects many aspects of working life and the management of individual human resource management (HRM) practices. In response, the participants indicated if the COVID-19 pandemic had a detrimental impact on their organisation. The findings indicate that 27% of respondents partially agree, 51% strongly agree, and 22% of HR managers disagree that the COVID-19 pandemic is negatively affecting their organisation. Müller *et al*. (2023) discuss how the COVID-19 pandemic has affected organisational culture. According to the authors, 43 718 people visited the village in 2020 despite the unfavourable circumstances surrounding the COVID-19 pandemic, representing a 41.18% decrease in attendance from 2019. Research conducted in the Czech Republic by Tothova *et al*. (2022) supports this opinion. Similarly, Zámková *et al.* (2023) found that the pandemic affected not only the place of purchase but also consumer motivations, as they focused more on health, safety, and the sustainability of supply chains. Loo-See and Woon (2022) discussed the effect of COVID-19 on the ASEAN tourism industry in relation to this sector. According to the chosen authors, the COVID-19 pandemic has had a major impact on the business environment of all branches and firms.

Our main aim was to explore areas that the existing literature has identified as relatively underresearched in terms of the effects and impacts of CSR on the business environment during the COVID-

19 pandemic. While scholars have analyzed numerous aspects of CSR, certain critical dimensions remain insufficiently examined, particularly regarding their influence on corporate operations, strategic decision-making, and long-term sustainability in times of crisis. Given the scope and limitations of this study, we selected these key areas, forming the research foundation. We systematically analysed the interplay between CSR activities and business resilience, identifying direct and indirect impacts on organisations, employees, and stakeholders. In particular, we sought to assess how CSR initiatives influenced financial performance, corporate culture, risk management, and stakeholder relationships in an unprecedented global crisis.

We formulated and addressed the following research questions, designed to provide deeper insights into the role of CSR in shaping business practices and resilience strategies during the pandemic:

RQ1: *What is the magnitude of the individual effects and impacts of the social, economic and environmental components of CSR?* This research question aims to map the extent to which the three components of CSR affect specific areas where an effect is naturally expected. Focusing on this issue will make it possible to quantify the set of knowledge on the effects of CSR from various perspectives.

RQ2: *Is it possible to observe a concurrence between the individual effects of CSR resp. the interrelationships between CSR effects?* – whether direct effects for the organisation or mediated effects (*i.e*., impacts) for the region or society – can help to gain a more comprehensive understanding of the internal structure of the various aspects of CSR. Focusing on this issue will make it possible to identify potential synergies (referred to as concurrency in statistics) and lysergic effects (referred to as opposites in statistics).

RQ3: *Is it possible to identify certain latent links between the internal and external impacts of CSR behaviour that would explain this phenomenon more comprehensively?* The analysis of latent factors (variables) allows for a more comprehensive view of the correlation structure between the monitored areas. Focusing on this research question allowed for a statistically reliable interpretation of groups related to variables and can help create new theoretical or practical implications.

RESEARCH METHODOLOGY

From this point of view, we used a questionnaire to implement the above research plan. Before its creation, we analysed research questions and then developed them into variables. The variables were then reformulated into individual questions in the questionnaire. At the same time, their type was determined (about the analytical intentions arising from the focus of this study). All variables listed were of the 'scale' type, and we used a scale of 1 to 5 for responses. We developed the questionnaire based on theoretical concepts of CSR and previous empirical studies and underwent pilot testing to ensure its reliability and validity.

We used random sampling in the survey to address the respondents, while for capacity reasons, the organisations were not limited by stratification criteria. Finally, 190 organisations whose questionnaires were valid participated in the survey. We then subjected the data from these organisations to statistical surveys. This consisted of sample strength analysis, reliability testing, and several descriptive and inference statistics procedures. We used factor analysis with the principal component analysis (PCA) extraction method to analyse the latent relationships between the variables. Noteworthy, PCA is a statistical method used to reduce the dimensionality of data while preserving as much information as possible. It is primarily used in machine learning, data analysis, and visualization when working with large datasets containing multiple variables. We interpreted the results in graphical and tabular form and supplemented them with an interpretive text to answer research questions.

We collected data electronically via an online questionnaire survey distributed among organisations operating in the Slovak Republic. This questionnaire was designed to capture the impact and effects of CSR in social, economic, and environmental dimensions. We used the following methods to disseminate the questionnaire and reach respondents:

- Direct email communication: We sent the questionnaire directly to the contact database of businesses and organisations identified as relevant to the research.
- Distribution through professional networks: We distributed the questionnaire through professional and expert groups, such as LinkedIn, professional associations, and chambers of commerce.
- Collaboration with partner organisations: Some organisations helped distribute the questionnaire among their members or partners.

Data collection took place from 2020 to 2021, which allowed us to record the organisations' responses to different periods of the COVID-19 pandemic and their social responsibility during the crisis.

The research focused on quantitative methods. The questionnaire contained scale questions (1-5 Likert scale) that assessed the impact of CSR in the social, economic, and environmental areas. We collected 190 valid responses and processed them using statistical methods, including factor analysis and PCA. The data, which were later processed using the statistical software SPSS Statistics and Minitab, formed the main material for statistical processing to expand the knowledge base regarding selected aspects of social responsibility. The next part of the article will present the results, divided into four parts and four subchapters. The first will deal with testing and evaluating the reliability of the results obtained from the questionnaire. The next three subchapters will deal with three research questions each.

RESULTS AND DISCUSSION

Several factors affect the reliability of the quantitative analysis. There are currently approximately 596 000 organisations operating in Slovakia (the data is current as of 07/2023). One hundred ninety of them participated in the survey, which represents a 7.11% confidence interval with a 95% confidence level. For example, if we got the average value for the variable 'employment support' at the level of 4.50, then there would be a 95% probability that if we had a complete sample (*i.e.*, 596 000 organisations), the actual result would be at the level of 4.1455 up to the value of 4.855 (these values were obtained as the difference between the average value and the product of the scale used and the confidence interval → *i.e.*, 4.50 ± (5 x 0.0711)). We used a scale from 1 to 5 in all questions (*i.e.*, variables). We tested the reliability of this scale by means of a reliability test. The measure that interpreted the level of reliability was the value of Cronbach's alpha. For 32 variables, Cronbach's alpha value was 0.916. Values above 0.700 were normally considered sufficient. When testing reliability, we also checked whether Cronbach's alpha would not increase if we excluded any variable from the analysis. If this were to happen, it would be justified to consider the suitability of the variable for this research. Table 1 shows the results of this testing.

We can see from the table that the eventual removal of a variable would not increase the value of Cronbach's alpha, so no value in the last column of the Table was higher than the total value of Cronbach´s alpha 0.916. Thus, the scale used was sufficiently reliable for all variables and would not hurt the results' accuracy. In the case of continuous variables, we recommended testing for extreme values to test the reliability of the data. Extreme values (for example, very low or very high) can significantly affect some position indicators, for example, the average, and therefore, such a test should be performed. If the test reveals extreme values, the case should be considered, and consideration should be given to keeping the case in the data structure (*i.e.*, whether it is a random or a system error). We used the Grubbs outliers test. We gradually tested all 32 variables. We did not identify extreme values in any case. Thus, we did not have to exclude any cases from the analysis. From the above data analyses conducted before the statistical analysis itself, it follows that the data was sufficiently reliable to proceed to descriptive and inferential statistics procedures that would allow us to answer the research questions.

Table 1. Results of reliability testing

Variable	Scale means if item deleted	Scale variance if item deleted	Corrected item-total correlation	Squared multiple correlation	Cronbach's alpha if item deleted
Imp_a	108.492	277.326	0.330	0.418	0.915
Imp_b	108.724	278.413	0.354	0.493	0.915
Imp_c	108.730	273.230	0.456	0.477	0.913
Imp_d	108.915	276.706	0.392	0.395	0.914
Imp_e	109.195	278.509	0.400	0.399	0.914
Imp_f	108.915	278.046	0.431	0.405	0.913
Imp_g	109.148	275.520	0.394	0.500	0.914
Imp_h	108.883	271.454	0.515	0.593	0.912
Ef_So_a	108.052	279.763	0.417	0.533	0.914
Ef_So_b	107.772	279.549	0.453	0.466	0.913
Ef_So_c	108.650	273.601	0.518	0.606	0.912
Ef_So_d	108.925	276.771	0.505	0.666	0.913
Ef_So_e	109.031	274.127	0.461	0.652	0.913
Ef_So_f	108.788	273.636	0.452	0.680	0.913
Ef_So_g	108.349	278.048	0.425	0.423	0.914
Ef_So_h	108.698	275.371	0.404	0.583	0.914
Ef_Ec_a	108.338	271.980	0.571	0.685	0.912
Ef_Ec_b	107.957	276.583	0.495	0.628	0.913
Ef_Ec_c	108.449	271.834	0.561	0.625	0.912
Ef_Ec_d	108.825	275.687	0.503	0.622	0.913
Ef_Ec_e	108.619	273.450	0.499	0.681	0.912
Ef_Ec_f	108.455	274.749	0.441	0.686	0.913
Ef_Ec_g	108.661	272.204	0.573	0.627	0.911
Ef_Ec_h	108.465	275.218	0.434	0.635	0.913
Ef_En_a	108.518	267.272	0.616	0.658	0.911
Ef_En_b	108.026	273.941	0.482	0.697	0.913
Ef_En_c	108.518	269.677	0.556	0.653	0.912
Ef_En_d	109.026	271.526	0.581	0.655	0.911
Ef_En_e	108.867	271.083	0.551	0.657	0.912
Ef_En_f	108.984	269.760	0.572	0.735	0.911
Ef_En_g	109.047	269.407	0.596	0.577	0.911
Ef_En_h	108.719	270.479	0.507	0.722	0.912

Source: own study.

The First Research Question: The Magnitude of Effects and Impacts of the CSR Components

The first research question aimed to examine the magnitude of the individual effects and impacts of CSR's social, economic, and environmental components. We used 32 variables for this review (8 variables for three components of CSR + 8 types of impacts). We used standard descriptive statistics tools to evaluate the magnitude of the observed effects, in particular position measures (such as the mean), variability measures (such as standard deviation), and asymmetry measures (such as distribution skewness). Tables 2 to 5 show the test results.

Table 2 contains descriptive statistics for the eight observed effects concerning the social component of CSR. We identified the highest effect of this CSR component in strengthening the company's reputation (Ef_So_b = 4.381) and the corporate culture (Ef_So_a = 4.100). Therefore, we can assume that this result was due to socially responsible activities, which manifested in the social aspect by respect for ethical principles concerning employees and other stakeholders. On the other hand, we identified the lowest effects of the social component of CSR in cost reduction (Ef_So_e = 3.121) and in risk management (Ef_So_d = 3.227). This may be due to the lower degree of coherence of the social component of CSR with these two areas. The size of the standard deviation was relatively consistent, as confirmed by the positive values of kurtosis. In three cases (cost reduction = Ef_So_e; revenue increase

= Ef_So_f; investor attractiveness = Ef_So_h) the standard deviation was higher, indicating a wider variance of responses and thus less consistent respondents' views on the magnitude of these three effects with respect to the CSR's social component. The distributions were skewed to the left for almost all variables, which means that respondents tended to choose higher values from the scale of 1 to 5 used. This reliability of the data should give confidence in the conclusions drawn. In the same way, we analysed a group of variables that monitored the effects of the economic component of CSR. Table 3 provides descriptive statistics capturing position, variability, and asymmetry measures.

Table 2. The magnitude of effects of the social component of CSR

Statistics	Ef_So_a	Ef_So_b	Ef_So_c	Ef_So_d	Ef_So_e	Ef_So_f	Ef_So_g	Ef_So_h
Mean	4.100	4.381	3.502	3.227	3.121	3.365	3.804	3.455
95% CIFM-LB	3.987	4.273	3.361	3.108	2.970	3.206	3.677	3.296
95% CIFM-LB	4.213	4.488	3.643	3.346	3.273	3.523	3.931	3.613
5% Trimmed mean	4.173	4.470	3.526	3.220	3.135	3.405	3.861	3.505
Median	4.000	4.000	4.000	3.000	3.000	3.000	4.000	4.000
Standard deviation	0.789	0.745	0.981	0.829	1.057	1.105	0.886	1.103
Skewness	-1.034	-1.684	-0.263	0.005	-0.110	-0.405	-0.762	-0.569
Kurtosis	1.622	4.531	-0.429	0.321	-0.615	-0.444	0.858	-0.179

Source: own study.

Table 3. The magnitude of effects of the economic component of CSR

Statistics	Ef_Ec_a	Ef_Ec_b	Ef_Ec_c	Ef_Ec_d	Ef_Ec_e	Ef_Ec_f	Ef_Ec_g	Ef_Ec_h
Mean	3.814	4.195	3.703	3.328	3.534	3.698	3.492	3.687
95% CIFM-LB	3.674	4.072	3.559	3.200	3.387	3.546	3.353	3.537
95% CIFM-LB	3.955	4.318	3.847	3.456	3.681	3.850	3.630	3.838
5% Trimmed mean	3.879	4.284	3.761	3.350	3.567	3.767	3.526	3.764
Median	4.000	4.000	4.000	3.000	4.000	4.000	4.000	4.000
Standard deviation	0.979	0.856	1.003	0.892	1.023	1.061	0.965	1.048
Skewness	-0.854	-1.211	-0.621	-0.196	-0.349	-0.666	-0.407	-0.718
Kurtosis	0.471	1.694	0.081	0.463	-0.473	-0.015	-0.055	0.310

Source: own study.

As we can see from this Table, the highest effect of the economic component of CSR was again identified to strengthen the company's reputation (Ef_Ec_b = 4.195). According to these results, the economic aspect of CSR also affects the company's reputation, which we can explain by the relatively strong link between the amount of money spent on marketing and CSR activities and the brand value. We identified the lowest effects in the areas of risk management (Ef_Ec_d = 3.328), better human resources management (Ef_Ec_g = 3.492), and cost reduction (Ef_Ec_e = 3.534). Even in this case, we confirmed the relative isolation of the two areas mentioned above, *i.e.,* cost reduction and management risks. The standard deviation was relatively stable for all variables (ranging from 0.856 to 1.061). Thus, we can state that the range of respondents' answers was relatively uniform and did not deviate from the usual results of this survey (it did not contain a disproportionate number of strongly positive or strongly negative answers). Even in this case, we observed a negative skew of the distribution, which indicates that in the economic component of CSR, respondents tended to choose higher values for the eight observed effects more often. We chose an identical analytical approach for the third component of CSR, namely environmental. From a sample of 190 respondents, we performed descriptive statistics procedures, which, in this case, also resulted in the measures of position, variability, and asymmetry found in Table 4.

According to our survey results, the environmental component of CSR was again most pronounced in strengthening the company's reputation (Ef_Ec_b = 4.127). It is interesting to see that all three components of the triple-bottom-line concept, according to the respondents, contribute the most to building the company's reputation. Therefore, our results suggest that, in general, socially responsible activities have the greatest direct effect on the growth of a company's reputation. This reinforcement of previously published results, which identified these links on a qualitative or quantitative basis (Golden,

2017), should instil confidence in the validity of our findings. On the other hand, we can identify the three least intense effects (but on a scale of 1 to 5, they are still above average values) caused by the CSR's environmental component. Specifically, these are better human resources management (Ef_En_g = 3.105), risk management (Ef_En_d = 3.127), and revenue increase (Ef_En_f = 3.169). Unless the subject of the organisation's activities is an area that is directly related to the environment (*e.g.*, waste treatment), then the links between the organisation's environmental activities and the direct impacts resulting from it are relatively weak (Madzík, 2015). In this case, the stability of the results did not show any non-standard values, as the standard deviation was approximately the same for all variables. As in the previous two cases, respondents tended to rate the effects of the environmental component of CSR slightly above average, declaring that the average values were higher than 3.000 for all variables and the negative skew observed for all variables. To better illustrate the effects of CSR components, Figure 1 shows their size is shown by the radar graph.

Table 4. The magnitude of effects of the environmental component of CSR

Statistics	Ef_En_a	Ef_En_b	Ef_En_c	Ef_En_d	Ef_En_e	Ef_En_f	Ef_En_g	Ef_En_h
Mean	3.634	4.127	3.634	3.127	3.285	3.169	3.105	3.433
95% CIFM-LB	3.472	3.979	3.474	2.985	3.133	3.013	2.952	3.265
95% CIFM-LB	3.797	4.274	3.795	3.268	3.437	3.325	3.258	3.602
5% Trimmed mean	3.705	4.243	3.705	3.141	3.317	3.188	3.117	3.482
Median	4.000	4.000	4.000	3.000	3.000	3.000	3.000	4.000
Standard deviation	1.134	1.028	1.119	0.986	1.058	1.088	1.066	1.172
Skewness	-0.726	-1.502	-0.687	-0.359	-0.349	-0.192	-0.107	-0.660
Kurtosis	-0.225	2.018	-0.078	0.134	-0.608	-0.585	-0.419	-0.320

Source: own study.

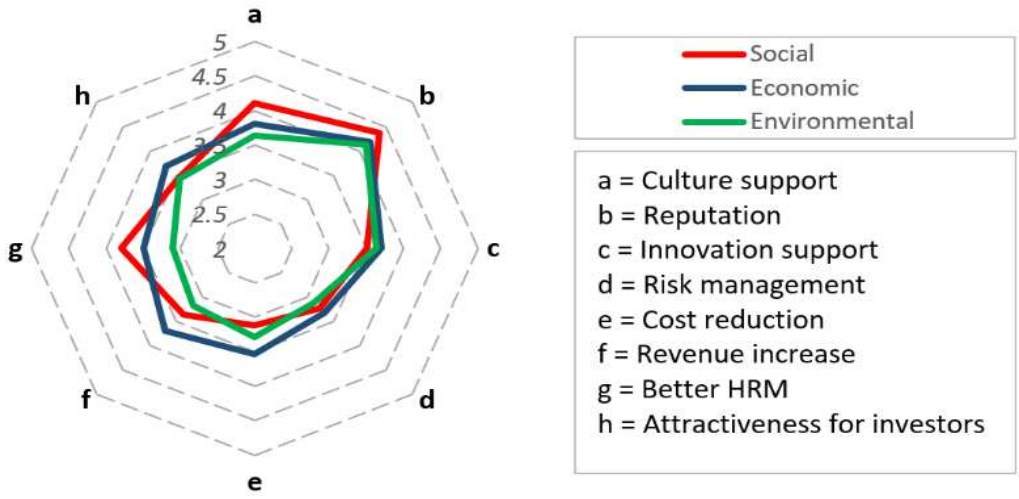


Figure 1. Average values of effects in the social, economic and environmental components of CSR
Source: own elaboration.

The fourth area analyzed was the regional and social impact of CSR activities. In the group of questions, organisations were to assess how much the focus on CSR affects the eight areas monitored. Even in this case, they had a choice from a scale from 1 (which represented minimum impact) to 5 (which represented the maximum impact). Table 5 shows the results.

When examining the impact of CSR on the region and society, we used the same approach as in the three previous analyses. An interesting finding is that the impact assessment recorded a lower level from 3.005 to 3.661 compared to the effects of the social (from 3.121 to 4.381), economic (from 3.328 to 4.195), and environmental (from 3.105 to 4.127) components of CSR. This can be partly explained by the fact that the direct effects on the organisation are easier to identify and more verifiable than the relatively difficult-to-identify and measure indirect impacts of CSR on the region and society.

We recorded the highest indirect impact on the region and society in the area of employment support (Imp_a = 3.661) and the lowest in the areas of elimination of social inclusion (Imp_e = 2.957) and motivation of other subjects to philanthropy and volunteering (Imp_g = 3.005). Employment promotion is one of the most demonstrable impacts of any organisation, and, on the other hand, impacts such as eliminating social inclusion and motivating others to philanthropy and volunteering are relatively abstract and difficult to measure, so perceptions of these impacts may be less intense.

Table 5. The magnitude of the impact of CSR activities on the region and society

Statistics	Imp_a	Imp_b	Imp_c	Imp_d	Imp_e	Imp_f	Imp_g	Imp_h
Mean	3.661	3.428	3.423	3.238	2.957	3.238	3.005	3.269
95% CIFM-LB	3.495	3.283	3.262	3.088	2.827	3.112	2.844	3.111
95% CIFM-LB	3.827	3.573	3.584	3.387	3.087	3.363	3.165	3.428
5% Trimmed mean	3.720	3.467	3.470	3.264	2.967	3.252	3.005	3.299
Median	4.000	4.000	4.000	3.000	3.000	3.000	3.000	3.000
Standard deviation	1.158	1.011	1.120	1.042	0.904	0.876	1.118	1.104
Skewness	-0.492	-0.505	-0.367	-0.263	-0.353	-0.389	-0.287	-0.432
Kurtosis	-0.740	-0.239	-0.567	-0.008	0.504	-0.069	-0.614	-0.453

Source: own study.

The Second Research Question: Concurrency Resp. the Opposition Between Individual Effects and Impacts of CSR

The second research question analysed the relationships between the effects (for the organisation) and the impacts (for the region and society) of CSR activities. We based this analysis on correlation analysis, where Pearson's linear correlation coefficient served to measure the intensity of relationships. This analysis aimed to verify whether it is possible to identify concurrency (positive correlation) or opposition (negative correlation) between pairs of variables. Thus, all 32 monitored variables were included in the analysis, based on which we constructed a correlation matrix using the standard procedure of bivariant correlation analysis. For interpretation purposes, we modified this matrix to form a correlation heatmap to make the intensity of the relationships more visible. Figure 2 shows the results.

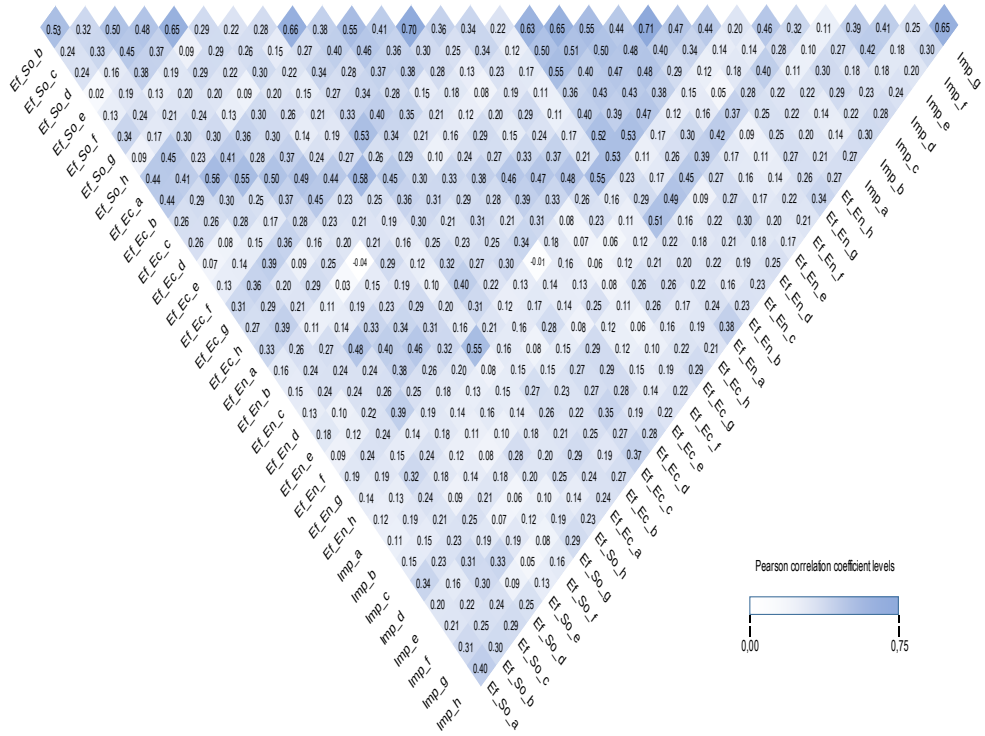


Figure 2. Heatmap of the correlation table

Source: own elaboration.

Correlation analysis identified several statistically significant links. An interesting finding is that all significant bonds were positive. Therefore, the analysis revealed a parallel between CSR's effects and impacts. This means that no pair of effects and/or impacts showed a synergic effect, and the results were synergistic. From a statistical point of view, we identified only the concurrence of several relationships, while statistically significant opposition was not identified. Table 6 shows the most intense of these relationships. It also contains the intensity of the relationships expressed by Pearson's correlation coefficient (r) and the significance level (p-value).

Table 6. Identified links between effects or CSR impacts

#	Pair of variables	Relationship	r	p-value
1	Cost reduction as a result of environmental CSR activities and revenue increase as a result of environmental CSR activities	Ef_En_e Ef_En_f	0.706	7.73E-30
2	Cost reduction as a result of economic CSR activities and revenue increase as a result of economic CSR activities	Ef_Ec_e Ef_Ec_f	0.697	7.41E-29
3	Strengthening corporate culture as a result of economic CSR activities and strengthening the reputation of the business as a result of economic CSR activities	Ef_Ec_a Ef_Ec_b	0.659	7.14E-25
4	Motivation of other subjects for philanthropy and volunteering and motivation of other subjects for CSR	Imp_g Imp_h	0.654	1.57E-24
5	Costs reduction as a result of social CSR activities and revenue increase as a result of social CSR activities	Ef_So_e Ef_So_f	0.647	6.53E-24
6	Strengthening the reputation of the business as a result of the environmental CSR activities and innovation support as a result of environmental CSR activities	Ef_En_b Ef_En_c	0.645	1.22E-23
7	Strengthening corporate culture as a result of environmental CSR activities and strengthening the reputation of the business as a result of environmental CSR activities	Ef_En_a Ef_En_b	0.628	3.91E-22
8	Increasing attractiveness for investors as a result of economic CSR activities and increasing attractiveness for investors as a result of social CSR activities	Ef_Ec_h Ef_So_h	0.583	1.27E-18
9	Innovation support as a result of economic CSR activities and innovation support as a result of social CSR activities	Ef_Ec_c Ef_So_c	0.557	8.95E-17
10	Innovation support as a result of economic CSR activities and risk management as a result of economic CSR activities	Ef_Ec_c Ef_Ec_d	0.549	3.02E-16

Source: own study.

The correlation analysis examined three CSR components (social, economic, and environmental) and their impacts on the region and society. From the results in this table, we may see several similar features between the ten identified links. The most common synergistic effect manifested within the CSR component, *i.e.*, between different effects but as a result of the same CSR component. An example is the relationship between reducing costs and increasing revenue. The relationship between these effects was intense and even identified in all three components. The ratio between revenues and costs determines the economic efficiency of each organisation. Therefore, it is logical that our survey also revealed this link.

We identified another strong relationship between the pairs, promoting corporate culture and strengthening the company's reputation. The intensity of this relationship has proven to be significant in the economic and environmental components. This insight not only deepens our understanding but also provides practical implications for corporate strategy. The cross-relationships between the effects of the three components of CSR were generally not as intense as the internal relationships between these components. Nevertheless, the analysis identified a relationship between increasing the attractiveness for investors regarding the economic component of CSR and the same variable regarding the social component of CSR. We also identified the relationship between the support of innovation as a result of the economic component of CSR and the support of innovation as a result of the social com-

ponent of CSR. These results suggest the link between the economic and social components is relatively strong. This linkage can manifest in both direct ways (*e.g.*, economic and non-economic benefits) and indirect ways (*e.g.*, investment in education).

The Third Research Question: Latent Links Between Effects and Impacts of CSR

The correlation structure in the previous analysis identified several statistically significant links. However, from an interpretive point of view, their in-depth analysis can be extensive and confusing. For this reason, we paid attention to the third research question, which focused on verifying latent links between variables. We used factor analysis to examine them, aiming to identify hidden patterns in the correlation structure and express them by certain (independent) factors. We processed all 32 variables in the factor analysis, using PCA and Varimax factor rotation as the extraction method. We used Keizer's rule to select the number of hidden factors, which determines the number of factors based on the eigenvalue size (should be greater than 1). The initial results demonstrated the suitability of the data for factor analysis; the Keizer-Mayer-Olkin Measure of Sampling Adequacy value was 0.809. The extracted values in the commonality table were all above 0.500 (the minimum recommended value is 0.200), and thus, the data structure was sufficient for all variables to perform factor analysis. Table 7 provides an overview of the factor analysis results. We shortened it to include only relevant factors.

Table 7. Results of factor analysis and the degree of variability explained

Factor	Extraction sums of squared loadings			Rotation sums of squared loadings		
	Total*	% of Var**	Cum %***	Total*	% of Var**	Cum %***
F1	9.079	28.371	28.371	4.326	13.518	13.518
F2	2.599	8.120	36.492	2.805	8.767	22.284
F3	2.350	7.343	43.835	2.794	8.731	31.015
F4	1.815	5.673	49.508	2.707	8.459	39.474
F5	1.676	5.236	54.744	2.280	7.125	46.599
F6	1.388	4.337	59.081	2.143	6.695	53.294
F7	1.228	3.837	62.918	1.849	5.780	59.074
F8	1.159	3.622	66.540	1.740	5.437	64.510
F9	1.023	3.195	69.735	1.672	5.225	69.735

Note. Significant codes: * Total – eigenvalue of the extracted factor; ** % of Var – percentage of explained variability; ** Cum % – cumulative percentage of explained variability
Source: own study.

The statistical procedure identified nine factors by analyzing the correlation structure, which explained 69.74% of the variability. With a higher number of factors, the values of the eigenvalue were already below the level of 1 000, so we decided on nine factors, according to Kaiser's rule. Table 10 contains a rotated factor matrix on which it is possible to see the correlation structure of individual variables concerning identified factors. The obtained solution resulted from eight rotary iterations using Varimax and Kaiser normalization. We did not display correlation coefficients less than 0.200 in the matrix for review reasons.

Factor analysis identified a total of nine factors in the correlation structure. Their qualitative statement, found in the previous table, should be followed by their naming. We usually based the naming of factors on analysing the intensity of the correlations between a given factor and variables. We showed the most intense bonds in bold in the previous table. However, to maintain interpretive accuracy, it is necessary to remember that the factors are 'formed' by each variable only in different intensities. We named the nine factors identified as follows:

Factor 1: Focus on the environment. This factor showcases the positive effects of the environmental component of CSR, instilling hope and inspiration. It also highlights the impact of 'environmental protection' on the region and society, further strengthening the relevance of this factor.

Factor 2: Internal and external value of the organisation. This factor, which includes strengthening the corporate culture and reputation, is a source of pride and commitment. We identified these effects in both the economic and social components of CSR, reinforcing their significance.

Table 8. Rotated factor matrix

Var.	Factor								
	F1	**F2**	**F3**	**F4**	**F5**	**F6**	**F7**	**F8**	**F9**
Ef_En_b	**0.827**	0.234							
Ef_En_c	**0.743**			0.207					
Ef_En_a	**0.707**	0.294							
Ef_En_d	**0.696**		0.348		0.307				
Imp_c	**0.638**							0.394	
Ef_En_f	**0.604**		0.212	0.450					0.319
Ef_En_e	**0.595**			0.456					0.224
Ef_En_g	**0.525**		0.244		0.232		0.201		0.338
Ef_Ec_b		**0.770**		0.322					
Ef_Ec_a	0.277	**0.712**		0.232					
Ef_So_b		**0.701**	0.280				0.212		
Ef_So_a		**0.636**					0.338		0.276
Ef_So_e			**0.758**	0.342					
Ef_So_d		0.227	**0.737**		0.324				
Ef_So_f			**0.659**	0.342					0.383
Ef_So_c		0.225	**0.577**		0.229			0.349	
Ef_Ec_e			0.215	**0.806**					
Ef_Ec_f				**0.799**					0.219
Ef_Ec_c		0.263	0.342	**0.468**	0.384		0.235		
Imp_e					**0.704**			0.327	
Imp_d					**0.660**				0.288
Imp_f					**0.654**				
Ef_Ec_d		0.321	0.334	0.388	**0.471**				
Ef_So_h						**0.818**			
Ef_Ec_h		0.245		0.203		**0.796**			
Ef_En_h	0.562					**0.694**			
Imp_g							**0.847**		
Imp_h							**0.810**		
Imp_a								**0.817**	
Imp_b								**0.726**	
Ef_So_g		0.204							**0.739**
Ef_Ec_g		0.391	0.305						**0.570**

Source: own study.

Factor 3: Targeted employee management. The effects of social activities of CSR mainly form the third factor. Similar values were identified in innovation support, risk management, cost reduction and revenue increase in the correlation structure.

Factor 4: Economic and strategic performance of the organisation. This factor consists mainly of three effects associated with economically oriented CSR activities. Specifically, it is about promoting innovation, reducing costs and increasing revenue.

Factor 5: Elimination of risks and unethical practices. This factor consists of four variables: elimination of corruption and other unethical practices in business, elimination of social inclusion, increased transparency, and risk management resulting from CSR economic activities.

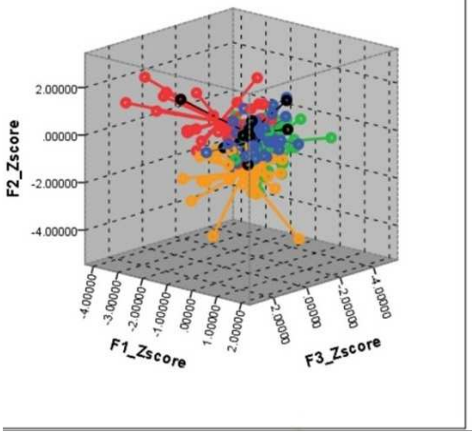
Factor 6: Increasing attractiveness for investors. This factor is mainly one effect, according to which the factor is also named – increasing the attractiveness for investors. In the sixth factor, this effect is reflected in all three components of CSR – social, economic and environmental.

Factor 7: Be a role model for others. The seventh factor consists of two main impacts: motivating other subjects to engage in philanthropy and volunteering and motivating others to engage in CSR.

Factor 8: Benefits for the region. This factor, which includes employment promotion and regional development, fosters optimism and support. It underscores the strong links between these impacts of CSR activities.

Factor 9: Effective human resources management. The last identified factor recorded a strong correlation against the variable better human resource management in CSR's social and economic component.

These nine factors explained the latent links between the 32 variables examined. Factors may generalize the results of this survey, complement theoretical aspects of CSR, or contribute to broader analytical options related to CSR. For illustration only, cluster analysis can be cited, which makes it possible to create internally homogeneous groups of cases (in our case, respondents/organisations), these groups being relatively heterogeneous. We may explain the intensity of individual factors using a Z-score, thus achieving relatively suitable assumptions for any classification or descriptive procedure. Figure 4 shows an example of using the nine factors identified above to categorize organisations according to their characteristics. We used the K-means cluster procedure, with only the first three factors displayed (since nine-dimensional space cannot be displayed).



Cluster Number of Case	Cluster 1 Mean (N=54)	Cluster 2 Mean (N=40)	Cluster 3 Mean (N=15)	Cluster 4 Mean (N=34)	Cluster 5 Mean (N=46)
F1_Zscore	0,461	0,174	0,436	-1,117	-0,010
F2_Zscore	0,398	-0,094	0,695	0,663	-1,103
F3_Zscore	0,114	-0,808	0,654	0,085	0,293
F4_Zscore	0,169	0,625	0,157	-0,562	-0,378
F5_Zscore	0,025	-0,446	0,144	0,227	0,143
F6_Zscore	0,189	0,249	-1,882	0,449	-0,157
F7_Zscore	0,503	-0,331	-0,666	-0,461	0,256
F8_Zscore	-0,058	0,311	-0,850	-0,227	0,242
F9_Zscore	-0,715	0,657	0,312	0,176	0,036

Figure 3. Use of nine identified factors for analytical purposes (example of cluster analysis)
Source: own elaboration.

Figure 3 shows a graphical representation of the identified groups. There were five of these groups. Although they overlap in the figure, we should note that only three dimensions were shown, with dimension nine (*i.e.*, the nine factors identified above) being used to classify the cases. The characteristics of these five clusters are in the form of average values of the factor Z-score. If the values were close to zero, then the given factor in the given group was at the average intensity. Higher values represent above-average and lower-average factor intensity in a given group. For example, the third cluster consists of 15 organisations (N = 15) with a weak focus on increasing attractiveness for investors (Factor 6). We may also interpret the remaining four clusters similarly.

Our findings confirmed that CSR significantly impacts business entities, especially in the areas of reputation, customer loyalty and long-term financial stability (Vățămanescu *et al*., 2021). Le and Quang (2021) reached similar conclusions. They identified CSR as a key factor influencing the performance of small and medium-sized enterprises (SMEs), with brand trust and customer loyalty playing a mediating role in ensuring the competitiveness of companies in times of crisis or pandemic. Furthermore, CSR also plays an important role in employee management, with its positive impacts particularly evident during crisis events such as the pandemic. Research by Mao *et al*. (2020) showed that CSR activities that focused on supporting employees led to an increase in employees' psychological capital (*i.e.*, self-confidence, optimism, resilience), which positively impacted loyalty and work performance. Similarly, the relationship between CSR and financial performance remains a subject of academic debate. While some studies (Bae *et al*., 2021) have not found clear evidence of a positive impact of CSR on stock value during the pandemic, other work (Khanchel & Lassoued, 2023) has shown that companies with active CSR initiatives have experienced lower stock price declines and greater stability in financial markets. This discrepancy suggests that the effect of CSR may depend on the sector and geographical context, as well as on specific

forms of CSR engagement. The results are also consistent with the work of Garel and Petit-Romec (2020), which showed that companies with higher CSR engagement achieve better results in long-term sustainability and stakeholder relations. This effect was even more pronounced during the pandemic, as CSR initiatives in employee support and ethical business practices helped companies minimize reputational and operational risks. Another important finding of this study demonstrates a positive correlation between CSR and the transparency of corporate financial practices. Research by El-Feel *et al*. (2022) suggests that companies with higher levels of CSR were less likely to manipulate financial statements, thereby demonstrating higher levels of ethical integrity and managerial transparency. This phenomenon indicates that CSR can also function as a risk management mechanism that helps minimize information asymmetries between management and stakeholders. Companies should perceive CSR as a strategic tool for enhancing competitiveness and long-term sustainability (Al Frijat *et al*., 2023). Our study showed a similar trend, with CSR initiatives aimed at ensuring a stable work environment and employee wellbeing being perceived as one of the most significant benefits of CSR during the pandemic.

CONCLUSIONS

The presented research aimed to expand knowledge about the effects and impacts of social responsibility for the organisations which implement socially responsible activities and for the region and society in which they operate. We based the research on the processing of data from a nationwide survey. We processed a total of 190 valid questionnaires, which enabled the use of descriptive and inference statistics procedures. The analytical outputs were about three research questions the authors set themselves to answer.

The first research question focused on examining the magnitude of the effects and impacts of CSR's social, economic, and environmental components. Using descriptive statistics, we found that the greatest socially responsible activities are reflected in the strengthening of the good name of society – regardless of whether it is a social, economic, or environmental aspect of CSR. The second research question focused on verifying the existence of concurrency or the opposite of phenomena. Bivariate correlation analysis revealed that the effects and impacts of CSR showed a synergistic effect. Thus, we identified the concurrence of the observed phenomena (effects). We found statistically significant links between the same CSR and cross-sectional aspects. We did not find any statistically significant opposition to the phenomena. The third research question aimed to verify the identification of latent links between variables leading to a better understanding of social responsibility. Factor analysis was used for this. Through it, we identified nine latent factors: (1) focus on the environment, (2) internal and external value of the organisation, (3) targeted management of employees, (4) economic and strategic performance of the organisation, (5) elimination of risks and unethical practices, (6) increasing the attractiveness for investors, (7) being a role model for others, (8) benefiting the region, and (9) effectively managing human resources. These nine factors make it possible to explain in a more comprehensive way certain latent patterns in the perception of effects and impacts by organisations. The presented article aimed to expand knowledge about the effects and impacts of social responsibility. Regarding the COVID-19 pandemic, He and Harris (2020) wrote that, like other global events with planet-wide impact, COVID-19 could potentially change how we see the world, think, and conduct our lives. Notwithstanding the human tragedy of lost lives, broken families, and scarred communities, the economic and social changes caused by a pandemic-driven lockdown will constitute a cultural legacy which will live long in our memories and those of future generations. They also wrote that the COVID-19 pandemic represents one of the most significant environmental changes in modern marketing history, which could have a profound impact on corporate social responsibility.

Based on the information above and the article's content, we want to provide direction for further research. It is mainly about investigating the impact of the COVID-19 pandemic, especially after the post-COVID-19 period, in the most critical areas that evoke CSR and the business environment, for example, corporate culture, human resources, and the financial and economic situation of companies.

Although this study's results provide valuable insights, it is important to point out some limitations of the research. One of the main limitations is the results' generalizability, as the research was conducted in only one country (Slovakia), which may affect their possibility of application in a wider international context. Regional specificities of the business environment and differences in legislative or economic conditions may affect the perception and implementation of CSR in other countries. Another limitation is that the research does not consider differences between individual types of businesses – the analyzed organisations came from different industries without specific distinctions by size, sector or CSR strategy. Although this approach allowed for a more general view of CSR during the pandemic, it could be useful in future research to focus on specific industries (*e.g.*, manufacturing vs. services) or the differences between small and large enterprises. Given these limitations, we recommend expanding future research to the international level and focusing on specific sectors and business categories, which could bring even deeper insights into the role of CSR in different business contexts.

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Understanding the importance of home-country skills of African immigrant entrepreneurs in South Africa

Bernard Lama Ngota, Elroy Eugene Smith, Ayanda Pamella Deliwe

ABSTRACT

Objective: The article aims to understand and describe the impact of home-country skills on African immigrant entrepreneurial endeavours in a host country. Furthermore, the article investigates how home-country entrepreneurial skills affect immigrant entrepreneurial motivations, activities, and outcomes.

Research Design & Methods: Following an interpretivist research paradigm, we applied a qualitative research approach. We identified 12 African immigrant entrepreneurs through purposive sampling and semi-structured interviews with the participants. We then analysed the collected data using a content analysis.

Findings: We observed that African immigrant entrepreneurs who migrate with skills obtained through owning or being involved in a business, and apprenticeship in their home country, are much more prepared for entrepreneurship in their host country. Furthermore, the findings suggested that African immigrant entrepreneurs associated with a family business gain entrepreneurial skills and are more ready to start up a business venture in their host country.

Implications & Recommendations: The study identified a gap in the literature regarding the entrepreneurial skills and knowledge of African immigrant home-country residents in the host country context. The obtained results are useful for immigrant entrepreneurial practice, particularly for immigrants considering going international.

Contribution & Value Added: It is the first study in a developing country that investigates the significance of African immigrant home-country skills in motivating entrepreneurship in the host country.

Article type:	research article
Keywords:	African immigrant entrepreneurship; entrepreneurial skills; home country; entrepreneurship; African business; South Africa
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INTRODUCTION

Research on immigration and immigrant entrepreneurship has gained significant attention in recent decades (Duan *et al.*, 2023; Guzi *et al.*, 2023). The literature attributes this growing interest to the potential development impacts of both migration and immigrant entrepreneurship, which scholars consider important topics for many countries (Duan *et al.*, 2023). The increasing number of research articles on immigrant entrepreneurship highlights its role in regional and global economic development (Duan *et al.*, 2023). Despite the growing body of research, there is a lack of understanding about the impact of home-country context on African immigrant entrepreneurship in host countries (You & Zhou, 2018; Duan *et al.*, 2021).

Studies have shown a sharp rise in research on immigrant entrepreneurship since 2000 (Dabić *et al.*, 2020). Research has also emphasised the impact of immigrant entrepreneurship on host country economies (Ngota *et al.*, 2019a; Asoba & Mefi, 2020; Dabić *et al.*, 2020; Omorede & Axelsson, 2022). In the USA, skilled immigrants have contributed to the economy through high entrepreneurship and

in-novation (Fairlie, 2013). Similarly, in New Zealand and South Africa, immigrant entrepreneurs have made significant economic contributions despite challenges (Omisakin, 2017; Ngota *et al.*, 2018).

Scholars have found immigrant entrepreneurs to be highly entrepreneurial, contributing to economic growth and innovation (Fairlie, 2013). Studies in Turkey and Korea have also shown that immigrant entrepreneurs create significant opportunities in the economy despite facing challenges (DeLancey, 2014). Moreover, the literature sees immigration as a key economic driver that boosts the entry of newer, more creative, and entrepreneurial immigrants (Brenner *et al.*, 2006). Overall, immigrant entrepreneurship plays a vital role in economic development, and we should not underestimate its impact.

Research has consistently shown that immigrant entrepreneurs are twice as likely to start a business as their native counterparts (Vandor & Franke, 2016; Duan *et al.*, 2021). This is particularly significant in countries like South Africa, where unemployment rates are alarmingly high (32.6% as of 2023) (StatsSA, 2023). Immigrants, especially Africans, bring valuable skills and expertise from their home countries and use them to start businesses in their host countries (Ngota *et al.*, 2019b). However, they often face significant obstacles, including discrimination and skill mismatches, making entrepreneurship a vital alternative career path.

Studies have highlighted the importance of immigrant entrepreneurs in driving innovation and economic growth. In the U.S., skilled immigrants have contributed to a higher rate of high-tech start-ups compared to the UK (Brenner *et al.*, 2006). Moreover, a Canadian study found that immigrant entrepreneurs exported ten times more goods to their home countries than all Canadian exporters combined, due to their familiarity with and access to these markets (Head & Ries, 1998). Overall, immigrant entrepreneurship plays a crucial role in economic development, job creation, and innovation, making it essential to support and encourage immigrant entrepreneurs in their endeavours.

Notwithstanding their significant entrepreneurial contributions, the impact of the home-country context on African immigrant entrepreneurship in host countries remains understudied. Most research has focused on Asian immigrant entrepreneurs in the US (Duan *et al*., 2021), neglecting the experiences of African immigrants. Furthermore, studies have primarily examined how host country environments and co-ethnic communities affect immigrant entrepreneurship, overlooking the influence of home country contexts (Aliaga-Isla & Rialp, 2013; Nkongolo-Bakenda & Chrysostome, 2020; Duan *et al.,* 2021). Duan *et al*. (2021) argue that African immigrant entrepreneurship in host countries like South Africa is shaped by sociocultural, political, and economic factors in their home countries. However, few studies have holistically examined the home-country effects on African immigrant entrepreneurship (Brzozowski *et al.,* 2017; Bagwell, 2018; Duan *et al.,* 2021). These authors suggest that there is a lack of research on how home-country socioeconomic, cultural, and political environments impact African immigrants' entrepreneurial endeavours in host countries. Addressing this knowledge gap is crucial to understanding the complexities of African immigrant entrepreneurship.

If the analysis accurately represents the reality, it is essential to investigate ways to encourage African immigrant entrepreneurship, business development, and growth (Brenner *et al.*, 2006). One approach is to explore how African immigrant entrepreneurs' home country skills prepare them for entrepreneurship in the host country. Understanding the contributions of home country skills is crucial to recognizing the role of immigrants in entrepreneurship. This study aims to bridge the gap between African immigrant entrepreneurship and the impact of their home country skills. It raises important questions about the role of home country skills in entrepreneurial motivation and how we can harness them to support migrant entrepreneurship. By examining the complex relationship between home country skills and entrepreneurial motivation, this study sheds light on the experiences of African immigrant entrepreneurs and the factors driving their success, ultimately informing strategies to support their entrepreneurial endeavours.

This article is structured as follows. Firstly, we will discuss the research questions and literature review, entrepreneurial skills transfer, home country context, and entrepreneurial ecosystem perspective. Then, we will present the research methods and design, including the study's design, population, sampling, data collection, analysis, and ethical considerations. Finally, we will discuss the empirical findings concerning the research questions, followed by conclusions and recommendations based on the findings.

Research Questions

The study aimed to investigate whether entrepreneurial home-country skills play a role in assisting African immigrants to venture into entrepreneurship in a host country such as South Africa. To make this happen, we determined the following research questions:

- What is the role of entrepreneurial home-country skills in assisting African immigrant entrepreneurs in starting up a business?
- What is the impact of the home country context on the entrepreneurial efforts of African immigrants?
- What is the role of the entrepreneurial ecosystem towards entrepreneurship?

LITERATURE REVIEW

Entrepreneurial Skills Transfer From Home to the Host Country

African immigrant entrepreneurs transfer valuable skills from their home countries to their host countries, enabling them to start and manage businesses successfully (Ngota *et al.*, 2019b; Asoba & Mefi, 2021). Research by Ngota *et al.* (2019b) highlights the significance of entrepreneurial skills acquired in the home country, which one can apply in host countries. There is support for this phenomenon in studies showing that firm-appropriate training and skills are often acquired through co-ethnic firms (Waldinger *et al.*, 1990; Boadu *et al.*, 2023; Minja *et al.*, 2023).

In West and Central Africa, people transmit entrepreneurship skills through apprenticeships lasting three to five years, equipping young individuals with hands-on experience and skills. Next comes a settlement through the apprentice in a similar business (Ngota, 2017; Ezenwakwelu *et al.*, 2019). This training enables them to become successful entrepreneurs, contributing to economic growth in their host countries. African migrants in South Africa, for instance, bring unique entrepreneurial skills, starting and managing commercial ventures that help address the country's skills shortage (Czaika, 2018; Hyndman-Rizk & de Klerk, 2019; Boadu *et al.*, 2023; Minja *et al.*, 2023).

By leveraging their skills and experience, immigrant entrepreneurs contribute to their host countries. Their ability to disseminate entrepreneurial skills acquired in their home countries enables them to establish successful businesses, creating jobs and stimulating economic growth. This highlights the importance of recognizing and supporting immigrant entrepreneurship, which can positively impact the host country's economy.

The Impact of the Home Country Context on Entrepreneurial Efforts

Dabić *et al.* (2020) emphasise the home country's significant impact on entrepreneurial ventures, differing from traditional theories focused on host countries. Researchers (Wang & Liu, 2015; Brzozowski *et al*., 2017) agree that personal attributes, host country environment, co-ethnic community, and home country context influence immigrant entrepreneurship. Social networks and family ties from the home country positively impact immigrant entrepreneurship (Brzozowski *et al.,* 2017; Duan *et al.*, 2021). The home country's entrepreneurial ecosystem benefits immigrant entrepreneurs, enabling them to capitalise on opportunities in both countries. African immigrant entrepreneurs rely on resources from their home country to pursue opportunities, launch businesses, and improve performance. These resources enable them to establish businesses in host countries, contributing to economic development (You & Zhou, 2018; Ngota *et al.*, 2019a; Duan *et al.*, 2021). The home country context significantly influences African immigrant entrepreneurship, providing valuable resources and skills to succeed in host countries. This highlights the importance of considering the home country context in understanding immigrant entrepreneurship and its economic impact.

Entrepreneurial Ecosystem Perspective Towards Entrepreneurship

The entrepreneurial ecosystem framework highlights the significance of the business environment in supporting entrepreneurial ventures. Scholars argue that this environment promotes entrepreneurship by providing opportunities and resources, leading to high-growth businesses (Nicotra *et al.*, 2018;

Duan *et al.*, 2021). The entrepreneurial ecosystem offers a systematic framework for conducting entrepreneurship research across disciplines and regions (Duan *et al.,* 2021). It refers to a system of socio-economic, political, and infrastructural elements that promote innovative businesses and increase productivity (Isenberg, 2011; Stam, 2015).

African immigrant entrepreneurs engage in international business activities, leveraging their ties to their home country (Bagwell, 2018; Duan *et al.,* 2021). They are more likely to start businesses out of perceived opportunity rather than necessity (Duan *et al.,* 2021). These entrepreneurs obtain necessary information through ethnic group members and social media, finding opportunities in ethnic and mainstream markets (Duan *et al.*, 2020; Duan *et al.*, 2021).

The resource-based view and opportunity structure theory suggest that disparities in entrepreneurial activities and business performance between African immigrant entrepreneurs and their native-born peers are due to differences in resources and opportunities. Despite the entrepreneurial ecosystem's recognition as an economic development strategy, current studies have been primarily typological and theoretical, with little exploration of its influence on entrepreneurial activities (Spigel & Harrison, 2017). African immigrant entrepreneurship studies under the entrepreneurial ecosystem framework remain largely neglected, despite gaining global recognition among researchers (Von Bloh *et al.*, 2019).

This article examines how the home-country context equips and influences African immigrants to become entrepreneurs in host countries like South Africa. By exploring the entrepreneurial ecosystem's impact on African immigrant entrepreneurship, this study aims to fill the existing research gap and provide valuable insights for policymakers and practitioners.

RESEARCH METHODOLOGY

Regarding the literature on the transferability of skills from one's home country to the host country among African immigrant entrepreneurs, there is a lack of consensus on the most accurate and trustworthy way to measure this phenomenon and the motivations behind the involvement in entrepreneurship. Selecting the appropriate measurement technique is the primary concern in analysing the factors that influence African immigrant entrepreneurship in a host country's economy. In general, we may distinguish qualitative, quantitative, and mixed-method approaches. The most prevalent qualitative methods include interviews, focus groups, and observation. On the other hand, the main quantitative research methods include surveys, online polls, and questionnaires, while there could be mixed methods which will combine an element of qualitative and quantitative approaches (Creswell & Plano, 2018).

To explore the home country skills of African immigrant entrepreneurs in South Africa, we used the results from the semi-structured interviews conducted among African immigrant entrepreneurs (owners/managers) in 2023. The adequate sample comprised 12 interviews, derived from a non-probability sampling, namely convenience and purposive sampling. To accomplish the research objectives, we used an interpretative research paradigm (phenomenological research) together with a qualitative research methodology. According to Hammersley (2013), the interpretivism paradigm is based on the idea that humans cannot understand knowledge in the social sciences in the same way as they can in the physical sciences because humans interpret their surroundings and take action based on that understanding while the rest of the world does not. A qualitative research methodology was the most applicable and successful strategy for answering the study's research question by collecting data from African immigrant entrepreneurs operating in South Africa. Based on prior studies and the nature of the study, it was obvious that the main question under investigation required a qualitative response. Therefore, to obtain rich data, we chose cases of African immigrant entrepreneurs and administered personal interviews.

Moreover, we adopted the qualitative technique to get an in-depth understanding of participants' experiences and viewpoints, as well as to examine the research questions in a nuanced and contextualised manner. The representativeness of this study was ensured by using convenience and purposive sampling since there is no readily available database of all African immigrant entrepreneurs in South Africa (Palinkas *et al.*, 2015). The sample selection was guided by the recommendations of Green and Thorogood (2004) who for example, noted that most qualitative researchers who perform an interview-based study with a particular research question find, that after interviewing 20 or so people from

one analytically specific participants 'category,' the research generates little new information (Daher, 2023; Rahman, 2023). Within the African immigrant group, the researcher approached potential participants, associations, and networks, explained the study, and screened them for eligibility (must be an owner/manager of African descent other than South African, been in business for at least a year, and at least 18 years old). The researcher selected 12 participants who met the predefined criteria for inclusion. The participants included African immigrant business owners/managers. Given the possible interview limitations, the researcher used an interview protocol to guide the questions regarding the home country skills context. In particular, we formulated the skills from home country question as follows: Do entrepreneurial skills acquired in their home countries significantly influence the possibility of African immigrants venturing into entrepreneurship in South Africa?

The researcher collected both primary and secondary data. Secondary data came from books, internet, and journal articles. The researcher used a semi-structured interview schedule to collect primary data from African immigrant entrepreneurs. We designed the instrument to collected data from African immigrant entrepreneurs on whether skills acquired in their home countries influence their entrepreneurial endeavours in the host country. The themes and questions developed underwent critical validation by key entrepreneurship experts and supported by the literature. We conducted a pilot study on three immigrant entrepreneurs regarding the semi-structured personal interview schedule and protocol. The researcher administered semi-structured personal interviews to the participants from June 2023 to September 2023 at the participants' business locations. The interviews were in person, face-to-face, allowing for rich and nuanced data collection. The researcher conducting the research maintained a neutral and empathetic stance, ensuring that respondents felt comfortable sharing their experiences and opinions. The researcher's positioning was that of a curious and non-judgmental inquirer, seeking to understand the respondents' perspectives and experiences.

Participants Profile

The demographic characteristics of the African immigrant entrepreneurs who participated in the study were business owners/managers. They were of African descent other than South Africans, had been in business for at least a year, and were at least 18 years old. The majority of the participants in the study were men (11; 1 woman). The study found that more African men than women migrate, likely due to cultural factors where men are typically the breadwinners and women are expected to prioritize household duties (Ngota & Rajkaran, 2016). We may see this gender imbalance also in entrepreneurship, where African men are more likely to take high-risk ventures than women. The study's findings on age distribution revealed that most men immigrant entrepreneurs were between 50-60 years old, while women entrepreneurs were between 30-40 years old. This aligns with previous research indicating that young people are more open to migration than older individuals (Ngota & Rajkaran, 2016). The majority of African immigrant entrepreneurs were between 20-50 years old, with few above 60 years old. This is supported by authors (Azmat & Zutshi, 2012; Ngota & Rajkaran, 2016; Dana & Ratten, 2017) who argue that younger individuals in African populations are more likely to take risks, such as migrating for better opportunities, while older individuals prioritize family and cultural responsibilities. The majority of the African immigrant entrepreneurs were from Cameroon (05), followed by those from Nigeria (04), about two participants came from Ghana, and only a few came from the Democratic Republic of Congo (DRC). The researcher targeted specific countries and sectors based on their relevance to the research topic and the need to capture diverse perspectives. Furthermore, the majority of the participants were engaged in services, and services and trading businesses (05 respectively), and only one African immigrant entrepreneur was into service and agricultural businesses. Many of the African immigrant entrepreneurs (05) seem to have been operating their businesses for about 10 to 20 years, followed by the group (03) that have been operating their businesses between 5 to 9 years, and four have been operating their businesses for less than 5 years. The majority of the entrepreneurs (08) employ between 1 and 4 people, while four (04) employ between 5 and 10 employees.

Data Analysis and Trustworthiness

The researcher reduced and coded the data gathered from the semi-structured in-depth interviews. The researcher created a coding framework that took into consideration a list of themes, preliminary codes, and categories (Braun & Clarke, 2006; Khoa *et al.*, 2023). The researcher coded the data manually to be able to engage with the rich data collected. The researcher then analysed the data using the qualitative content analysis method, which allows for the investigation of the 'occurrence, meanings, and associations of specific themes, words, or concepts' (Braun & Clarke, 2006; Khoa *et al.*, 2023). Moreover, the researcher employed content analysis to identify and interpret patterns and themes in the data.

To ensure trustworthiness and evaluate the data credibility, we used four criteria, *i.e.,* confirmability, credibility, transferability, and dependability (Johnson & Rasulova, 2016). To ensure confirmability, audit trails were provided that highlighted all the procedures that were employed in the process of data analysis, to offer the basis for the results (Johnson & Rasulova, 2016). The researcher employed techniques that included persistent observations, prolonged engagement, data collection triangulation, and member checks to ensure data credibility (Johnson & Rasulova, 2016). The collected and transcribed qualitative data were transferable by subjecting the issue under study to undergo adequate thick description; this was to permit the readers to properly understand the topic (Tobin & Begley, 2004). The researcher ensured dependability by making sure that the qualitative data that was collected went through an inquiry audit (Shenton, 2004). Therefore, to assure consistency in the findings and the possibility of repeating the study, the researcher sought the services of another, experienced researcher to assist with the review and examination of the study's procedures and the data analysis approach.

Ethical Considerations

The study acknowledged all ethical considerations proposed by Sekaran and Bougie (2016) while engaging with participants. Informed consent was obtained from respondents by disclosing the survey procedures and how the data would be used later, emphasising the importance of participation. Wherever possible, we used fictitious names and codes to anonymise the transcribed data collected.

RESULTS AND DISCUSSION

This section highlights and analyses the research findings based on the responses of the 12 participants. We believe that the immigrant entrepreneurial process begins in the entrepreneur's home country, where the African immigrant entrepreneur's home country context can shape their entrepreneurial motivations and facilitate their venture into entrepreneurship in the host country. When we examined the context, three themes emerged:

- Entrepreneurial background.
- Entrepreneurial skills acquired from home country.
- Home country skills as entrepreneurial motivation.

We will discuss the emerging codes identified during data analysis in greater detail in the subsequent section.

Entrepreneurial Background

The next section reveals participants' entrepreneurial backgrounds, including business ownership experience and family business involvement. This data sheds light on the characteristics and influences that shape their attitudes and behaviours. Notably, most participants had previously owned businesses in their home countries before relocating to South Africa. P#1 comments: 'When I graduated from the university, I spent a few years running a business of my own before I left for South Africa.' I had a business where I was selling second-hand clothes. After that one closed, I moved on to another business where I was selling Nigerian films.' This sentiment was shared by other entrepreneurs, such as P#7, who explains: 'I used to have a business back in my home country.' Similarly, P#3 comments:

'I had a clothing retail business back home.' P#4 elaborates: 'I was involved in agriculture, with a poultry farm of 1200 chickens and a pig farm with over 18 pigs.' Retail businesses were a prominent business that some participants indicated they owned in their home country, P#9 stated: 'I ran a mixed provisions retail business, selling basics like toiletries.' Similarly, P#11 affirmed: 'I had a provision shop, what is known here as a spaza shop, back in my home country.' In line with being involved in retail businesses, it was also discovered that some participants were engaged in other service businesses. P#10 notes that: 'I had a similar business like this one back in my home country. I had a motor mechanic workshop.' Participants' desire to own businesses in their home countries motivates them to pursue entrepreneurship in their host country, South Africa. This supports findings by Brzozowski *et al*. (2017), Bagwell (2018), and Duan *et al.* (2021) that immigrant entrepreneurship is influenced by individual qualities and home country factors.

Some entrepreneurs also reported a sense of skill acquisition stemming from their involvement in a family business. P#1 describes: 'In my lifetime, I have grown up in a family business.' P#1 further explains: 'Growing up in a business environment instilled a passion for entrepreneurship in me. I helped my uncle at his store and my mother at village markets, learning the ins and outs of business. These experiences made the business a part of my being.' P#9 also remarks: 'I grew up in a family of business owners. Helping my parents at their liquor store during holidays inspired me to consider starting my own business one day.' This can be likened to a study by Evans *et al.* (2019) who attested that trust in a family is a motivator for familial learning processes, making family a significant role player in the entrepreneurial learning framework. Moreover, some researchers (Rwigema & Venter, 2004; Nieman & Nieuwenhuizen, 2009) indicated, that individuals who grow up in a family environment where the family members are businesspeople, are more likely to start up their own businesses or can become part of the family business.

Although the study suggests that many African immigrant entrepreneurs have a background in business ownership or family enterprise in their home countries, not all participants shared this experience. Some African immigrant entrepreneurs contradicted this finding, stating that they had no prior involvement in business ownership or family businesses in their countries of origin. P#2 explains: 'I have never been involved in any business operations back in my home country because I was a student. This is my first ever business I am involved in here in South Africa.' P#8 also noted: 'I was not involved in any business back at home. This is my first business that I am getting involved within this country.'

Entrepreneurial Skills Acquired from Home Country

The analysis of the data collected from African immigrant entrepreneurs showed evidence of entrepreneurial skills acquisition from their home countries before their relocating to South Africa. Entrepreneurship knowledge can be acquired formally or informally. One may acquire formal knowledge in entrepreneurship through formal education such as from business schools, entrepreneurship programmes, and courses (Adams *et al*., 2013; Ezenwakwelu *et al*., 2019). On the other hand, people may acquire informally knowledge in entrepreneurship through informal learning including mentorship, apprenticeships, and hands-on experience (Adams *et al.*, 2013; Ezenwakwelu *et al*., 2019). Moreover, one could acquire entrepreneurial knowledge informally through apprenticeship in the home country. P#3 explains: 'I learned this work and the training to operate this form of business back from my home country in the form of traineeship.' In the same light, P#2 comments: 'I acquired business knowledge through an apprenticeship after my studies.' P#5 remarks: 'The skills I learned as an apprentice in my home country have made me confident and knowledgeable in this field.'

Parents promote their children's informal acquisition of entrepreneurial knowledge since it is evident that they recognise its value as the cornerstone of sustainable economic growth and development. P#2 comments: 'My parents sent me to learn entrepreneurial skills with a successful business owner.' To guarantee sufficient knowledge transfer, gaining entrepreneurial skills informally through an apprenticeship requires rigorous mentoring and quick learning. P#12 explains: 'My boss taught me business skills throughout my apprenticeship.' Apprenticeship can transmit entrepreneurial skills in various areas, such as motor mechanics, as described by P#11: 'I did my apprenticeship as a motor mechanic in my home country.' P#3 added: 'I learned electrical work through a train-

eeship back in my home country.' Moreover, P#6 remarks: 'I did my apprenticeship in a big electronic workshop as an electrician for phones, laptops, and any electronic device in my home country.' Other artisan skills, like hairdressing, can be learned through apprenticeships, as noted by P#8: 'I received training at a salon.' Acquiring entrepreneurship knowledge this way can take time, with P#3 commenting: 'My traineeship lasted from 1999 to 2004, which was five years.' Similarly, P#4 remarks that 'as for these skills that I possess, I was trained for it for a complete five-year duration.' P#11 states: 'I received training for about five years as an apprentice in another mechanical workshop.' P#3 added: 'I was trained in this business for about five years.'

Apprenticeship transmits entrepreneurial skills, but training also contributes to business skill acquisition (Hernandez *et al*., 2023). African immigrant entrepreneurs highlighted that training played a significant role in contributing to their entrepreneurial skills from their home country to the host country. P#8 explains: 'I received training for my current business, perfecting my hair styling skills learned in my home country with further training in South Africa.' She added: 'Another entrepreneur taught me what I know.' According to P#2, other entrepreneur businesses serve as avenues for acquiring entrepreneurial skills, with entrepreneurs acting as mentors. He describes: 'Someone taught me how to do this business back at home, I was trained and mentored to operate this line of business by someone who took me in as an employee, and it took me about two years before I could own my own business.' Traditionally, entrepreneurship is taught in schools to equip students with knowledge. Education in their home country may have formally prepared some African immigrant entrepreneurs, providing the necessary knowledge and skills to venture into entrepreneurship in the host country (Ngota *et al*., 2019b). According to P#6, 'I studied economics in the high school. So, what I studied in school and the business that I was operating back in my home country, the coaching I received from friends who were already in the business environment back at home prepared me for business ventures. This experience enabled me to venture into business in South Africa.' These findings affirm Nieuwenhuizen's (2003) study showing that individuals who have been noted for entrepreneurial success, owes it to the direct connection to education, signifying that entrepreneurship skills and abilities can be learned. As such, the study suggests that valuable entrepreneurial abilities can improve when African immigrants attend tertiary education (Nieuwenhuizen, 2003; Olutuase *et al*., 2023).

Home Country Skills as Entrepreneurial Motivation

Migrant and diaspora entrepreneurs leverage skills from their home countries to drive innovation, job creation, and economic growth in their host countries, despite facing numerous challenges. Their home country skills and knowledge motivate entrepreneurial ventures, fostering resilience and success in new environments (Duan *et al*., 2023; Ngota *et al*., 2017; Ngota *et al*., 2019b). P#3 remarks: 'I ventured into business in this country because I needed to survive and be my own boss.' P#3 attributed his entrepreneurial motivations in the host country to his home country's acquired entrepreneurial skills and said, 'My entrepreneurial knowledge and skills that I had acquired back from my home gave me all the needed motivation to venture into entrepreneurship.' Kushnirovich and Heilbrunn (2008) and Ngota *et al*. (2017) indicate that immigrants can be pushed into self-employment due to the inherent bias and discrimination in the host country labour market. P#5 remarks: 'The fact that I was unemployed in South Africa motivated my desire to apply my previous business knowledge to venture into a business to survive.' There is also a real sense of entrepreneurial motivation from friends towards starting up a business in the host country, as described by P#9: 'I saw my brother doing well in his business, which motivated me to start my own.' The home country business knowledge and experience are also entrepreneurial-driven. P#5 explains: 'My business experience, unemployment, and friend's motivation drove me to venture into entrepreneurship.' P#7 adds: 'Unemployment in South Africa led me to start a small business to survive.' The importance of home country business knowledge and skills is highlighted by P#3: 'I wanted to do what I learnt back home – have a business to control my finances. Unemployment made me realize I have skills to survive.' According to P#5, unemployment drives individuals to pursue entrepreneurship: 'Unemployment drove me to follow my dream and start a small business.' She adds: 'Unemployment, survival needs, and home country business experience drove my desire to start up a business.'

Moreover, starting a new business in the host country seems to be an alternative route to escape the harsh discrimination found in the labour market of the host country as described by P#8: 'The job market was discriminatory, so I decided to start my own business to make a living.' Venturing into entrepreneurship gives entrepreneurs some degree of financial independence. P#8 explains: 'Being my boss, independent, making income, and previous business skills pushed me to establish my own business due to unemployment.'

Although the entrepreneurial skills acquired in their home country were a major factor in motivating African immigrant entrepreneurs to start their businesses in their new nation, language barriers may have made it difficult for them to find work. As P#11 comments: 'Language played a bigger role for me as a foreigner from a French country, so I had to start a business to survive.' Furthermore, P#2 remarks that 'Language was a barrier that prevented me from finding a job, so I looked at starting my own business as an alternative.' Van Tubergen (2005) argues that, in nations with high unemployment rates among natives, immigrants are pushed out of the labour market into self-employment with a high probability of venturing into entrepreneurship.

The entrepreneurial spirit of African immigrants has become a powerful catalyst for economic growth and job creation in their host countries. Their innovative ventures realize personal dreams, generate employment opportunities, and provide self-employment, showcasing their entrepreneurial flair in action. By doing so, they contribute significantly to the economic development of their host nations, leaving a lasting impact. For example, P#12, a Nigerian entrepreneur in South Africa, employs 10 people, noting, 'Nine workers are South Africans and one is a foreign national in the alignment department.' These immigrant entrepreneurs do not show discrimination in employment preference, as described by P#9: 'I employ five people, including three South Africans, and two foreign nationals.' African immigrant entrepreneurs offer employment and entrepreneurial skills training. P#11 explains: 'I have five employees, including two South Africans and three foreign nationals, who work as apprentices learning skills and knowledge.' P#4 adds: 'I have one employee in retail and 8-10 in the chicken business, with a minimum of five employees at all times, working for a wage due to fluctuating workload.'

Discussion

The findings of this study align with previous research (You & Zhou, 2018; Duan *et al*., 2021) indicating that the home country context plays an important role in shaping the African immigrant entrepreneurial process. A significant majority of participants had prior business ownership experience in their home countries, which equipped them with valuable entrepreneurial skills. Notably, involvement in home country businesses can catalyse developing entrepreneurial capabilities. These findings align with You and Zhou's (2018) argument that African immigrants' pre-migratory entrepreneurial background and ability to leverage global networks in their home country can significantly influence their entrepreneurial success.

Moreover, prior involvement in a family business likely shaped their entrepreneurial skills and experiences. Brannon *et al*. (2013) and Adjei *et al*. (2019) identified two ways entrepreneurship can be related through family links: biological and spousal relationships. This study supports Adjei *et al*.'s (2019) notion that family relationships provide resources like networking opportunities, educational support, and economic assistance that can either constrain or facilitate entrepreneurial activities. The intersection of family and business systems impacts entrepreneurial processes and success (Nordqvist & Melin, 2010). Family businesses play a crucial role in shaping entrepreneurial skills, and providing resources, and competencies that influence business outcomes. Family relationships can either support or hinder entrepreneurial endeavours, highlighting the importance of considering the role of family in entrepreneurial development. This study sheds light on the complex factors that contribute to entrepreneurial success.

Further analysis of the data revealed that entrepreneurial skills in the home country context can be transmitted through two primary channels: training and apprenticeship. The training method aligns with findings from previous studies (Erasmus *et al.*, 2010; Ngota, 2017), which describe training as a systematic approach aimed at enhancing employees' knowledge, skills, and behaviour to achieve business objectives. Regarding apprenticeship, the study found that some African immigrant entrepreneurs gained knowledge and skills by working under their employers as apprentices. This finding is

consistent with existing literature (Adams *et al.*, 2013; Ngota, 2017; Ezenwakwelu *et al.*, 2019), which highlights apprenticeship as a traditional and informal training method prevalent in West African countries. This approach involves young individuals being mentored by experienced entrepreneurs, who impart their skills, knowledge, and expertise to empower the next generation of entrepreneurs. Ngota (2017) observed a stark difference between West and Southern African countries in terms of entrepreneurial training. While Southern Africa has a strong tradition of formal education for entrepreneurship, West and Central Africa relies on a strong tradition of informal apprenticeships, where young entrepreneurs learn through practical experience and guidance from experienced business owners, rather than formal education (Adams *et al.*, 2013; Ngota, 2017; Ezenwakwelu *et al.*, 2019). Therefore, training is designed to enhance employee performance within the organisation, especially when their work standards are low due to skill gaps, knowledge deficiencies, or unfavourable attitudes among certain groups or individuals (Ngota, 2017; Ezenwakwelu *et al.*, 2019).

The study revealed that when African immigrant entrepreneurs combine their home-based skills, leverage available resources, and capitalize on environmental opportunities while navigating the host country's entrepreneurial ecosystem, they can successfully establish a new business venture. We may find support for it in the works of scholars (Nkealah, 2011; Adomako *et al.*, 2023; Ratten, 2023), who found that immigrants exhibit a higher propensity for entrepreneurial aspirations and activities compared to their South African counterparts, also, they observed a relatively lower entrepreneurial inclination among South Africans. Moreover, the study revealed that African immigrant entrepreneurs in the host country are motivated to start their businesses for a range of reasons, including overcoming discriminatory unemployment practices, ensuring survival and economic stability, addressing language barriers, pursuing self-employment and autonomy, fostering a passion for entrepreneurship, and capitalizing on potential business opportunities. These findings are corroborated by previous research (Guler, 2005; Nieman & Nieuwenhuizen, 2009; Khosa & Kalitanyi, 2015; Ngota *et al.*, 2018), which also showed that African immigrants in host countries like South Africa are driven to entrepreneurship due to factors such as high unemployment rates, currently at 32.6% (StatsSA, 2023), discrimination in the job market. These studies reinforce the notion that African immigrants are compelled to explore entrepreneurial opportunities as a means of overcoming employment barriers and securing economic stability as well as providing employment opportunities for others. According to Ngota (2017), the development and expansion of small businesses, including those founded by African immigrant entrepreneurs, are believed to play a crucial role in reducing poverty by generating employment opportunities. Fairlie (2013), who found that immigrant entrepreneurs have been instrumental in creating new jobs and wealth, supports this notion.

Research Limitations and Future Research Directions

This study explored a previously underexamined aspect of 'grey activities' in the immigrant entrepreneurial sphere, a topic that has received limited attention in existing research. However, the researcher acknowledges that the findings are subject to a degree of uncertainty, due to the subjective nature of the data and limitations in data quantity, which may impact the generalisability and accuracy of the results. A key limitation of using purposive sampling in this research is that the findings may lack generalisability, as the sample was intentionally selected based on specific characteristics, which may not accurately reflect the experiences and circumstances of all immigrant entrepreneurs. Despite the limitations, the researcher believes that this study's findings will contribute significantly to understanding the primary motivations of African immigrant entrepreneurs, thereby laying the groundwork for further research on the nature, extent, and economic impact of African immigrant entrepreneurship. Future studies can build upon this foundation by employing a larger, more diverse sample, including other immigrant groups, to provide a more comprehensive and nuanced analysis of immigrant entrepreneurship.

CONCLUSIONS

This article concluded by highlighting the key insights gained into African immigrant entrepreneurship, particularly in relation to the home country context. It aimed to empirically assess the importance of home country entrepreneurial skills on African immigrant entrepreneurs in South Africa. The evidence supports the identification of various factors that can be harnessed to support and enhance African immigrant entrepreneurship, enabling businesses to reach their full potential. The research revealed that African immigrants' entrepreneurial drive and ambition are not solely a product of the host country environment, but are also influenced by their home country background, which contributes to the development of their entrepreneurial skills, knowledge, and experience. Moreover, the research found that entrepreneurial skills were being effectively transmitted to African immigrant entrepreneurs through a combination of training programs and a robust apprenticeship culture, a practice that is notably absent in many parts of the Southern African region. Moreover, we found that African immigrant entrepreneurs in South Africa are driven to start their businesses because of a diverse range of motivations, including unemployment and lack of job opportunities, language barriers that hinder employment prospects, a desire for financial independence and self-sufficiency, the need for survival and economic stability and the presence of untapped business opportunities. These complex motivations underscore the resilience and resourcefulness of African immigrant entrepreneurs in South Africa.

Thus, we recommend that apprenticeship programs, which are currently underutilised in South Africa, require formalisation and a mandate to provide entrepreneurship training to young South Africans aspiring to start their businesses. This initiative would empower them to improve their economic prospects amidst the country's escalating unemployment rates. Furthermore, the study suggests that policymakers should prioritise raising awareness about the social inclusion of African immigrant entrepreneurs and their business activities within the host country's communities. This increased awareness can foster a more inclusive environment, promoting integration and acceptance of African immigrant entrepreneurs, and ultimately supporting their entrepreneurial success.

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The contribution of co-authors is equal and can be expressed as 40% for the primary author, and 30% each for the other authors: B.L. Ngota prepared the introduction, literature review, and the material and methods section, carried out the analysis, drew conclusions including the references for the study, based on his Ph.D. thesis, while Prof. E.E. Smith and Dr Deliwe proofread, edit, and supervised the paper for publication.

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Use of Artificial Intelligence

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Conflict of Interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Personality alchemy: The influence of personality traits on the circular entrepreneurial intentions of higher education students

Sofia Gomes, Micaela Pinho, João M. Lopes

ABSTRACT

Objective: The study explores the influence of Portuguese higher education students' personality traits on their intentions to become circular entrepreneurs using their perceived circular behavioural control as a mediator. We considered internal locus control, proactive personality, perceived creativity and propensity to take risks as personality traits.

Research Design & Methods: We used an online questionnaire to collect data from 510 Portuguese university students. We performed the quantitative analysis through the partial least square method.

Findings: We found that the propensity to assume risk, creativity, internal locus of control, and proactivity were (by these order) personality traits with a positive influence on either respondents' circular behavioural control and, using this, their circular entrepreneurs' intention.

Implications & Recommendations: The results of this study allowed us to infer implications for higher education students, universities, and policymakers. Students demonstrated intentions to promote circular entrepreneurial activities, and these intentions can be worked on and learned at universities by encouraging creativity, innovation, and proactivity and inciting greater levels of confidence in students. These skills allow you to accelerate the implementation of circularity in new businesses. To achieve this, greater coordination with the business community is essential by proposing challenges and problems that universities can help resolve. Political decision-makers must formulate circular entrepreneurship policies and include them in the national development plan, encouraging the formulation of new sustainable businesses.

Contribution & Value Added: This study highlights the relationship between personality traits and the intention to become a circular entrepreneur, providing novel evidence in this field. Moreover, it introduces perceived circular behavioural control as a mediator between personality traits and entrepreneurial intentions, an innovative approach in empirical research models. These insights can contribute to the development of policies and strategies aimed at fostering circular entrepreneurship, helping to create environments more conducive to sustainable innovation and economic development based on resource reuse and regeneration.

Article type:	research article
Keywords:	circular entrepreneurship; circular entrepreneurial intention; personality traits; perceived circular behavioural control; higher education students
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INTRODUCTION

Circular entrepreneurship is a more particular and emerging form of sustainable entrepreneurship that aims to protect people and their environment (Geissdoerfer *et al.*, 2020). Although related, a circular entrepreneurial process is different from a sustainable one, as the entrepreneurs' environmental knowledge is crucial to successfully manage the complex circular processes of multi-stake-

holder management (Poblete *et al.*, 2021). Moreover, while sustainable entrepreneurs apply a common 'what' (*i.e.*, socially or environmentally beneficial innovations), circular entrepreneurs, besides the 'what,' also introduce the 'how' (*i.e.*, circular principles) in their business models (Henry *et al.*, 2022). Circular entrepreneurship is the process of evaluating and exploring opportunities within the field of circular economy (Wang *et al.*, 2013; Zucchella & Urban, 2019). Circular entrepreneurship is becoming a new, promising reality, in the manner of needed radical paradigmatic change (Urban, 2019). Since the concept of circular entrepreneurship is relatively recent, research remains scattered (Heshmati, 2017; Suchek *et al.*, 2022), especially with regard to the determinants or motivation of circular-oriented entrepreneurs' intentions. A few very recent studies have begun to explore these intentions (Al-Awlaqi & Aamer, 2022; Dantas *et al.*, 2022; Henry *et al.*, 2022). Dantas *et al.* (2022) examined the antecedents and consequences of circular entrepreneurship in emerging markets. As for the antecedents, the authors conclude that circular entrepreneurs can be either intrinsically or extrinsically motivated. Henry *et al.* (2022) explored the motivations and identities of circular founders. According to the authors, circular founders have an innovative mindset and ambitions of growing scale. Besides, the authors also found that social altruism and noneconomic motives drive their circular entrepreneurs' intentions. Al-Awlaqi and Aamer (2022) explored the individual entrepreneurial factors affecting the adoption of circular business models in small and medium-sized enterprises in the Republic of Yemen. The authors found that innovativeness and risk-taking propensity influenced entrepreneurs' intentions to adopt circular business models. However, the intentions of young students, seen as potential future circular entrepreneurs, still need to be investigated. There is evidence among university students of these intentions in the context of sustainable-oriented entrepreneurs (Fatoki, 2020; Qazi *et al.*, 2021). It seems widely accepted that sustainable and, therefore, circular entrepreneurs are people with high environmental values and are strongly motivated to protect the ecosystem. However, other personality traits may influence the intentions to be circular-oriented entrepreneurs, such as proactivity and risk propensity (Fatoki, 2020; Qazi *et al.*, 2021), need for achievement and self-efficacy (Qazi *et al.*, 2021), and perceived behavioural and locus of control (Fatoki, 2020). Thus, there is a need for more in-depth knowledge about the influence of personality traits in promoting sustainable entrepreneurial activities. This personality alchemy refers to the process of inner transformation, where the individual consciously works to refine and develop their characteristics, seeking a balance between different personality traits to achieve an ideal state of functioning and personal success, which is essential for the success of entrepreneurial activities.

In this context, we sought to extend these analyses to the context of circular entrepreneurship among young Portuguese university students, based on the theory of planned behaviour (TPB) and the entrepreneurial traits theory. Therefore, we intended to explore the influence of Portuguese college students' personality traits on their intention to become circular entrepreneurs moderated by perceived circular behavioural control. The trend towards community engagement and collaborative initiatives also supports circular entrepreneurship by encouraging resource efficiency and waste reduction. In economic terms, the Portuguese government is strengthening the viability of these models through policies such as the Circular Economy Action Plan, which is aligned with European guidelines to encourage the business transition to practices that minimise waste and maximise the use of resources (APA, 2021). The Circular Economy Action Plan has driven Portuguese companies to adopt circular approaches, contributing to the country's economic growth and resilience, since entrepreneurship increases investment, creates jobs and promotes competitiveness. In the educational field, educational institutions have been incorporating the circular economy into their curricula, while training programmes and workshops complement this training, equipping students with the necessary skills to foster a transition to a sustainable economy, as well as promoting a wider social shift towards circular practices (Alves *et al.*, 2024; Deda *et al.*, 2022).

The study presented in this article seeks to extend these analyses to the context of circular entrepreneurship among young Portuguese university students, based on the TPB and the entrepreneurial traits theory. Therefore, we intended to explore the influence of Portuguese college students' personality traits on their intention to become circular entrepreneurs moderated by perceived circular behavioural control.

After the introduction, the article is composed of four more sections. The next section contains the literature review and development of hypotheses, followed by a section with the research methodology with the description of the samples, variables and data analysis. Then comes the section on the results and discussion of the results with the presentation of the theoretical and practical implications as well as the limitations and future lines of research. Finally, the last section contains the conclusion.

LITERATURE REVIEW AND HYPOTHESES DEVELOPMENT

Theoretical Framework

Circular entrepreneurship is a more specific and emerging form of sustainable or green entrepreneurship that aims to protect people and the environment simultaneously (Geissdoerfer *et al.*, 2020). It can be represented by young business initiatives oriented towards circularity to create value (solutions to emerging problems at the environmental level, creation of new products, processes, and pro-circular practices) and explore existing opportunities at the level of circularity. It can also be prosecuted by companies that have already implemented the transition from linear to circular business models (Zucchella & Urban, 2019).

The TPB offers a robust framework for understanding circular entrepreneurship by emphasizing the significance of attitude toward entrepreneurship as a predictor of entrepreneurial intention (Ajzen, 1991). In this context, perceived circular behaviour control plays a crucial role in shaping these intentions, highlighting the need for aspiring entrepreneurs to have a strong belief in their ability to implement circular practices effectively. Moreover, the TPB framework includes subjective norms and perceived behavioural control, both of which are critical in predicting business start-up intentions and subsequent behaviours, as evidenced by empirical studies (Kautonen *et al.*, 2013; Lopes *et al.*, 2024). These elements collectively underscore the importance of fostering a positive entrepreneurial attitude, supportive social norms, and a sense of control over circular business activities for successful circular entrepreneurship.

Entrepreneurial traits theory significantly influences the adoption and success of business models (Thai & Mai, 2023), with traits such as internal locus of control, proactive personality, perceived creativity, and propensity for risk-taking being particularly relevant. An internal locus of control encourages entrepreneurs to take responsibility for their actions and outcomes, fostering persistence in the face of challenges (Al Mamun *et al.*, 2021). A proactive personality drives individuals to anticipate and act on opportunities, essential for innovating within the circular economy. Furthermore, perceived creativity enables entrepreneurs to develop unique solutions that align with circular principles, while a propensity for risk-taking allows them to navigate the uncertainties inherent in circular business ventures (Lopes *et al.*, 2024). Collectively, these traits empower entrepreneurs to implement and sustain circular business models effectively.

The interplay between behavioural intentions and entrepreneurial traits is critical in circular ventures, as these components collectively shape the pathway to successful entrepreneurship. Entrepreneurial intentions, influenced by attitudes, subjective norms, and perceived behavioural control, are further strengthened by traits such as an internal locus of control and a proactive personality (Lopes *et al.*, 2024; Lopes *et al.*, 2023). This synergistic effect enables entrepreneurs to plan and execute circular business strategies with greater efficacy. For instance, a proactive entrepreneur with high perceived creativity is more likely to overcome barriers and innovate within the circular economy, driven by strong behavioural intentions (Kumar & Shukla, 2022). Understanding this dynamic interaction provides valuable insights for nurturing successful circular entrepreneurs capable of driving sustainable economic growth.

Circular Entrepreneurial Intention and Perceived Circular Behaviour Control

Circular-oriented entrepreneurial intention is an individual's intention to start a business based on circular principles. Intention is a mental state that explains individuals' thinking and behaviours (Arru, 2020). As for circular entrepreneurship, behaviours are influenced either by micro (individual) or macro (environmental) factors that will affect individuals' propensity to engage in specific business actions. Perceived behaviour control is similar to self-efficacy. Ajzen (1991) introduced it as a construct in his theory of planned behaviour. Perceived behaviour control refers to the person's

belief that their behaviour is under their control. Moreover, we may define it as the perceived ease or difficulty of performing a particular behaviour. According to Ajzen (2002), perceived behavioural control comprises self-efficacy and perceived controllability. Self-efficacy involves internal factors such as knowledge and skills, while perceived controllability consists of the perception of achievement, which depends on the individual (Vamvaka *et al.*, 2020). In the case of entrepreneurship, perceived behaviour control reflects the ability of individuals to start and achieve success with a new business involving feelings of capability and perceived controllability (Liñán & Chen, 2009).

Previous research has demonstrated a positive relationship between perceived behaviour control and overall entrepreneurial intention (Lortie & Castogiovanni, 2015). We found the same pattern for students (Munir *et al.*, 2019; Shi *et al.*, 2020). Moreover, several studies on sustainable entrepreneurship have confirmed a positive relationship between perceived sustainable behaviour control and sustainable entrepreneurial intention (Fatoki, 2020; Thelken & de Jong, 2020; Yasir *et al.*, 2021). In this way, we formulated the following hypothesis:

H1: Higher education students' perceived circular behaviour control positively affects their circular entrepreneurial intention.

Personality Traits, Perceived Circular Behaviour Control, and Circular Entrepreneurial Intention

The literature describes personality traits as consistent reactions of individuals to external or environmental factors (Cao *et al.*, 2022). Several studies positively relate personality traits with the entrepreneurial intention (*e.g.*, Karabulut (2016) analyzed the influence of internal locus of control, need for achievement, risk tolerance, and entrepreneurial alertness as dimensions of personality traits on the entrepreneurial intention of Turkish graduate students; Murugesan and Jayavelu (2017) analyzed the influence of the Big-Five personality traits and self-efficacy on the entrepreneurial intention of students in the Bachelor of Technology; Laouiti *et al.* (2022) conducted a gender-based approach to evaluate the influence of the Big-Five on the entrepreneurial intention of students in Bachelor of Technology in France; Ahmed *et al.* (2022) analyzed the influence of big-five personality traits on entrepreneurial intention when mediated by risk aversion) of Pakistani university students).

In this regard, an entrepreneurs' success depends, among other external factors, on his personality traits, determining the decision to start a business (Cao *et al.*, 2022). Entrepreneurs with more powerful personality traits for favourable decision-making tend to be more successful than entrepreneurs who crumble in the face of obstacles inherent in starting an entrepreneurial activity (Butz *et al.*, 2018; Şahin *et al.*, 2019). Thus far, the most studied personality traits that drive entrepreneurial intention are discipline and internal locus of control, the need for achievement, risk-taking propensity, tolerance, consistency, determination, and entrepreneurial alertness (Cao *et al.*, 2022; Espíritu-Olmos & Sastre-Castillo, 2015; Farrukh *et al.*, 2018; Karabulut, 2016). Other studies use the Big Five model (openness, conscientiousness, extraversion, agreeableness, and neuroticism) to explain entrepreneurial intention (Şahin *et al.*, 2019). Less studied are the personality traits of proactivity and perceived creativity (Fatoki, 2020; Lopes *et al.*, 2023). However, many studies still show inconsistent and insignificant results on the impact of personality traits on entrepreneurial intention (Farrukh *et al.*, 2018), requiring this relationship to be more substantiated.

Internal Locus of Control

Internal locus of control is the level at which people believe that they, as opposed to external factors, have control over the outcomes of their lives. A person's locus of control is conceptualized as internal or external. The external locus of control consists of beliefs that life outcomes result from extrinsic factors that people do not control like chance or faith. By contrast, internal locus control reflects an individual's degree of control over his life (Cao *et al.*, 2022). Individuals with greater internal locus control tend to be more successful, control their internal and external environment through actions, and take more risks. The internal locus of control has been positively related to pro-environmental behaviours (Chiang *et al.*, 2019; Derdowski *et al.*, 2020; Pavalache-Ilie & Unianu, 2012; Trivedi *et al.*, 2015). In this regard, Peyton and Miller (1980) show that individuals with greater internal locus control

tend to: i) positively control the environment; ii) seek positive information to solve environmental problems; iii) effectively use this information; iv) resist social pressures and discard biased or erroneous information; v) expect to obtain long-term benefits, *e.g.*, making additional efforts in the short term to obtain better results in the future; vi) be more responsible and more able to change their self-concept. This personality trait has been commonly used to explain higher education students' intention to start a traditional entrepreneurial business (Cao *et al.*, 2022; Farrukh *et al.*, 2018; Tentama & Abdussalam, 2020) and sustainable entrepreneurial intention (Fatoki, 2020; Hirschfeld & Wagner, 2022; Muñoz *et al.*, 2020). Thus, we formulated the following hypotheses:

H3: Higher education students' internal locus of control positively affects their perceived circular behaviour control.

H3a: Higher education students' internal locus of control positively affects their circular entrepreneurial intention when mediated by perceived circular behaviour control.

Proactive Personality

We may define proactive personality as the active attempts that an individual makes to change external or environmental factors. Individuals with pro-active personalities tend to more easily identify opportunities, exempt themselves from social pressures and make impactful decisions in their environment (Parker *et al.*, 2010). Consequently, more proactive individuals tend to be more successful at work and show more perceived behaviour control, leadership, awareness and self-confidence (Abid *et al.*, 2021). Previous research has demonstrated a relationship between proactive personality and conventional entrepreneurial intention (Delle & Amadu, 2016; Hu *et al.*, 2018; Luo *et al.*, 2022). Research on the entrepreneurial intention of higher education students has also shown that students with a more proactive personality tend to perceive a greater probability of starting a new business (Cai *et al.*, 2021; Nasaj, 2021; Paul & Shrivatava, 2016). Li *et al.* (2020) and Luo *et al.* (2022) demonstrated that proactive higher education students perceived entrepreneurial behaviour and demonstrated greater control over it. Fatoki (2020) showed a direct contribution of the proactive personality to sustainable entrepreneurial intention based on a greater propensity of these individuals to detect business opportunities. Lopes *et al.* (2023) demonstrated that a proactive personality influences sustainability-oriented entrepreneurial intention when mediated by subjective norms. As for younger students, research shows that high proactiveness boosts students' ability to think outside the box, influencing their choice to become an entrepreneur (Fragoso *et al.*, 2020; Neneh, 2019). We formulated the following hypotheses:

H3: A proactive personality of higher education students positively affects their perceived circular behaviour control.

H3a: A proactive personality of higher education students positively affects their circular entrepreneurial intention when mediated by perceived circular behaviour control.

Perceived Creativity

Creativity is intrinsically linked with new ideas, creating new products, and innovation. Thus, a creative mind is fundamental to entrepreneurship because the success of entrepreneurs depends on their capacity to innovate. The literature considers creativity as an essential requirement for an individual to become an entrepreneur (Laguía *et al.*, 2019) and is part of the stereotype of the entrepreneurial individual. However, perceived creativity is often overlooked in research about the motivations underlying the start of entrepreneurial activity (Shi *et al.*, 2020). In one of the few studies that address the relationship between perceived creativity and entrepreneurial intention, Nabi *et al.* (2018) concluded that there is a positive relationship between students' creativity and the intention to become entrepreneurs. Zampetakis and Moustakis (2006) related the perceived creativity of students with future entrepreneurial intentions.

Notwithstanding, several studies have concluded that perceived creativity alone does not directly contribute to entrepreneurial purpose (Nguyen *et al.*, 2021), and the relationship between perceived creativity and entrepreneurial intention may be mediated by the sense of entrepreneurial self-efficacy (Laguía *et al.*, 2019) and by controlling perceived behaviour (Tiwari *et al.*, 2017). Thus, more creative

students are more self-confident and therefore believe that they are more capable of starting their own business, inducing pro-entrepreneurial behaviours. At the level of sustainable entrepreneurship, perceived creativity can be important to recognize an opportunity and influence the start of sustainable entrepreneurial activity when mediated by the alert behaviour perceived by the entrepreneur (Yasir *et al.*, 2020) or by the green self-identity (Jiang *et al.*, 2020). Since circular business requires significant levels of innovation, we formulated the following hypotheses:

H4: Higher education students' perceived creativity positively affects their perceived circular behaviour control.

H4a: Higher education students' perceived creativity positively affects their circular entrepreneurial intention when mediated by perceived circular behaviour control.

Risk-taking Propensity

Risk propensity refers to an individual's attitude towards risk aversion or acceptance (Hoogendoorn *et al.*, 2019). Some individuals are more risk-tolerant, others naturally avoid risks, and entrepreneurs belong to the most risk-averse group. Research on traditional entrepreneurial intention shows that individuals' propensity to tolerate risk is an important personality trait to explain the intention to start an entrepreneurial business since risks and uncertainties are inherent to business (Deng *et al.*, 2018). Direct relationships have been established between entrepreneurial intention and risk acceptance (Schlaegel *et al.*, 2021). However, this relationship is still controversial and even inconclusive since the way risk is perceived can be influenced by the socio-cultural environment of individuals (Farrukh *et al.*, 2018). Furthermore, when considering sustainable entrepreneurial intention, scholars did not find any direct effects of risk propensity (Fatoki, 2020), which can be explained by the fact that, so far, no significant differences have been identified in terms of risk propensity for entrepreneurs oriented for sustainability and mainstream entrepreneurs (Hoogendoorn *et al.*, 2019). However, according to Hoogendoorn *et al.* (2019), risk propensity is not irrelevant to sustainability since ecological entrepreneurs are more likely to tolerate risk. The study of circular entrepreneurship is still very recent and is surrounded by uncertainties motivated by opportunities and needs related to solutions for solving environmental and individual problems. By analogy with the results related to sustainable entrepreneurship, we hypothesised:

H5: Higher education students' propensity to accept risk positively affects their perceived circular behaviour control.

H5a: Higher education students' propensity to tolerate risk positively affects their circular entrepreneurial intention when mediated by perceived circular behaviour control.

Figure 1 describes the structural research model.

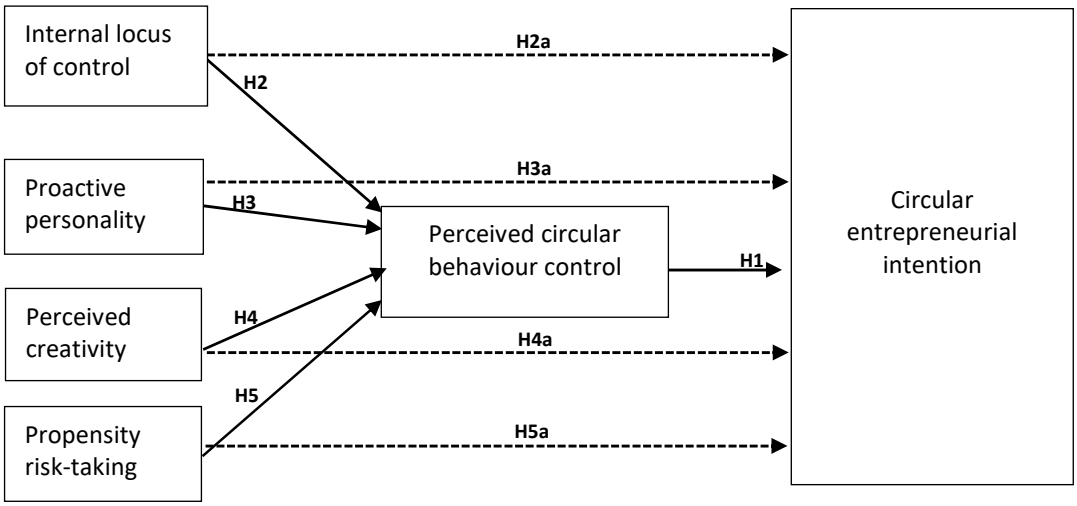

Figure 1. Research model
Source: own elaboration.

RESEARCH METHODOLOGY

Data Collection

The data for this study were collected through an online questionnaire distributed by email to Portuguese higher education students from five Universities and published on social networks (Facebook and Linkedin). Thus, it is a non-probabilistic sample. It was guaranteed that only higher education students answered the questionnaire through the following initial question: 'Are you currently attending a higher education establishment in Portugal?' If the respondents chose 'yes,' they proceeded to the remaining questions; if they answered 'no,' the questionnaire ended. In total, we obtained 510 valid responses. In 2022, according to Pordata (2022), around 433 thousand students were enrolled in Portuguese higher education. Considering an error margin of 5%, 385 responses would be needed. Although the number of participants in our sample was higher, considering that we collected the sample using a non-probabilistic technique for convenience, the sample was not representative of students who attend Portuguese education. All participants were aware of the study's purpose and their participation was voluntary and anonymous. We obtained informed knowledge from all participants. We conducted a pre-test with 10 participants to assess their understanding of the questions and the response time.

The questionnaire (link in the Appendix) consisted of six sections adapted from Fatoki (2020): Section 1 evaluated circular entrepreneurial intention with three items. Section 2 assessed the perceived circular behaviour control with three items. Section 3 assessed the internal locus of control with six statements. Section 4 considered proactive personality with six items. Section 5 assessed perceived creativity with three statements, and section 6 evaluated risk-taking propensities with seven items. Respondents answered all the statements on a 5-point Likert scale with 1 – strongly disagree, 2 – disagree, 3 – neither disagree nor agree, 4 – agree and 5 – strongly agree.

Moreover, we also collected socio-demographic indicators such as gender, age, residence, and the level of education. We also evaluated the professional situation.

Data Analysis

We performed a statistical analysis of the constructs contained in the research model and the items that measure the constructs using the SPSS (v.25) software. Then, we used the partial method least square (PLS) of smart PLS (V.3.0) to test the hypotheses formulated in the research model. The PLS method is the second generation of multivariate techniques combining statistical analysis with regressions. As we collected the data and did not have a normal distribution, confirmed by obtaining the kurtosis and skewness statistics, we fine-tuned the PLS method since it does not require data normality. Moreover, it allows for optimizing the relationships established between latent variables (or constructs) and between these and the indicators (or items) that measure them (Ringle *et al.*, 2020). In this way, we analysed the data in four steps. The first step was to analyse the statistics of the model constructs and the items. In the second step, we tested measurement validity and reliability. The third step tested the research model and hypotheses via bootstrap analysis with the estimation of multiple linear regression. Bootstrapping is a non-parametric procedure for testing the significance of path coefficients estimated in PLS-SEM. In bootstrapping, subsamples are created with observations randomly drawn from the original data set (with replacement). The subsample is then used to estimate the PLS path model. This process is repeated until a large number of random subsamples are created, which in this study were 10 000. Parameter estimates obtained from the subsamples served to derive 95% confidence intervals for significance tests (Ringle *et al.*, 2020).

RESULTS AND DISCUSSION

Statistical Description of Latent Variables and Items

The sample comprises 510 student participants, of whom 304 were women (59.6%). The average student age was 22.70 years, with a minimum age of 17 and a maximum age of 57. Regarding occupation, 79.2% were students, and 20.8% were working students. Most respondents (83.1%) were undergraduates, while

the remaining were masters or doctoral students. Regarding the geographical location of universities, 44.7% of respondents studied in the central region of Portugal, 31.7% in the Lisbon metropolitan area, and 18.5% in the northern region. Table 1 contains a description of the six latent variables of the model.

Table 1. Statistical description of the variables and items of the research model

Variables and indicators	Mean	Std deviation
Circular entrepreneurial intentions (CEI)	**3.24**	**1,160**
CEI1.	3.33	1.155
CEI2.	3.16	1.145
CEI3.	3.22	1.179
Perceived circular behaviour control (PCBC)	**2.95**	**1,083**
PCBC1.	3.08	1.164
PCBC2.	3.07	1.038
PCBC3.	2.69	1.048
Internal locus of control (ILC)	**3.94**	**0.852**
ILC1.	3.76	0.989
ILC2.	3.59	0.930
ILC3.	4.31	0.750
ILC4.	4.22	0.809
ILC5.	3.83	0.800
ILC5.	3.95	0.833
Perceived creativity (PC)	**3.77**	**0.9093**
PC1.	3.63	0.916
PC2.	3.93	0.880
PC3.	3.76	0.932
Proactive personality (PP)	**3.93**	**0.8352**
PP1.	4.07	0.898
PP2.	3.61	0.885
PP3.	3.72	0.808
PP4.	4.04	0.827
PP5.	4.18	0.766
PP6.	3.98	0.827
Risk-taking propensity (RTP)	**3.76**	**0.9016**
RTP1.	3.85	0.920
RTP2.	3.69	0.903
RTP3.	3.36	0.944
RTP4.	4.48	0.681
RTP5.	4.11	0.791
RTP6.	3.55	1.021
RTP7.	3.27	1.051

Source: own study.

The results reveal that Portuguese higher education students intend to start an entrepreneurial activity oriented towards circularity (M = 3.24). Despite the high perceived circular behaviours control (M = 2.95), higher education students found it challenging to start a circular business (M = 2.63). Concerning personality traits, internal locus of control (M = 3.94) and proactivity (M = 3.93) were those that characterized the respondents, followed by perceived creativity (M = 3.77) and risk-taking propensity (M = 3.76).

Measures of Reliability and Validity of the Model

We performed a confirmatory factor analysis (CFA) to specify the reflective nature of the research design. The latent variables are the common cause of the items that measure them, and the observed variables do not have causal effects on the corresponding constructs (Hair *et al.*, 2019). All indicators show high confirmatory factor loads (> 0.70), except items ILC3, RTP4, and RTP5 which we removed

from the analysis. Thus, six items will measure the latent variable of internal locus control, and five will measure the latent variable risk-taking propensity.

The model presents a great model fit according to the reference values of Hair *et al.* (2019): GFI = 0.964 (reference value > 0.90); CFI = 0.953 (reference value > 0.90); IFI = 0.978 (reference value > 0.90); RMSEA = 0.063 (reference value < 0.08).

We evaluated the sample reliability from three measures based on the reference values proposed by Hair *et al.* (2019): Cronbach's alpha (Cα> 0.70), composite reliability (CR > 0.70), and average variance extracted (AVE > 0.50). We also used the Fornell-Larcker criterion (Fornell & Larcker, 1981) to assess the discriminant validity of the variables. Table 2 also shows the results of these measures. The CR and AVE results were higher than the reference values and the model was then reliable and convergent. There as also discriminant validity according to the results obtained through the application of the Fornell-Larcker criterion since the square root of the AVE of each variable (in bold on the diagonal) is greater than the correlation of each latent variable (off the diagonal). Table 2 synthesizes the results.

Table 2. Evaluation of the model reliability and validity

Variables	Confirmation factor loads	Cα	CR	AVE	CEI	PCBC	ILC	PC	PP	RTP
CEI		0.950	0.968	0.909	**0.953**					
CEI1.	0.940									
CEI2.	0.969									
CEI3.	0.951									
PCBC		0.853	0.911	0.773	0.654	**0.879**				
PCBC1.	0.886									
PCBC2.	0.878									
PCBC3.	0.874									
ILC		0.703	0.792	0.535	0.251	0.324	**0.731**			
ILC1.	0.785									
ILC2.	0.810									
ILC3.	0.345									
ILC4	0.783									
ILC5.	0.865									
ILC6.	0.819									
PC		0.756	0.860	0.341	0.309	0.400	0.387	**0.821**		
PC1.	0.843									
PC2.	0.744									
PC3.	0.871									
PP		0.827	0.872	0.535	0.309	0.329	0.539	0.617	**0.731**	
PP1.	0.718									
PP2.	0.809									
PP3.	0.541									
PP4.	0.775									
PP5.	0.794									
PP6.	0.816									
RTP		0.840	0.886	0.609	0.365	0.413	0.382	0.499	0.550	**0.781**
RTP1.	0.765									
RTP2.	0.836									
RTP3.	0.762									
RTP4.	0.366									
RTP5.	0.182									
RTP6.	0.756									
RTP7.	0.779									

Note: AVE Square Root in bold. CEI – circular entrepreneurial intentions; PCBC – perceived circular behaviour control; ILC – internal locus of control; PC – perceived creativity; PP – proactive personality; RTP – risk-taking propensity; Cα – Cronbach's alpha; CR – composite reliability; AVE – average variance extracted.
Source: own study.

We also conducted the common method bias (CMB) through the Harman one-factor test. The research model contains six constructs with an accumulated variance of 62.75%, with the largest factor explaining only the variation of 30.27%. In this way, as no factor had a variance greater than 50%, it was unlikely that our data would be affected by the CMB. Results revealed that the model had predictive relevance for predicting perceived circular behaviour and circular entrepreneurial intention once Q^2 was greater than zero (Q^2 = 0.175 and Q^2 = 0.385, respectively). The latent variables related to personality traits explain 23.8% of the variance of perceived circular behaviour, and this explained 42.8% of the variance of circular entrepreneurial intention.

Research Model Testing

We tested the relationships presented in our model through bootstrapping. Figure 2 presents the results.

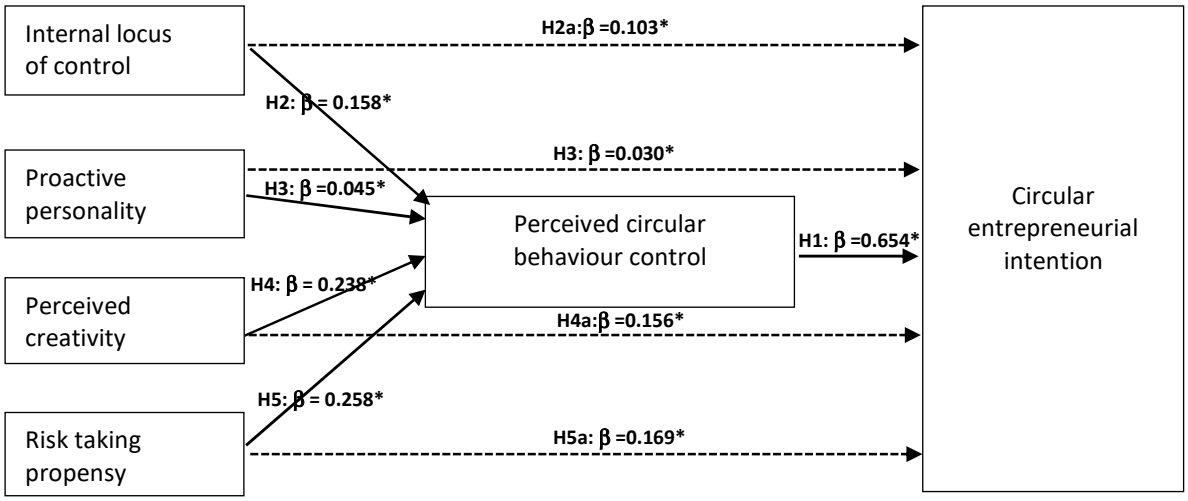

Figure 2. Results of the research model and hypothesis testing via bootstrapping
Note: *p < 0.001. N = 510. Coefficient estimates generated with 10.000 bootstrap iterations.
Source: own elaboration.

The results confirmed the first hypothesis that perceived circular behaviour control positively and expressively influenced respondents' circular entrepreneurial intention (β= 0.654). We also noted that the four personality traits positively influenced the perceived circular behaviour control, ensuring hypotheses H2 to H5. Specifically, the propensity to assume risks was the personality trait that most contributed to the perceived circular behaviour control (β= 0.258), followed by respondents' perceived creativity (β= 0.238) and internal locus of control (β= 0.158). A proactive personality was the trait that least contributed to the perceived circular behaviour control (β= 0.045).

Finally, we confirmed the influence of personality traits on circular entrepreneurial intention, mediated by the respondents' perceived circular behaviour control. Thus, we accepted hypotheses H2a to H5a. The range of contributions of personality traits to circular entrepreneurial intention was also uneven (by decreasing order): risk-taking propensity (β= 0.169), perceived creativity (β= 0.156), internal locus control (β= 0.103), and proactive personality (β= 0.030).

Discussion

Circular entrepreneurship understood as a process of exploration and exploitation of opportunities in the circular economy domain (Zucchella & Urban, 2019) is, to date, a subject underexplored in the empirical literature (Veleva & Bodkin, 2018). The present article contributes to the literature by analysing how certain individual characteristics and personality traits can stimulate a circular entrepreneurial attitude. Therefore, the study extends the TPB and the entrepreneurial traits theory by investigating which personality traits of younger university students have the potential to affect their circular behavioural control and, through this, their intention to become circular entrepreneurs. Since there are no studies (at least that the authors are aware of) that have investigated the relationship between person-

ality traits and the intention to become a circular entrepreneur, the comparison of our results with empirical evidence is compromised. Nevertheless, this comparison will be made whenever possible

Our findings suggest that respondents have demonstrated a circular-oriented entrepreneurial intention. Since most participants belonged to Generation Z, the results corroborate the greatest concerns younger people have shown about the environment and sustainability (Krasulja *et al.*, 2020). Evidence confirms that Generation Z members believe reducing resource consumption, waste management, recycling, and reusing products can benefit the environment (Lakatos *et al.*, 2018).

Moreover, our findings support all the hypotheses. First, respondents' circular entrepreneurial intention was explained by their perceived circular behaviour control and personality traits. The results demonstrate that controlling perceived circular behaviour is a strong antecedent that positively influences circular entrepreneurial intention. Although no study has tested this relationship at the level of circular entrepreneurship, a positive contribution of perceived behavioural control over sustainable entrepreneurial intention has yet to be confirmed (Fatoki, 2020; Thelken & de Jong, 2020; Yasir *et al.*, 2021). Furthermore, evidence from emerging markets shows that circular entrepreneurs are motivated both intrinsically and extrinsically (Dantas *et al.*, 2022).

Secondly, the findings revealed that respondents' risk profile and creativity were the main determinants of their circular behavioural control and intention to become circular entrepreneurs. Empirical evidence denotes that the more creative young people consider themselves to be, the higher their entrepreneurial intentions (Zampetakis *et al.*, 2011) and more creative students tend to be more capable and competent in recognizing entrepreneurial business opportunities and more effective in controlling their behaviour (Yasir *et al.*, 2020). The relation between risk-taking propensity and sustainable entrepreneurial intention is not consensual in the empirical literature. While some studies undertaken with students' found no statistically significant association between risk-taking propensity and the choice to become a green entrepreneur (Fatoki, 2020; Qazi *et al.*, 2021), other researchers found a positive effect between them (Hoogendoorn *et al.*, 2019). Regarding creativity, our results align with empirical literature concerning sustainable entrepreneurs (Fatoki, 2020).

Thirdly, our findings show that respondents' locus of internal control and proactiveness were the two personality traits with the most negligible influence on their perceived circular behaviour control and, indirectly, on their circular entrepreneurial intention. The finding for proactivity is a little odd since it is well-known that people with a proactive personality are likely to become entrepreneurs (Mustafa *et al.*, 2016). In the context of sustainable entrepreneurship, we confirmed the positive effect of the internal locus of control on students' intention to become a sustainable entrepreneur (Arkorful & Hilton, 2022; Fatoki, 2020) although the external locus of control has more influence on entrepreneurial intention compared to an internal locus of control (Arkorful & Hilton, 2022). We found a significant and high effect of proactivity on students' green entrepreneurial intentions elsewhere, where this personality trait was the most effective (Qazi *et al.*, 2021). Empirical evidence also corroborated the positive effect of the internal locus of control on perceived behaviour control (Chiang *et al.*, 2019; Derdowski *et al.*, 2020).

The results provide important insights into how both the TPB and entrepreneurial traits theory can be adapted or refined in the context of circular entrepreneurship, where sustainability and innovation are central. The strong influence of perceived circular behaviour control on circular entrepreneurial intention supports TPB's assertion that perceived behavioural control is critical for shaping intentions. However, it also challenges the theory by suggesting that the type of behaviour control (specifically, control over circular practices) may need to be distinct in models of sustainable entrepreneurship. The role of creativity and risk propensity as primary traits influencing circular behavioural control and intention reinforces the entrepreneurial traits theory's emphasis on cognitive and risk-oriented traits in entrepreneurial success. However, the minimal impact of internal locus of control and proactiveness on circular entrepreneurship intention challenges the theory's universality, implying that traits essential to traditional entrepreneurship may hold less weight in the context of circular entrepreneurship. These findings suggest that both theories could be improved by accounting for context-specific traits and perceived controls, allowing for greater predictive accuracy in fields where creativity and sustainable practices are key. This nuanced understanding not only refines each theory but also highlights the

importance of adapting models of entrepreneurship to align with emerging values and sectors, like those prioritizing circular and sustainable business approaches.

Theoretical Implications

Although this study is exploratory and serves as a starting point for future comparative studies, it contributes to the theoretical deepening of circular entrepreneurship literature. The present research has five main theoretical implications. Firstly, the results demonstrate that circular entrepreneurship presents distinct challenges, opportunities and skills that interact significantly with the personality traits of future entrepreneurs, differentiating it from other types of entrepreneurship. In terms of challenges, since circular entrepreneurship is based on the circular economy, a change in consumers' mentality is necessary to reduce resistance to recycled or reused products and increase their acceptance (Grafström & Aasma, 2021), with the entrepreneur proactivity is essential in this transformation. Furthermore, this type of entrepreneurship is based on innovation and differentiation, looking for circular products and services, innovation in materials, processes and business models (Grafström & Aasma, 2021) and as such, creativity is essential. Circular businesses require investments in innovation that may have a slow return and acceptance, leading to a moderate-high risk propensity. In this way, the results demonstrate that circular entrepreneurship stands out due to the need to close production cycles, requiring a high level of systemic thinking and collaboration with different actors in the value chain (Iacovidou *et al.*, 2021), this type of entrepreneurship requires high perceived creativity to develop regenerative models and strong internal locus of control to deal with regulatory and market challenges. However, it distinguishes itself from other types of entrepreneurship, such as sustainable entrepreneurship, which shares the traits of innovation and purpose with circular entrepreneurship but with a broader focus than just circularity, seeking a balance between profit and impact on society and traditional entrepreneurship that prioritizes profit and efficiency without an explicit focus on sustainability or social impact, having a high propensity for risk. Secondly, it contributes to the development of knowledge on the TPB and Entrepreneurial Traits Theory. Thirdly, it highlights the intentions of Portuguese high students to become socially responsible entrepreneurs. Fourthly, through a unique multidimensional model, it demonstrates that personality traits are antecedents of both perceived circular behaviour control and circular entrepreneurial intention. Finally, it shows that being risk-prone and creative are two important determinants of the intention to be a sustainable entrepreneur. We theoretically show that personal characteristics such as personality traits play a significant role in the development of circular enterprise culture.

Practical Implications

The results of this study serve as a reference for establishing policy guidelines to encourage the adoption of circular businesses. A set of practical implications for students, universities, companies, and policymakers emerged from the present study. Firstly, although we found that students express their intention to become circular entrepreneurs, we know that what is said is not always what is done. Therefore, the educational systems must promote an emphasis on entrepreneurship in line with what is recommended in the circular economy (Pizzi *et al.*, 2022). Besides, as a place of reflection and innovation, the university should encourage students' creativity by fostering freedom of thought and by stimulating them to think outside the box. Secondly, the university is a preparation for the job market and should instil in students greater levels of confidence (internal locus of control). Thirdly, throughout their university education, young people should be imbued with self-confidence, self-esteem, and positive attitudes to become circular entrepreneurs (Khan *et al.*, 2021). Fourthly, universities should develop new entrepreneurship course units at the level of circular entrepreneurship since conventional business models are becoming increasingly outdated. In this regard, it is of the utmost importance to provide students with a broader knowledge of other scientific areas, such as chemistry, since circular business opportunities require profound background knowledge. Fifth, initiatives should be promoted to change the organizational culture of teaching establishments so that a solid corporate culture oriented towards circularity is created. Implementing recycling practices, saving energy and water, waste

management, and saving plastics in bars and cafeterias can induce and improve students' pro-circular behaviours and increase their interest in circularity.

Finally, as for policymakers, circular entrepreneurship policies must be formulated and included in the national development plan. Specific funding must be promoted for universities and companies to adopt circular practices (Yasir *et al.*, 2022). Moreover, effective support policies for circular business initiatives should be encouraged, such as funding vouchers for opening new circular businesses, subsidized bank financing rates, and tax benefits through the reduction of the tax burden on the acquisition of assets oriented towards circularity (*e.g.*, the possibility to amortize assets acquired second-hand, deductibility of taxes on the consumption of second-hand goods, decrease taxes on the consumption of water and electricity in companies with systems to optimize the consumption of these resources and increase the period of deductibility of losses). By decreasing entrepreneurs' risk, these initiatives improve entrepreneurs' pro-circular behaviour and increase circular entrepreneurial intention. Moreover, since young people are increasingly digital, encouraging interaction between the circular economy and emerging technologies such as the internet of things or digitalisation can reduce the risk involved in adopting circular business by increasing transparency and the availability of real-time data.

Limitations and Future Research

This study is not exempt from limitations. We collected data through an online questionnaire and social networks. Even though these drawbacks are recognized in the literature (Andrade, 2020), in this study, specifically in the case of university students, where everyone has access to the internet and social networks, the risk of sampling bias was lower. Furthermore, we collected data only in five higher education institutions, with the sample being collected using a non-probabilistic technique for convenience, making it impossible to generalize the results. We believe that the strengths of the study offset these limitations. The present study is the first to investigate the circular entrepreneurial intention of Portuguese university students. Moreover, this is the first study that uses a multidimensional model to predict the influence of younger personal traits on their circular entrepreneurial intentions employing a circular behaviour control variable. In future research, it would be interesting to extend the study to students of all the Portuguese high education institutions. It would also be interesting to conduct the same study design with college students from other countries to conduct a comparative analysis and test for cultural differences. Future research should include individuals' circular habits in their daily lives to see whether individuals with more circular daily routines are more prone to start a circular business. Finally, future studies should test the influence of individuals' Big Five personality traits in predicting their circular entrepreneurs' intentions.

CONCLUSIONS

The world is changing, and humanity runs severe risks of suffering irreparable damage. Human ambition has depleted natural resources, and the time has come to act to remedy the ecological and environmental disasters. We must learn to live in tune with nature and one another. The circular economy is a critical concept for driving sustainability transformations. By working with circular movements, nature creates a viable environment through interconnected ecological relationships. The concretization of a circular economy requires the intervention of civil society as consumers and entrepreneurs as producers. Concerning the production side, it is essential to know what drives producers to replace economic systems based on linear 'take-make-consume-dispose' models with circular models. To this end, the present study explored the drivers of Portuguese college students' intention to become circular entrepreneurs. Our findings are optimistic since respondents revealed a great interest in being circular entrepreneurs. Thus, they followed in the footsteps of their predecessors when, in the late 90s, a young generation began a cultural change culminating with an entrepreneurship boom. Moreover, respondents' risk-taking propensity, creativity, internal locus of control, and proactivity were determinants in defining both their circular behaviour control and intention to become circular entrepreneurs. The study's empirical findings contribute to the literature on the determinants of the circular entrepreneurial intention of future entrepreneurs.

This study provides five key contributions to understanding circular entrepreneurship among young students. Firstly, it advances knowledge on the TPB and entrepreneurial traits theory by applying these frameworks to the context of circular entrepreneurship, expanding theoretical insights into how perceived behaviour control, internal locus of control, proactive personality, perceived creativity, propensity, and risk-taking influence entrepreneurial intentions. Secondly, it highlights the intentions of Portuguese high school students to become socially responsible entrepreneurs, shedding light on a growing inclination among youth towards sustainable and community-oriented business practices. Thirdly, the study employs a unique multidimensional model to demonstrate that personality traits act as precursors to both perceived circular behaviour control and circular entrepreneurial intention, offering empirical evidence of a complex relationship between individual characteristics and sustainable entrepreneurship. Fourth, the finding that perceived circular behavioural control mediates the relationship between personality traits and circular entrepreneurial intentions introduces a novel perspective, suggesting that young individuals' confidence in their sustainable actions bridges the influence of traits like creativity and risk propensity on their entrepreneurial goals. Ultimately, the study emphasizes the theoretical importance of personality traits in fostering a culture of circular enterprise, positioning characteristics like creativity and risk tolerance as crucial determinants in the drive toward circular entrepreneurship.

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Appendix A:

Questionnaire available at:
https://drive.google.com/file/d/1l3yrM4sy0auxvWGxEHLLtL7gHGZROm78/view?usp=drive_link

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The contribution share of authors is equal for each of them. SG, MP, JLM – conceptualisation, literature writing, SG, MP, JLM – methodology, calculations, discussion.

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Use of Artificial Intelligence

The authors declare that they used grammarly for proofreading.

Conflict of Interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Clarifying the sharing, gig, and on-demand economies and their implications for entrepreneurship: A systematic literature review

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ABSTRACT

Objective: The article aims to develop conceptual clarity around the three distinct terms emanating from the growing platform economy, i.e., the sharing, gig, and on-demand economies and link them to entrepreneurship.

Research Design & Methods: We applied the aggregative systematic review methodology. We did it to clarify and operationalise the differences among the on-demand, gig, and sharing economies, as well as seek to address implications for how each specific type of platform economy concept influences entrepreneurship and impacts our understanding of it.

Findings: The article sets out to define and increase understanding of what is behind the on-demand, gig, and sharing economies. We argue that the lack of consistent definitions of all three phenomena has resulted in several misconceptions and perhaps reduced potential progress with further studies, which now require more knowledge structuring and organisation regarding the three concepts.

Implications & Recommendations: The article provides important nuances to concretise fundamental distinctions among the three concepts and their implications for platform entrepreneurship. Although, at first glance, the differences might seem subtle, they are essential to address a rising complexity related to entrepreneurship.

Contribution & Value Added: Through its findings, the article presents criteria for enhancing conceptual clarity among the sharing, gig, and on-demand economies as well as links these three concepts to entrepreneurship. By doing so, the article also identifies some intersections with different entrepreneurship forms.

Article type: original literature review

Keywords: Entrepreneurship; the gig economy; the sharing economy; the on-demand economy; SLR

JEL codes: L26

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INTRODUCTION

Entrepreneurship has become largely reliant on digitalisation (Nambisan, 2017). Thus, interest regarding platform entrepreneurship has increased (Kraus *et al.*, 2022a; 2022b). As more entrepreneurial opportunities become tied to digitalisation (*e.g.,* Autio, 2017), both through its reach in customer groups and through its importance for business model innovation (Ghezzi & Cavallo, 2020; Kraus *et al.*, 2019), the focus on different platform economies and their impact on entrepreneurship has increased in research discussions (*e.g.,* Cockayne, 2016; Kraus *et al.*, 2022b; Nambisan & Baron, 2021; Woodcock, 2020).

Although the platform economy is a relatively new phenomenon and, on an aggregate level, we can tie it to companies such as Facebook and Amazon, in this study, we investigated its sub-related terms: the sharing economy, the gig economy, and the on-demand economy. These relate more to the rapid development of companies such as Airbnb, Uber, Lyft, TaskRabbit, Mechanical-Turk (a subsection of Amazon), Bolt, Deliveroo, and Voi. The concepts of the sharing, gig, and on-demand economies as

well as the entrepreneurial ventures operating in these spaces have rapidly gained ground as a result of both an established platform economy infrastructure (Kenney & Zysman, 2016) and innovative business model developments (Bick, 2019; Ghezzi & Cavallo, 2020). On a research level, to this day, the literature has either unambiguously praised all phenomena related to digital technology or adopted a highly critical perspective, focused on precarious work conditions that many of the platform businesses create (*e.g.,* Cockayne, 2016; De Stefano, 2016; Ravenelle, 2017; Schor, 2017). However, regardless of the approach presented, we identify that on a more exploratory level, scholarly works use concepts such as the gig, sharing, and on-demand economies interchangeably without making clear distinctions on their different assumptions and foci (Kraus *et al.*, 2022b; Woodcock, 2020). Although the first studies on the subject date to the 2010s, the multifaceted and rapid growth of the platform economy requires clarity and structure on the basic differences among the key terminologies used.

We based the motivation for this study on the premises that entrepreneurship in the digital age is a highly heterogenous phenomenon (Sahut *et al.*, 2021; Elia *et al.*, 2020; Kraus *et al.*, 2019) and that different digital contexts and their terminologies mean different things to different types of entrepreneurial opportunities (Sutherland & Jarrahi, 2018; Liang *et al.*, 2022; Acs, 2022), whether they are non-profit social entrepreneurial opportunities, micro-mobility gigs, or fast-fashion on-demand delivery business opportunities. An example that illustrates this confusion is Uber, which the literature labels both as the sharing economy (*e.g.,* Geissinger *et al.*, 2020; Garud *et al.*, 2022) and the gig economy (*e.g.,* Berger *et al.*, 2019; Burtch *et al.*, 2016). In this article, we claim that the basic assumptions behind business model innovations built on terms such as 'sharing economy,' 'on-demand economy,' and 'gig economy' have different meanings for different entrepreneurial processes. Hence, we aimed to develop conceptual clarity around the three distinct terms emanating from the growing platform economy and link them to entrepreneurship. We did this through an aggregative systematic literature review (SLR). We posed two guiding questions:

1. What are the distinctive and differentiating features of the sharing, gig, and on-demand economies?
2. What implications do these types of platform economies have on entrepreneurship?

These questions reflect the articulated need in the literature for more nuanced insights on the platform economy and its link to the entrepreneurship ecosystem (Cutolo & Kenney, 2022).

The article contributes to the existing literature on platform entrepreneurship in at least three different ways. Firstly, our study provides conceptual clarity on the maze of terminology that has been tied to the growing platform entrepreneurship literature. In other words, it indicates important differences that need to be acknowledged when applying these terms for different types of entrepreneurial opportunities. Secondly, our study provides a balanced viewpoint on the sub-categories within the platform economy and how they relate to both positive and negative perspectives tied to entrepreneurship. Finally, the study stakes out new avenues for future research with respect to the interplay between entrepreneurship and the three types of platform economies.

The paper is structured as follows: first, we outline the methodology and steps of the systematic literature review; next, we present the literature review alongside the bibliometric and thematic analysis; and finally, we discuss the implications for entrepreneurship and conclude with recommendations for future research.

MATERIAL AND METHODS

Our point of departure was the need to develop conceptual clarity around the emerging phenomenon of platform entrepreneurship, more specifically, developing stronger connections among different types of entrepreneurship and the terms 'sharing economy,' 'gig economy,' and 'on-demand economy'. Therefore, we decided to conduct an SLR as it focuses on developing a process to identify relevant scholarly work in a transparent and replicable manner (*e.g.,* Hägg & Kurczewska, 2022; Pittaway & Cope, 2007). Gough *et al.* (2012, p. 1) argue that 'systematic reviews are a form of research; they are (and the theoretical and ideological perspectives underlying these methods) a way of bringing together what is known from the research literature using explicit and accountable methods.' In

the following sections, we will address the specific type of aggregate literature review adopted in this study and its different steps.

Aggregative Systematic Literature Review

Gough *et al.* (2012) distinguish between two types of systematic reviews, *i.e.*, the aggregative and the configurative. They argue that the configurative review seeks to interpret and understand the world by arranging information and developing concepts. On the other hand, an aggregate approach seeks to collect empirical data to test and describe predefined concepts and their development (Gough *et al.*, 2012). The main difference between the two is that configurative reviews are explorative and seek to understand concepts in new ways and develop new patterns (*e.g.,* Hägg & Gabrielsson, 2020), whilst the aggregative review focuses on a priori methods and using predefined concepts and testing them (Gough *et al.*, 2012), implying an interest in the homogeneity of studies (see Hägg & Kurczewska, 2022). The logic underlying the aggregative systematic review method relies on identifying studies that support one another, giving the reviewer more confidence about the studied phenomenon (Gough *et al.*, 2012). Given the specific research questions on (1) the distinctiveness of the sharing, gig, and on-demand economies as well as (2) the implications of these types of platform economies on entrepreneurship, an aggregative systematic review method was suitable as it seeks to synthesise existing evidence in a structured manner and to compile results from previous studies to identify areas for further research. In the following section, we will address the steps taken to develop and conduct the review.

The Steps of the Systematic Literature Review

When developing an SLR, several steps need consideration. We followed and took inspiration from systematic review methodology guidelines found in prior studies (*e.g.,* Gough *et al.*, 2012; Pittaway & Cope, 2007; Tranfield *et al.*, 2003). These studies include numerous recommendations to acknowledge when developing an SLR as well as a few steps to be taken when crafting the study. Our research inspiration was Tranfield *et al.* (2003), with regard to the three main steps that an SLR should include. We will report on the steps taken to provide both clarity and transparency about the study.

Step 1: Study Purpose and Boundaries

We followed the study's purpose to develop conceptual clarity around the three distinct terms emanating from the platform economy – *i.e.*, 'sharing economy,' 'gig economy,' and 'on-demand economy' – and link them to entrepreneurship. As the starting point of every SLR, the boundaries for what will be studied need to be set (see Tranfield *et al.*, 2003). Here, we discussed what to include in the study, including the subcategories of the sharing, gig, and on-demand economies as well as their influence and connection to the growing phenomenon of platform and digital entrepreneurship (*e.g.,* Kraus *et al.*, 2022a, 2022b; Nambisan & Baron, 2021). One notable concern in scholarly discussions is the conceptual diffusion regarding how scholars use interchangeably sub-categories within the platform economy and how this creates a blurred understanding of what is what, who may be part of what, and for what reasons. Therefore, we decided to focus on three well-known terms that have received much attention in contemporary society and how they may play different roles depending on the type of entrepreneurship being studied. When setting the boundaries for our systematic review, we followed the advice of Tranfield *et al.* (2003) and of Hägg and Gabrielsson (2020) and developed a coding structure to enable standardisation of the information from each article, including the following: author-level data, topic area, theoretical frameworks, the methods used, the main question and purpose, and the main findings. The standardised coded material creates opportunities to develop transparency and to group the data for analysis.

Step 2: Conducting the Review (Search String, Database, and Inclusion and Exclusion Criteria)

To conduct the review, we started by creating a Boolean search string and used EBSCO Business Source Ultimate as the bibliographic database. Keywords used in the search were as follows: 'entrepreneur*' (or) 'business' (or) 'organisation' (or) 'organisation' and 'gig economy' (or) 'on-demand economy' (or) 'sharing economy' (or) 'platform economy'. We only include peer-reviewed articles written in English. The timeframe was set from 2008 as that year marks the birth of the most known platform economy

businesses (Uber and Airbnb). The search generated 1 102 hits, starting in 2014. Curtis and Mont (2020) applied the same logic of operation. In this article, we present the findings of SLRs covering the years 2014-2022. This left us with a final sample of 121 articles used in the study. While the sample of articles analysed may seem small, we attempted to extract only those that dealt directly with the platform economy and entrepreneurship. By doing so, we eliminated several articles dealing with the circular economy, crowdfunding and blockchain, and even the digital transformation of a company, along with a few articles from 2022 that dealt with the specifics of artificial intelligence and entrepreneurship. We have also excluded numerous articles related to labour markets, managing and organising work, working relations, nonstandard work arrangements, and trust, as well as logistics and platforms' typologies. However, we often considered articles that relate to business models, value creation, and innovation. This approach allowed us to focus on the purpose of the study and the guiding research questions.

Step 3: Analysis, Outcomes, and Implications

In the analytical process, we focused on creating clarity among the concepts which have often been used interchangeably in the literature. Gough *et al.* (2012) inspired us to make an aggregative review. More explicitly, in the following sections, we will discuss the development of the platform economy with attention to the interplay between the sharing, gig, and on-demand economies and entrepreneurship. This leads us to discuss how conceptual clarity about these sub-terms within the platform economy plays different roles for different types of entrepreneurship and their implications for future research when connecting platform and digital entrepreneurship to these terms. The final part of the aggregate SLR method was to provide some conclusions for how, when, and for what reasons the different terms are to be treated when conducting research in the digital context of entrepreneurship. Synthesising the analysis and reporting on the outcomes allowed us to identify future research avenues by highlighting gaps in the current literature while also providing practical insights for policymakers to shape evidence-based policies.

We are aware that 'sharing economy,' 'gig economy,' and 'on-demand economy' are terms not reserved only for the digital world and technology-driven developments; they also exist without the Internet. Therefore, to avoid misconceptions, we focused solely on conceptualising these terms as economies that emerged in the context of Internet platforms.

LITERATURE REVIEW

One of the main interests in research on entrepreneurship relates to the rapid digitalisation that we are experiencing today (Autio, 2017), which has only accelerated through the COVID-19 pandemic. With an increased focus on digitalisation, more scholars became interested in the development of innovative business models (Parente *et al.*, 2018) that centre on platforms regarded as a key advancement of the digital revolution (McAfee & Brynjolfsson, 2000) and most broadly defined as 'virtual locations through which various users communicate and transact' (Kenney & Zysman, 2019). The platforms, multisided digital frameworks for operations that enable interaction, offer a wide range of human activities and open new opportunities for innovation in many areas of life, from how we work and spend money to how we socialise and spend our leisure time. One of the most known examples is Airbnb, which focuses on connecting homeowners and individuals seeking a place to sleep. Other platforms connecting service providers with customers are Deliveroo and TaskRabbit. What these examples have in common is the use of an intermediary digital platform matching both sides of the market. Oftentimes these different activities are bundled together under the term 'sharing economy' or 'gig economy' as well as 'on-demand economy' (*e.g.,* Cockayne, 2016; Woodcock, 2020).

Scholars study the sharing, gig, and on-demand economies as part of the platform economy, and they rely on digital platforms that facilitate interactions among service providers, customers, and businesses. Therefore, what they have in common is peer-to-peer interactions matched and coordinated digitally. They are also all tied to some form of economic disruption (for example, the sharing economy challenges traditional ownership models, the gig economy disrupts conventional employment, and the on-demand economy shifts expectations around the timing of service delivery). Thus, there is an overlap

among these economies, which is why they are often grouped together under the platform economy. This overlap, considering the novelty of all these phenomena, creates confusion with regard to the terminology and weak societal understanding of these concepts. However, upon closer inspection, the rationale and underlying reasons for these distinct entrepreneurial activities are significantly different:

- The logic behind the sharing economy is basically one of sustainable behaviour to lessen the impact on the environment through the more efficient use of different resources. Acquier *et al*. (2017) characterise it as an access economy (sharing for optimising), platform economy (decentralised intermediation), and community-based economy (equality-based interaction).
- The on-demand economy aims to meet behavioural changes among customers to constantly decrease the delivery time (often focused on the last-mile delivery that has expanded in presence because of the COVID-19 pandemic).
- The gig economy has emerged as a vehicle to match unused service capacity with specialised customer demands (Cockayne, 2016). This economy describes a work environment in which temporary jobs are prevalent, and companies often prefer hiring independent contractors and freelancers over traditional employees (Hägg & Kurczewska, 2021). An example of this is the website Freelancer.com, where a customer broadcasts a project and, through the platform, finds a suitable service provider (*e.g.,* language editing) at an agreeable price.

The discussion on platform economies notably relates to labour markets. Rapid digitalisation brought changes to the structure of the economy, including the transformation of labour markets and the nature of work (Kenney & Zysman, 2019). The platform economy quickly resulted in the emergence of alternative work arrangements with less traditional and less stable relationships between employers and employees, resulting in work fracturing. However, online-based platforms with their redefined jobs offered through online marketplaces, which connect service providers and customers, also bring legal ambiguities and questions related to the creation and capture of value or control and responsibility over the platforms (*e.g.,* Novitz, 2021; Wood *et al.*, 2023). Therefore, the discussion about the role of platforms goes beyond the labour market and becomes a broader topic related to entrepreneurship, ethics, and the economy. Platforms have begun to be regarded as not only a new social technology or a new infrastructural formation of business and work but also an organisational form of the new economy that changes and rematerializes markets (Cohen, 2017) and, with its entrance, also disrupts industries.

The research discussion on the platform economy is a new phenomenon that started to emerge no longer than a decade ago. It attempts to follow and scientifically explore the developments taking place as well as different mutations of its meaning. This poses a challenge as the emerging boundaries of each development and mutation are blurred. The role of the platform in each sub-development (the gig economy, the sharing economy, and the on-demand economy) is different and serves different needs, which requires scrutiny to create clarity. What they all have in common, in addition to digital dependency, is the crowd and network effect, new types of communication, and the unique nature of their transactions. However, despite these common characteristics, growing interest in scholarly discussions provides a plethora of categorisations and taxonomies, depending on the perspective applied. For example, Kenney and Zysman (2019) distinguish platforms depending on the type of work. They identify workers employed directly by the platform and its contractors, platform-mediated work, and platform-mediated content creation. Adopting an income perspective, Forde *et al.* (2017) distinguish three other categories of workers: moderate beneficiaries, random surfers, and platform-dependent workers. In this article, we follow the three most classical forms of new economies that have emerged through the platform economy and attempt to distinguish their implications on entrepreneurship. Few articles have systematically covered any of these types of platform economies, even less so their entrepreneurial aspects. The most scientifically exploited type of platform economy is the sharing economy. According to an SLR conducted by Mallinson *et al.* (2020), the sharing economy literature primarily covers topics such as the determinants, motivations, barriers, and impacts of the sharing economy, along with its regulation and links to entrepreneurship, with the emergence of new types of businesses with new models and frameworks. To give another example, in their systematic analysis, Plewnia and Guenther (2018) identify four dimensions to characterise sharing systems: the shared good or service,

the market structure, the market orientation, and the industry sector. However, the bulk of articles lack coherent definitions in the platform economy literature.

DISCUSSION

The discussion section is divided into three sub-sections. The first addresses the bibliometric analysis and insights gained from the SLR. This part presents the descriptive data – such as the number of published articles, the division of the articles based on area, the type of study, the data collection approach, and the context of the studies. The second part focuses on a thematic analysis and describes the different key terms. Next will be an analysis of the relationship between the phenomena explored and entrepreneurship.

Bibliometric Analysis

The SLR addresses several key insights. An important first step when understanding the development of a research field or topic is the bibliometric development on how research emerges, grows, and matures. The topic of the platform economy (including the sharing, gig, and on-demand economies) and its relation to entrepreneurship is no different, and to gain an overview, we began our analysis by addressing the growth of articles in the area (Figure 1). In total, we analysed 121 articles. We noted a massive development of studies from 2017 to 2018, where the number of studies has seen substantial growth, reaching its peak in 2020. However, a more interesting finding is the incredibly slow growth of studies addressing the sharing, gig, on-demand, and platform economies in the early years (2014-2017), given their high presence in popular media outlets since the establishment of Airbnb in 2008 and Uber in 2009. A potential explanation is that the use of collaborative consumption was more popular in the early stage and that the topics were not focused on connections to entrepreneurship per se but more on flexible work, new types of sustainable consumption, as well as regulation and law issues. The clear connection to entrepreneurship has slowly grown as the platform economy has gained a more central position when addressing new trends and development in entrepreneurship research (*e.g.,* Nambisan, 2017).

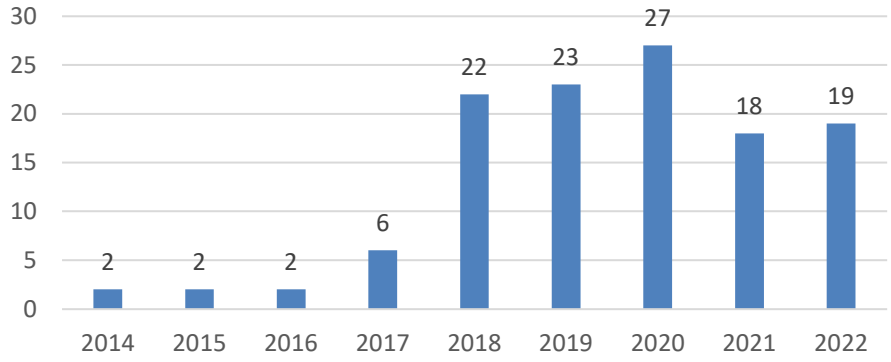

Figure 1. Number of articles included in the SLR (2014-2022)
Source: own elaboration.

When moving forward to Figure 2, we see that so far, most articles focus on the sharing economy (89 articles), and thus, we sought to develop our scholarly understanding of the phenomenon. This might also be why there is much confusion on what the sharing economy implies as most articles seem to research it as an economic phenomenon, whilst in hindsight, this might have been an oversimplification of the term itself (see, *e.g.*, Schor, 2017). Moreover, we noted an extremely slow development of studies that address the more overarching platform economy, as we observed that fewer studies mix the terms and that there are almost no studies on the on-demand economy.

Following the analysis, we can see in Figure 3 that most of the studies (77 articles) were of an empirical nature, where they seek to explore the phenomenon and try to provide pieces to the puzzle. The number of conceptual studies was fairly low (31 articles), and there were also relatively few review

articles (13 articles), which is natural in a new field lacking empirical understanding and conceptual clarity on what the concepts actually mean.

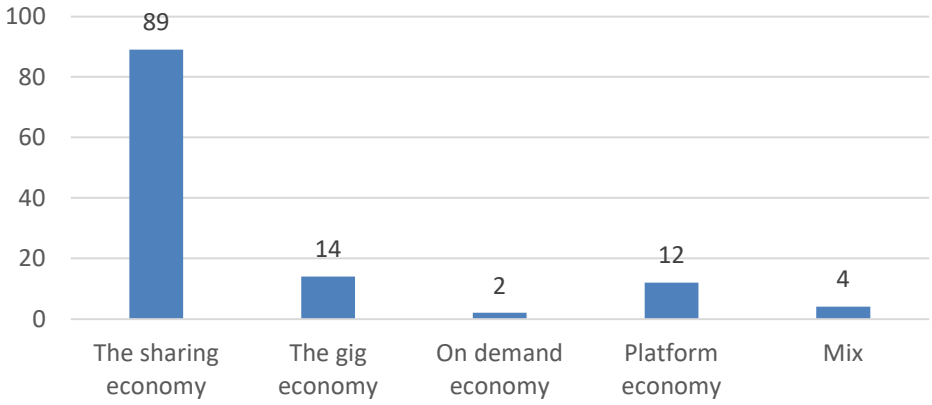

Figure 2. Categorisation of articles included in the SLR (2014-2022)
Source: own elaboration.

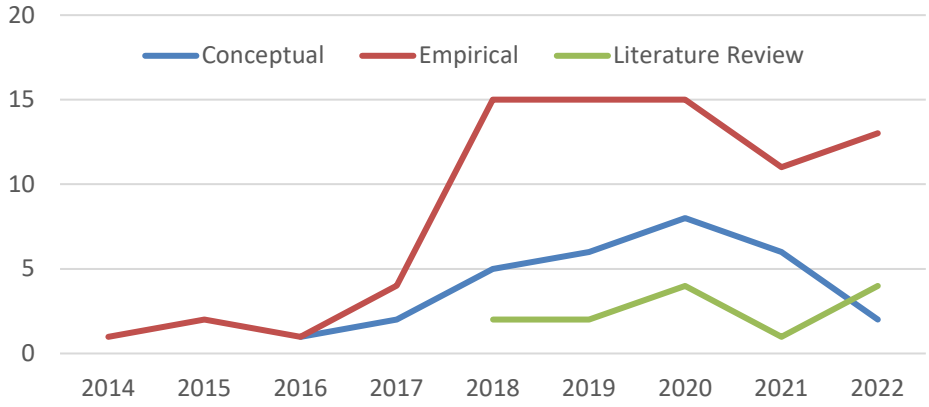

Figure 3. Types of studies conducted in the article included in the SLR (2014-2022)
Source: own elaboration.

Looking closer at the empirical articles (Figure 4), we found that the majority of the studies were qualitative throughout the period (49 articles in total, in contrast to 18 quantitative articles and 10 with the mixed-methods approach applied). This may imply that the field is highly driven by individual scholars who take a variety of perspectives to grasp the phenomenon, a similar development as has been seen in entrepreneurship (Landström, 2020). It might also explain why there has been a plethora of interpretations on what the sharing economy might mean, everything from the ideal sharing of devices and space to reduce overconsumption to highly economic-oriented business models such as Uber. However, the continued dominance of qualitative studies may become problematic in the long run to create conceptual clarity and boundary conditions for defining key terms.

Continuing the analysis of empirical articles, Figures 5 and 6 show the distribution of sources of data used in quantitative and qualitative research, respectively. As we can see in quantitative research, questionnaires and secondary data dominate. In the case of the qualitative approach, researchers frequently use secondary data and interviews as well as mixed methods to provide triangulation to their studies.

Finally, in Figure 7, we can see the contextual development of the studies. In the first phase, the studies mainly took place in North America and Europe, which is logical given the birth of Airbnb and Uber, as well as other platform economy businesses.

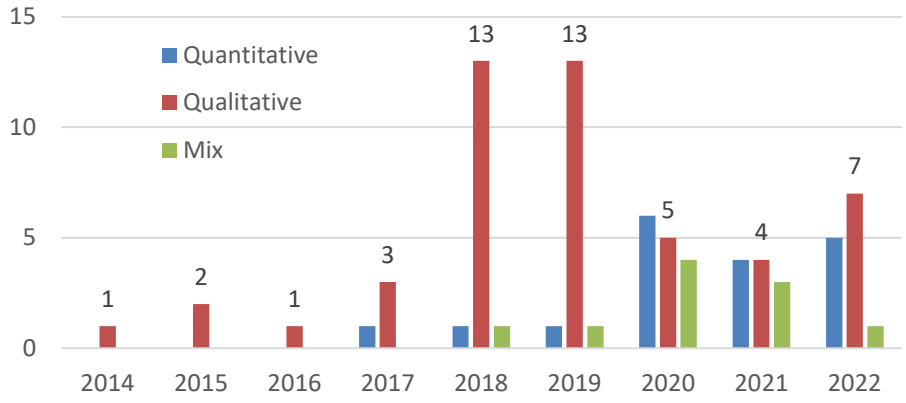

Figure 4. Data collection methods in articles included in the SLR (2014-2022)
Source: own elaboration.

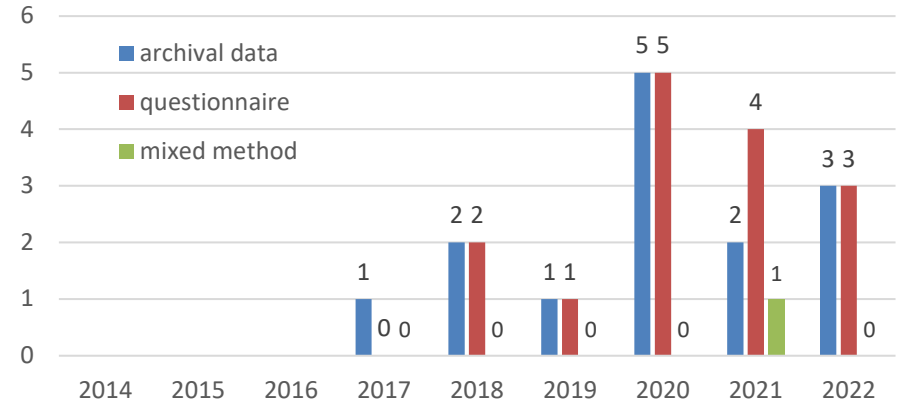

Figure 5. Source of data in articles in the SLR that apply quantitative methods (2014-2022)
Source: own elaboration.

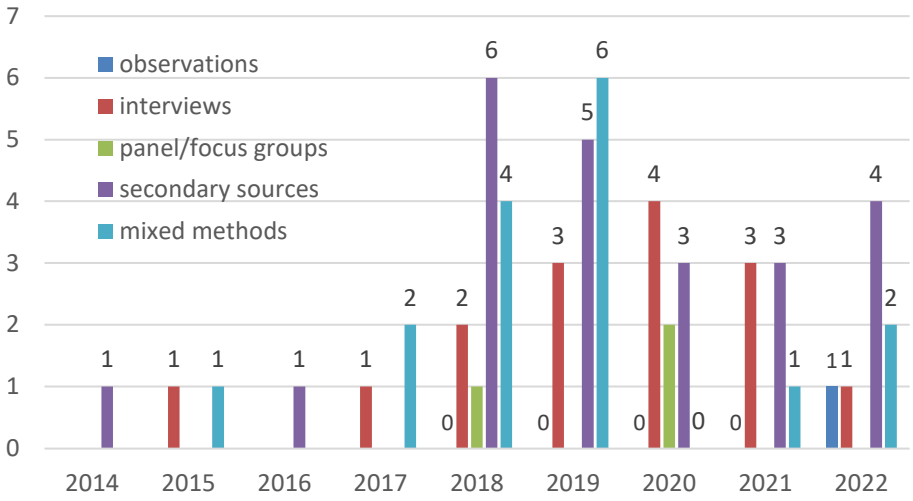

Figure 6. Source of data in articles in the SLR that apply qualitative methods (2014-2022)
Source: own elaboration.

An interesting trend is that Asia is starting to emerge as empirical ground for making sense of the platform economy and its sub-areas, and we can also see in 2019 that studies from Africa and South America are gaining presence in the sample.

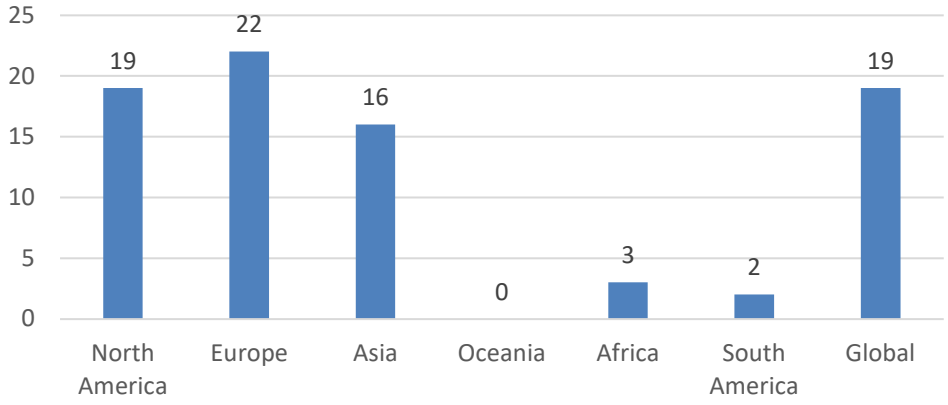

Figure 7. Geographical context of studies in the SLR articles (2014-2022)
Source: own elaboration.

Thematic Analysis

An important part of our SLR was a thematic analysis. Our coding structure enabled a standardisation of the information from each article, including the main research question, purpose, and main findings. The themes emerged through a structured coding process in which the research team manually reviewed and analysed the descriptive data. By systematically categorising and synthesising this data, patterns and recurring topics across the literature were identified, allowing us to extract and define the core themes.

The topics covered in the analysed articles on the platform economy are rather dispersed, and the research approach is interdisciplinary, primarily spanning disciplines such as business, economics, law, ethics, and ecology. The main themes include (but are not limited to) the following:

- *Business perspectives of the platform economy*, in particular strategies for success in new types of economies, how to gain competitive advantage in the conditions of new types of competition, new types of business models and ecosystems, creating business value within the new types of economies, and customers' satisfaction and loyalty in the new economy-driven business context (*e.g.,* Sigler & Corcoran, 2020).
- *Institutional frameworks of the platform economy*, in particular, institutional logics in the context of business model development, the impact of new economies on the tax regime, and institutional power as being subsequently leveraged by new entrants (*e.g.,* Elert & Henrekson, 2016).
- Changes in the labour market arising from platforms' new logic of employment (but related to some extent to entrepreneurship) (e.g., Ahsan, 2020).
- *Sustainability and green logic,* in particular examining emerging and innovative types of sustainable business models as well as sharing as part of a sustainable approach (*e.g.,* Turaa, 2020; Grinevich *et al.*, 2019).
- *Typologies and classifications to explore the phenomena*, in particular types of sharing, types of platforms and their consequences for running the business in new economies, and a conceptually and empirically grounded taxonomy of platform business models (*e.g.,* Kenney & Zysman, 2019).

Notably, we have not identified any major differences among the gig, sharing, and on-demand economies in terms of applied research perspectives, even as they represent different economic models with different assumptions. Here, we may link some of the conceptual confusion to the indifference among these types of companies when reporting about them in the public press. To provide a bit of clarity, some examples of gig-economy companies active today are Glovo (the food delivery platform), Helpling (a cleaning platform mainly operating in Germany), and Uber (the ride-hailing platform). From a sharing-economy perspective, some examples include Vinted (a second-hand platform) and CoachSurfing (a platform for sharing unused short-term homestays for travellers). Finally, examples of on-demand (last-mile delivery) platforms include Amazon Flex (giving individuals the opportunity to deliver goods using their own vehicles).

Most of the articles in all the subcategories were explorative in nature, with some elements of comparison between conventional business models and sharing economy business models to highlight the changes brought by emerging platform economies. The only difference that we identified through thematic analysis was that when addressing the sharing economy and its focus on social value, we see clear ties to social and sustainable entrepreneurial opportunities but not to commercial enterprises that focus on customer value, which we see in consumption-intense businesses in the on-demand and gig economies. An example of existing companies that distinguish the above is between the two platform companies Fairbnb.coop and Airbnb.com, where the former has a cooperative business model and focuses on socially and ecologically sustainable travelling, whilst the latter has a business model focused on customer value creation and financial performance. Furthermore, the issue of precariousness is tied more to the customer-centric platform business models accelerated by the on-demand and gig economies than the sharing economy (exemplified by Woodcock, 2020).

Relationship to Entrepreneurship

When developing the SLR methodology guided by our research questions, we sought conceptual clarity on the above mentioned platform economies and their relation to entrepreneurship. However, this connection is quite weak; it becomes clearer with time, but entrepreneurship is mainly a context or terminology that is added to a broader discussion that centres on the sharing, gig, or on-demand economy as a phenomenon (Geissinger *et al.*, 2020; Nambisan & Baron, 2021). Despite the weak ties, we could still distinguish some fundamental relationships between these three platform economies and the multitude of approaches that have emerged in understanding the differences among the types of entrepreneurship.

Some main insights are the widely different assumptions that drive the sharing, gig, and on-demand economies as well as how they relate to different types of entrepreneurship. Here, the market and sustainability logics are highly contradictory when tracing the basic assumption on why the (digital) sharing economy emerged in the first place (see Schor, 2017); whilst a multitude of platform companies have employed the sharing ideal as their discourse, they are oftentimes more tied to the market logics of the gig and on-demand economies. The differences driving each platform economy also bear some traces towards how we can tie and understand the growing research area of (digital) platform entrepreneurship (Kraus *et al.*, 2019; Nambisan & Baron, 2021), along with sub-topics such as social entrepreneurship, commercial entrepreneurship, and various connections between the selection of business models and the underlying platform economy logic at play.

From our data on dominating definitions, there are several traces of how each platform economy logic shows tendencies towards different entrepreneurship types. We argue that this is the key to creating clarity and definitional boundaries when understanding both broader and more precise implications that the platform economies have on entrepreneurship research. In establishing this relationship, we depart from dominating definitions about entrepreneurship and its relation to the assumptions driving the main definitions found on the sharing, gig, and on-demand economies as well as the claimed value of each type found in our review sample.

1. The sharing economy and entrepreneurship: Connecting the sharing economy with social and sustainable entrepreneurship.

According to our data, the dominating definition of the sharing economy is the one provided in popular science by Botsman (2013), where she specifies it as an economic model based on sharing, swapping, trading, or renting products and services, enabling access over ownership. Following the work of Hamari *et al.* (2016), scholars frequently refer to sharing economy as the peer-to-peer-based activity of obtaining, giving, or sharing access to goods and services coordinated through community-based online services. The third most used definition is by Acquier *et al.* (2017), who position it as resting on three key elements: (1) access economy, (2) platform economy, and (3) community-based economy.

Furthermore, some of the articles in our sample include sharing 'for a better world' and focus on 'the common good' and 'common goods,' which are oftentimes tied to the idea of solidarity and strengthening social ties. From these insights, it becomes quite apparent that we may find what drives the sharing economy ideal in research on social entrepreneurship and the definition by Zahra

et al. (2009, p. 522): 'Social entrepreneurship encompasses the activities and processes undertaken to discover, define, and exploit opportunities in order to enhance social wealth by creating new ventures or managing existing organizations in an innovative manner.' There are also traces of a similar logic in the definition by Bruyat and Julien (2001, pp. 170-171) and their arguments around the dialogic between individuals (the entrepreneurial entity) and the value created to the context in which it operates. Although less closely tied to the social good that ties social entrepreneurship with the sharing economy ideal, the perspective of Bruyat and Julien (2001) brings to our attention the multitude of entrepreneurial types that we do not see in the same sense in the definitions by Schumpeter, Kirzner, Shane and Venkataraman, or Gartner.

2. The gig economy and entrepreneurship: Connecting the gig economy with organising for venturing and growth.

When we moved to the gig economy, we found a slightly different definitional boundary and values claimed by this specific type of platform economy. The main characteristics we found in the articles were optimisation, cost reduction, and a focus on increasing the number of transactions and the speed of providing the services. The main was 'the collection of markets that match providers to consumers on a gig (or job) basis in support of on-demand commerce' (Congressional Research Service Report). Moreover, authors often refer to the gig economy in terms of jobs mediated by digital platforms (De Stefano, 2016).

In line with our reasoning, we found many similarities between the gig economy and the definition by Gartner (1988) related to entrepreneurship as the creation of an organisation. The main argument was the role that organisational activities have played in the growth of the gig economy, where the focus has been less on the profits and more on the creation of the platforms and the infrastructure around them. Some examples are Lime, Voi, and Uber, where profitability has become less of an issue given the massive accumulation of venture capital to grow and establish the organisation. We also see close ties to Schumpeter (1934) and the role of creative destruction that the gig economy ventures have embarked on. The main venture here is, of course, Uber, along with shadow organisations such as M-Turk and the most well-known (and initially addressed as a sharing economy) venture Airbnb. We based the rationale for positioning two of the most well-known sharing economy business models (Uber and Airbnb) on the characteristics of each business and how they deviate fundamentally from the basic assumptions that characterise the sharing economy and its claimed values. When analysing these well-known examples (given that they have appeared in many studies and been tied to a fuzzy explanation or rather a romanticised discourse from practice towards the sharing economy), it becomes obvious that they are not aligned with, for example, solidarity and common goods but rather the optimisation of resources on a financial basis and with a focus on the creation of organisations and creative destruction.

3. The on-demand economy and entrepreneurship: Connecting the on-demand economy with commercial and profit-oriented entrepreneurship.

Finally, the most recent platform economy, *i.e.*, the on-demand economy, has emerged in relation to the growth of, *e.g.*, Amazon and the expansion of e-commerce, fuelled by the pandemic and changed consumer behaviour, and businesses strive to reduce the delayed satisfaction with purchases that previously was synonymous with e-commerce. The on-demand economy values found in our sample focus on increased efficiency and optimisation, and one of the few articles in our sample that attempt to define the area is that of Cockayne (2016, p. 73). He argues that the on-demand or sharing economy refers to digital platforms that use mobile applications or websites to connect consumers with services or commodities. He explains that scholars use the term 'on-demand economy' interchangeably with the more widely recognised 'sharing economy.' However, to Cockayne, 'on-demand' more accurately conveys the nature of these digital and platform-based economic systems, whereas 'sharing' tends to idealise the broader changes in flexible labour practices that these systems help shape.

This relates to Shane and Venkataraman's definition (2000) focusing on profitable opportunities. However, in these business opportunities, we can also see much of Kirzner's (1979) findings because of the arbitrage profits they reap by providing a solution that is highly sought after from e-commerce busi-

nesses. The main difference between the on-demand economy and the gig economy is the logic of how the businesses are organised and how profits take a central place in the on-demand economy. Despite numerous overlaps between these platform models in relation to optimisation and efficiency, some differences that (so far) have not been fully acknowledged may have implications for how we address them with regard to entrepreneurship research. These may be subtle, such as how each type related to dominating definitions in entrepreneurship provides initial ideas on how to clarify boundaries and specify what logic to follow when contextually seeking to understand potential entrepreneurial opportunities.

Discussion

The aggregate SLR enabled us to identify common features of all three sub-terms deriving from the platform economy. What the sharing, gig, and on-demand economies unquestionably have in common is as follows: online intermediaries, service orientation, and efficiency of use, along with the undeniable advantage of platform owners. Platforms are also unregulated marketplaces (Martin, 2016), where the reduction of costs is possible. They enable and trigger a wide range of activities, often on a large scale, but if scholars consider entrepreneurial opportunities, profits, and risks, they also often raise the problem of fairness and equal distribution (*e.g.,* Cockayne, 2016; Forde *et al.*, 2017). Without more legal regulation and transparency of operation, responsibility, and social costs belong to those without any bargaining power (Woodcock, 2020).

However, our article aimed foremost to provide important nuances to concretise fundamental distinctions among the three concepts and their implications for platform entrepreneurship. To achieve this, based on our SLR and their dominating definitions, we developed a set of criteria enabling differentiation among the sharing, gig, and on-demand economies. The process of developing these criteria involved several key steps, including comprehensive reviews of existing definitions, the identification of dominant elements and characteristics, synthesis and comparison, and, finally, the criteria development.

Table 1 presents the characteristics of the sharing, gig, and on-demand economies, following these criteria. We divided the criteria into three groups: those devoted to their philosophy of operation (light grey), those related to the characteristics of platforms (medium grey), and those enabling to follow the match with different types of entrepreneurship (dark grey). In the first group of criteria, we considered the characteristics as the expected model and logic of operation, the type of transactions, their claimed value, and the position towards consumption. In the second group, we focused on the role of platforms, the sides that operate within them and their relationship, and their geographical reach. Finally, in the third group, we included the potential connection to entrepreneurship domains and core entrepreneurship definitions.

The analysis of the literature and a careful examination of the business environment in recent years brought to light another important observation for distinguishing between the sharing and gig economies. When digital platforms started to gain more prominence in the market, the nature of the sharing economy started to change. Based on the patterns in our study, was split into two separate paths. The first path related more to the ideal version of the sharing economy, which also exists beyond technology, based on the values of the non-commercial exchange of goods and services. This ideal type of sharing economy has less in common with the second path, which entails highly competitive and venture capital-backed platforms with purely profit-oriented purposes.

The latter path, the spread of the gig economy ideal – which, on a regular basis, uses sharing as a defining slogan (given its potential goodness in the value created) – intensively commercialises its activity and grows rapidly in size (often on a global scale), resulting in huge financial turnovers. This altered focus on the financial side and on optimisation and the predominance of consumption and competitive nature are why we see it as the 'gig economy.' The main consequence – a significant amount of confusion and vagueness in both research and practice – has necessitated understanding where sharing ends and where the 'gig' starts. The main reason for this confusion has been the broad interpretations of the concept of sharing. For example, Grinevich *et al.* (2019) distinguish between a 'pure sharing' economy, a second-hand economy, an on-demand economy, product service systems, and business-to-business (B2B) sharing. The unclear division between the gig and sharing economies is evident in our literature review. Articles on the gig economy are not numerous. Many articles in

Table 1. The characteristics of the sharing, gig, and on-demand economies as well as their relation to entrepreneurship

Characteristics	The (digital) sharing economy	The gig economy	The on-demand economy
Expected model of operation	Cooperation and collaboration Decentralised exchange and circulation	Competition Consumption	Competition Consumption
Logic of operation	Reciprocity	Contractual	Contractual
Types of transactions	Usually non-financial compensation Based on social agreement No transfer of ownership	Financial compensation Contract	Financial compensation Contract
Claimed value	Sharing 'for a better world' and common goods Solidarity, strengthening social ties	Optimising, reducing costs, increasing the number of transactions and their speed	Optimising, increasing efficiency
Position towards consumption	Limiting	Enhancing	Enhancing
The primary role of the platform: a) Perspective of the platform owner b) Perspective of the service provider c) Perspective of the user	a) Ideological/a source of income b) Exchanging for saving c) Exchanging for saving	a) A source of income b) Easy access to users – customers and cheap labour force c) A work marketplace for the giggers, ordering service for the customers	a) A source of income b) Access to cheaper professional services or customers c) A work marketplace
Sides of the platform	Platform owners (entrepreneurs) Users exchanging their services or goods	Platform owners (entrepreneurs) Companies providing services (entrepreneurs) The giggers – actual service providers (users) Customers (users)	Platform owners (entrepreneurs) Professional service providers (freelancers or entrepreneurs) Customers (Individuals or entrepreneurs)
Relationships among the sides	Advantage of platform owners The balanced relationships among users, based on exchange and equality Community-based Non-hierarchical	A definite advantage of platform owners The imbalanced relationship between companies and giggers, with the former being superior; high dependency of the giggers on their contractors Hierarchical	A definite advantage of platform owners The semi-balanced relationship between service providers and customers; independence of service providers Rather hierarchical
Geographical reach	Rather local	Local	Global
Potential connection to entrepreneurship domains	Social, ecological, green – all ventures that incorporate a non-profit motive or are not focused on shareholder value	For-profit ventures that, in some manner, connect the provider and the receiver in the service industry	Last mile delivery, for-profit ventures, all entrepreneurial opportunities that include consumer goods
Connection based on core entrepreneurship definitions	Bruyat & Julien (2001) Zahra *et al*. (2009)	Schumpeter (1934) Gartner (1988)	Kirzner (1979) Shane & Venkataraman (2000)

Source: own study.

our sample explore this phenomenon but use the terminology of the sharing economy and still claim that they develop the sharing economy stream of research (often because the analysed companies define themselves as part of it). One particularly illustrative business example is Uber, which, in the literature, is classified as both a gig economy and a sharing economy (Berger *et al.*, 2019; Burtch *et al.*, 2016; Geissinger *et al.*, 2020; Garud *et al.*, 2022).

When considering the different types of platform economies described in Table 1 (based on the various criteria found in our SLR), some of the representatives claimed values found in our sample include sharing 'for a better world.' A company such as Uber, with its focus and market presence, aligns much more with the gig economy. However, several empirical articles devoted to analysing Uber portray it as part of the sharing economy, which may be due to a broad and vague interpretation of what the sharing economy implies and potentially a positive outlook on the development of Uber as an entrepreneurial opportunity that sought to create positive change for drivers. However, we know now that the romanticised perspective of this creative destruction of the taxi industry was far from the truth and instead was built on venture capital injections to dope the market (The Guardian, 2022). Therefore, our argument is that we are seeing the initially broad and all-encompassing sharing economy as becoming more nuanced through digital technology transformation, becoming what we now refer to as the gig economy.

Given our argument, we may then ask, 'Are the digital sharing economy and the gig economy two sides of the same coin?' In this article, we claim that they are not and that we need more conceptual clarity to differentiate these two distinct phenomena. However, at the same time, we witness a disconnect between the reality and the idea of the original vision of the sharing economy (*e.g.,* Botsman, 2013; Hamari *et al.*, 2016; Schor, 2017). We may even argue that some forms of entrepreneurship mutated the ideal of the sharing economy, which led to the rise of the gig economy. In a sense, we may view the sharing economy as an ideal to pursue and the gig economy as our economic reality based on neoliberal market pressures (Cockayne, 2016; Woodcock, 2020). Nevertheless, the thesis that the gig economy is the consequence of the digital transformation of the sharing economy through entrepreneurship requires further research inquiry.

CONCLUSIONS

Following Barnes and Mattsson (2016), the rise of disruptive platform businesses should make us more sensitive to what is happening at the crossroads of technology, entrepreneurship, and formal institutions and their regulations. Although the ideas of sharing and arranging temporary jobs are nothing new in the economy, the rapid development of digital platforms and the widespread start-up culture enable the global reach and unprecedented scope of these platform economies, which scholars should scrutinise. From a research perspective, platform entrepreneurship is still a relatively fresh topic, with numerous concepts that overlap and take on hybrid meanings. Two phenomena that seem to be durable and change the rules of the game of entrepreneurship are the gig economy and the sharing economy. They both fall into conflicting definitions and scope but, at the same time, gain increasing public attention, given several idealised views on how they may create social and sustainable value. Such attention has taken on various shades, and the discussion is highly polarised as a result of broad interpretations of what each platform economy might imply. Scholars either praise the sharing and gig economies as a new type of economy helping to overcome many pressing defaults that have emerged in society or criticise it for worsening societal inequalities through market liberalism and deregulations (*e.g.,* Acquier *et al.*, 2017; Bick, 2019; Burtch *et al*., 2016; De Stefano, 2016; Grinevich *et al.*, 2019). However, researchers began to investigate both the gig and the sharing economies to determine what they have to offer to contemporary society and the economy, with growing pressure from grand societal challenges such as fending off economic crises and climate crises based on excessive consumption patterns. Thus, the question arises, 'Are they just new ways to operate within the capitalistic society, and do they enable the growth of consumerism, or are they changing the entrepreneurial landscape?'.

The conducted SLR does not answer this overriding question, but it takes a step back and attempts to set out definitions for and increase our understanding of what is behind these concepts.

We argue that the lack of consistent definitions of all three phenomena has resulted in numerous misconceptions and perhaps reduced potential progress with further studies, which now require more structuring and organisation of knowledge about these platform economy logics. Therefore, in this article, we developed criteria for enhancing conceptual clarity on the sharing, gig, and on-demand economies, which are the result of the growing platform economy. We also sought to link these three concepts to entrepreneurship, aiming to identify some intersections and determine how they could be related to sub-disciplines in entrepreneurship. We believe that bringing entrepreneurship into the discussion of the platform economies helps to differentiate these concepts. Drawing from different definitions of entrepreneurship sets some boundaries for both gig and sharing economies, and links the discussion with their natural component (entrepreneurship) as all the ventures studied are, in some ways, based on recognised entrepreneurial opportunities.

This study has implications for society and policymakers in several key areas. Firstly, it brings attention to many intertwined aspects found in the platform economy, including its regulatory framework, social and economic equity, labour protection, and environmental impact. Moreover, the article draws attention to the proper use of the terms 'sharing economy,' 'gig economy,' and 'on-demand economy.' Secondly, our study broadens the view of the link between entrepreneurship and the gig, sharing, and on-demand economies, indicating both positive and negative perspectives. Hence, it provides opportunities to reflect on a deeper understanding of the intersection between entrepreneurship, with its operation logic, and the different types of platform economies.

Future research could examine the differences and overlaps among the gig, sharing, and on-demand economies, nuanced in this study, and explore whether, in time, these models remain distinct or whether they are converging in practice. Noteworthy questions include the following:

- How do entrepreneurial processes and outcomes differ across the gig, sharing, and on-demand economies?
- How do these platform economies disrupt or complement traditional business models?
- How is entrepreneurship reshaping industries in the platform economy?

Future studies could also delve further into the social and ethical implications of entrepreneurship in the platform economy. On a more general level, we see great potential for a deeper inquiry into how platform entrepreneurship evolves and intersects with various economic, technological, social, and regulatory factors, given the growth of and interest in digital entrepreneurship (*e.g.,* Elia *et al.*, 2020; Kraus *et al.*, 2022b; Nambisan & Baron, 2021).

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Use of Artificial Intelligence

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Exploring entrepreneurial phases with machine learning models: Evidence from Hungary

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ABSTRACT

Objective: The article aims to explore the potential differences between the two phases of entrepreneurship, i.e., total early-stage entrepreneurial activity and established business, as defined by the Global Entrepreneurship Monitor (GEM). The study aimed to classify entrepreneurs using various machine learning models and to evaluate their classification performance comparatively.

Research Design & Methods: Using the Hungarian GEM datasets from 2021 to 2023, we analysed a subsample of 964 entrepreneurs. Due to inconsistent results from traditional analyses (e.g., correlations, regressions, principal component analyses), we employed machine learning approaches (supervised learning classification methods) to uncover latent relationships between variables.

Findings: The study utilized seven machine learning classification methods to examine the feasibility of grouping companies within the sample using Hungarian GEM data. Findings indicate that machine learning techniques are particularly effective for classifying businesses, although the performance of each method varies significantly.

Implications & Recommendations: These results provide valuable insights for researchers in selecting methodologies to identify various business phases. Moreover, they offer practical benefits for market research professionals, suggesting that machine learning techniques can enhance the classification and understanding of entrepreneurial phases.

Contribution & Value Added: The study adds to the existing body of knowledge by demonstrating the effectiveness of machine learning methods in classifying business phases. It highlights the variability in performance across different machine learning techniques, thereby guiding future research and practical applications in market research and entrepreneurship studies.

Article type:	research article
Keywords:	entrepreneurship; responsibility; Global Entrepreneurship Monitor; GEM; machine learning
JEL codes:	L26, C38

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INTRODUCTION

Entrepreneurship is a fundamental driver of economic growth, but its role varies across countries at different stages of economic development (Stel *et al*., 2005). Although just a small but significant share of new business ventures as innovators, who contribute to the diffusion of new products, services, and even processes into the economy. Moreover, since the sheer number of new ventures is large, entrepreneurship fosters both innovation and competition in economies, contributing it its continuous restructuration (Sternberg & Wennekers, 2005). Furthermore, the role of enterprises is also crucial in achieving sustainability. Agenda 2030, the framework for sustainable development of the United Nations, explicitly calls for all businesses to apply their creativity and innovation to solving sustainable development challenges (United Nations, 2015).

We aimed to elucidate the differences between early-stage and established enterprises by examining a comprehensive set of attributes (*e.g.*, demography, entrepreneurial motivations, market scope, attitudes towards responsibility, *etc*.) using the Global Entrepreneurship Monitor data for Hungary. Entrepreneurship demographics is a well-studied research area (see Wach & Głodowska, 2021). However, quantitative methods often fall short when investigating determinants of particular activities (for example in the case of responsible behaviour (Krankovits *et al*., 2023) or even differences between phases of entrepreneurship. Thus, we employed machine learning techniques to determine whether these variables can accurately determine the phase of entrepreneurship. This research is motivated by the increasing trend of utilizing machine learning in social science research, which offers a robust alternative to traditional analytical methods that often fall short of uncovering complex patterns (Celbiş, 2021; Chung, 2023; Razaghzadeh Bidgoli *et al*., 2024). Furthermore, by focusing on entrepreneurs in Hungary, we sought to provide localized insights that can contribute to both regional policymaking and the broader theoretical understanding of entrepreneurial dynamics. Our findings aim to bridge the gap in the existing literature by demonstrating the efficacy of machine learning in identifying nuanced differences in entrepreneurial phases, thereby offering a novel methodological approach that one can replicate in other contexts. Therefore, we posed two research questions:

RQ1: Is it feasible to determine the phase of entrepreneurship with sufficient accuracy using a variable set available in the Global Entrepreneurship Monitor?

RQ2: Are machine learning techniques adequate methods to classify entrepreneurs based on their attributes?

The article is structured as follows. The next chapter will summarize both (1) the conceptual framework applied and the variables analysed on the base of this, and (2) the background of the machine learning approach applied. Then, we will describe the dataset and the methodologies used. The article will conclude with the results, discussion, research limitations, and suggestions for further empirical research.

LITERATURE REVIEW AND HYPOTHESES DEVELOPMENT

Conceptual Framework and Explanation of Variables Used

The article uses the Hungarian data of the Global Entrepreneurship Monitor (GEM) and thus, the revised GEM conceptual framework (Kelley *et al*., 2016). The GEM is the world's foremost study of entrepreneurship, collecting data directly from entrepreneurs (GEM, 2024). GEM is a consortium of national teams to collect and analyse data on entrepreneurship and entrepreneurship ecosystems, representing countries with almost half of the global population and two-thirds of GDP in 2021, 2022, and 2023 (GEM, 2022, 2023, 2024). Sternberg and Wennekers (2005) summarise the main objectives of GEM in four points: (1) to empirically examine variations in entrepreneurial activity between countries over time, (2) to identify reasons behind differing levels of entrepreneurship, (3) to explore policies that may boost entrepreneurial activity, and (4) to understand the link between entrepreneurship and economic growth.

The GEM methodology distinguishes four phases of entrepreneurship considering the three typical entrepreneurial barriers (Reynolds *et al*., 2005). The first one is when the startup of a business including any self-employment or selling any goods or services is expected in the next three years. Nascent entrepreneurs have an existing enterprise which did not pay wages or salaries for three months, while baby businesses paid wages or salaries between three and 42 months. These latter two together are called total early-stage entrepreneurial activity (TEA). The fourth phase is the established business (EB), for which salaries or wages have been paid for more than 42 months (GEM, 2023).

According to the revised GEM conceptual framework (Kelley *et al*., 2016), both (1) social values about entrepreneurship and (2) individual attributes, including demographic characteristics (*e.g.*, gender, age), self-perceptions and motivations moderate the relationship between entrepreneurial activity and social, cultural, political, economic context. A variable set was chosen for the analysis to reflect this conceptual framework. However, the final model comprises only variables with significant determining power.

The literature on the demographic attributes of entrepreneurship is rather rich. Age is a principal determining factor of entrepreneurial activity. Younger age cohorts tend to be entrepreneurially more active (see for example Csákné Filep *et al*. (2023) or Lafuente and Vaillant (2013) which has a striking consequence on the ageing societies (Lévesque & Minniti, 2011). However, Kautonen *et al*. (2014) highlight that the entrepreneurial activity of owner-managers shows an inverted U-shaped curve with a threshold age of 40 years, while in the case of self-employers, it increases almost linearly with age. Similarly, educational attainment generally correlates with entrepreneurial activity (Csákné Filep *et al*., 2023), and the performance of SMEs (Filser & Eggers, 2014), while the entrepreneur's managerial knowledge, expertise and skills positively affect the firm's early internationalisation (Wach & Głodowska, 2021). Formal education has a positive causal effect on any type of self-employment for women, while it contributes to the shift from shrinking industry self-employment to high-growth one in the case of men (Ahn & Winters, 2023). However, Kurczewska *et al*. (2020) found that both education and professional experience are necessary for entrepreneurial success. Furthermore, the authors' model implies that the gender of the entrepreneur also contributes to the success, as businesses run by men are more likely to survive.

The GEM methodology investigates the role of four entrepreneurial motives: (1) to make a difference in the world, (2) to build great wealth or a very high income, (3) to continue a family tradition, and (4) to earn a living because jobs are scarce. Weber (1982) mentions the motive of building great wealth or a very high income as an entrepreneurial goal. He considers it the foundation of capitalism. However, empirical research does not support the notion that wealth accumulation is the sole or primary motivation for starting a business (*e.g.*, Amit *et al*., 2001). Continuing family tradition can also motivate entrepreneurial activity, whether it involves establishing a new enterprise or taking over and continuing an existing family business. However, Gorgievski *et al*. (2011) suggest that measuring an entrepreneur's performance requires more than just considering business criteria (*e.g.*, growth, profit, etc.). Factors that may have a trade-off relationship, such as achieving social impact or work-life balance, also require examination. The examination of entrepreneurial motivations widely acknowledges the dichotomy between necessity-driven and opportunity-driven entrepreneurship – this is explored by the fourth entrepreneurial motivation of the GEM, which investigates livelihood motives. Noteworthy, while opportunity-driven entrepreneurship is characteristic of developed countries, necessity-driven entrepreneurship is more typical of developing nations (Acs, 2006; Szerb, 2004).

Filser and Eggers (2014) suggest that while the manager's risk-taking and innovativeness affect the performance of Rhine Valley (Austria, Liechtenstein, Switzerland) SMEs, their proactiveness does not. Furthermore, Ključnikov *et al*. (2019) found that the risk-taking and competitive aggressiveness of Czech and Turkish SME managers differ by gender, while their innovativeness, proactiveness, and autonomy are similar.

According to the GEM methodology, market scope captures the regionally farthest group of consumers. As Wach and Głodowska (2021) found, both age and education increase the pace of internationalisation in the case of Polish entrepreneurs.

Thus, the first hypothesis of the study is as follows:

H1: Early-stage entrepreneurs and established businesses are different in their characteristics.

Machine Learning, as a Vehicle for Gaining a Deeper Understanding

If scholars cannot identify deeper correlations in statistical analyses, the question may arise whether deep learning or machine learning can help us. Both data mining methods are very popular, but there are significant differences in the focus of the method. While deep learning is an unsupervised method, *i.e.*, the data does not need to be labelled, machine learning classification methods are supervised learning, *i.e.*, there must be a test set and labels.

Deep learning presents significant advantages over traditional statistical analysis methods, enabling the analysis of complex data that may be challenging to analyse using conventional statistical approaches (Park & Hong, 2022). One of the key strengths of deep learning is its capability to handle

vast amounts of unlabelled and un-categorized data, making it particularly valuable in big data analytics scenarios (Najafabadi *et al*., 2015).

While statistical models like regression offer interpretability advantages over deep learning, the latter's ability to learn from data without the need for extensive hand-crafted feature engineering sets it apart (Staartjes *et al*., 2018). Moreover, deep learning models have been successful in tasks like medical image segmentation, object detection, and pollution forecasting, showcasing their versatility and effectiveness across diverse domains (Chen, 2023; Nath *et al*., 2021; Soria *et al*., 2020).

Data classification is a fundamental aspect of managing data in an entrepreneur's database. It involves organizing and categorizing information to facilitate decision-making processes and improve business operations. Through data classification, entrepreneurs can gain valuable insights into customer preferences, market trends, and operational efficiencies (Bhukya & Ramachandram, 2010). This structured approach enables entrepreneurs to identify patterns, trends, and relationships within their database, leading to informed strategic decisions and targeted marketing efforts (Wood & Salzberg, 2014).

Furthermore, data classification allows entrepreneurs to effectively segment their customer base, enabling personalized marketing campaigns and tailored product offerings (Stewart *et al*., 2019). By categorizing data into different classes based on common properties, entrepreneurs can better understand customer behaviour and preferences, ultimately enhancing customer satisfaction and retention (Bhukya & Ramachandram, 2010). Moreover, data classification supports risk assessment and fraud detection, helping entrepreneurs identify potential threats and take proactive measures to mitigate risks (Rezende *et al*., 2022).

In the context of relational databases, relational classification techniques offer advantages over propositional data mining approaches by directly classifying data involving multiple relations. This approach provides a more comprehensive understanding of interconnected data points, enhancing the entrepreneur's ability to extract meaningful insights from complex relational data structures and contributing to more accurate decision-making processes and business strategies (Vaghela *et al*., 2012).

In conclusion, data classification is indispensable for entrepreneurs to organize information, identify patterns, segment customers, assess risks, and make informed decisions. By leveraging data classification techniques, entrepreneurs can fully utilize their databases, leading to improved operational efficiency, targeted marketing strategies, and enhanced business performance.

Investigating the performance of machine learning techniques on entrepreneurship data, we formed a second hypothesis:

H2: Machine learning algorithms have reliable (above 90%) accuracy in distinguishing stages of entrepreneurial activity.

RESEARCH METHODOLOGY

We based the analysis on the GEM Adult Population Survey (APS) 2021, 2022 and 2023. Each APS dataset is representative of the 18-64-year-old adult population (n=2000), but we considered only the subsample of entrepreneurs in the analyses. The APS data collection was coordinated, supervised, and checked by the Global GEM team ensuring the consistency of responses in each GEM country. Thus, the resulting data were repeatedly checked before publication, so all variables and measures reflect the common GEM methodology (for example (GEM (Global Entrepreneurship Monitor), 2023; Reynolds *et al*., 2005)).

Hungarian GEM data are available only for 2021, 2022 and 2023 since the former national team terminated its membership in the international consortium in 2016. To have a larger sample of entrepreneurs, we merged these three years of data into one dataset database, assuming that the attitudes and behaviours of entrepreneurs do not change significantly over one year and there were no such new policies or other external circumstances which could significantly alter them. Thus, the sample comprised 964 entrepreneurs' answers (Table 1).

As the APS questionnaire has two similar question blocks with seven questions, each concerning responsibility in the case of nascent entrepreneurs and owner-managers, we merged answers to each pair of questions (see Table 2 and Table 3).

We elaborated relevant SDGs based on theUnited Nations (2015), where people, planet and profit were considered as social, environmental and economic pillars of sustainable development, respectively.

Table 1. Number of entrepreneurs in the sample

Year	Total early-stage entrepreneurial activity (TEA)	Established business owner (EB)	Total
2021	174	162	**336**
2022	186	138	**324**
2023	168	136	**304**
Total	**528**	**436**	**964**

Source: own study, based on GEM definitions.

Table 2. Variable descriptions

Variable label	Variable name	SDG goal*	Description
Social implications	SDG_soc	1-5	The entrepreneur considers social implications when making decisions about the future of their business
Environmental implications	SDG_env	6, 12-15	The entrepreneur considers environmental implications when making decisions about the future of their business
Steps to minimise environmental impact	SDG_steps1	6, 12-15	The entrepreneur has taken any steps to minimise the environmental impact of their business over the past year
Steps to maximise social impact	SDG_steps2	1-5	The entrepreneur has taken any steps to maximise the social impact of their business over the past year

Source: own study, based on GEM definitions.

Table 3. Other attributes involved in the classification model

Variable context label	Variable name	Measurement	Description / GEM question
Demographics	gender	nominal	What is your gender?
	age	Scale	What is your current age in years?
	HUreduc	ordinal	From Primary school (1) to Phd (10)
Attitudes	creativ	nominal, 3-point Likert	Other people think you are highly innovative.
	vision	Nominal, 5-point Likert	Every decision you make is part of your long-term career plan.
	consMOT2	Nominal, 5-point Likert	To build great wealth or a very high income
Business	consMKSC	Nominal	Market scope
	consCPTECH2	scale	Do you expect your business will use more digital technologies to sell your product or service in the next six months?

Source: own study, based on GEM definitions.

Based on our previous investigation of GEM data (PCA, statistical methods, correlation, data distribution) we could involve the data from Table 2 and Table 3 in the classification models. We then examined in detail the statistical parameters of the data (Table 4), their distribution (Boxplot diagrams and Density diagrams), and the correlation between them, and also ruled out multicollinearity (Variable Inflation Factor) to ensure that the models performed well.

To select suitable data for classification models in Python, researchers can employ various key strategies based on insights from research studies. Feature selection is a crucial step in data preparation for classification models, involving the removal of irrelevant or redundant features to enhance classification accuracy (Lee *et al*., 2015). Feature selection methods encompass filter, wrapper, and embedded techniques, which are fundamental in data mining and pattern recognition tasks (Chen *et al*., 2020). These methods aid in selecting the most pertinent features from the dataset, thereby boosting the performance of classification models (Peng & Liu, 2018).

Furthermore, the selection of characteristic variables is vital for developing effective classification models (Jin *et al*., 2021). By selecting the appropriate set of features, the model's accuracy can improve

significantly. Moreover, utilizing ensemble methods for feature selection can further enhance classification accuracy (Singh & Singh, 2021). Hybrid approaches that integrate different feature selection techniques can be particularly effective in improving data quality for classification tasks (Chanu *et al*., 2022).

Moreover, dimensionality reduction techniques like principal component analysis (PCA) can serve to clean noisy data and enhance the performance of artificial neural networks in classification tasks (Adolfo *et al*., 2021). Clustering techniques can also serve to improve classification accuracy by organising data into more manageable groups (Mathivanan *et al*., 2018). Furthermore, scholars have developed mutual information-based feature selection methods to identify relevant features for data classification (Bhuyan & Kamila, 2015).

For the classification model, we split the data into data and test sets in 2/3 and 1/3 proportions. In research, it is essential that the sampling is replicable, so we started the random sampling from random=12345 seed.

Several supervised classification methods (Figure 1) have been tested and are described in more detail (accuracy, confusion matrix, parameters in fitting methods, feature weights in prediction models) in the results section. Noteworthy, among the methods tested, those with the possibility to explore the built-in decision model are discussed in more explicit detail in the results section. As variables involved in the modelling require further analysis, we conduct (1) logistic regression, (2) support vector machine, (3) decision tree classifier and (4) gradient boosting classifier methods.

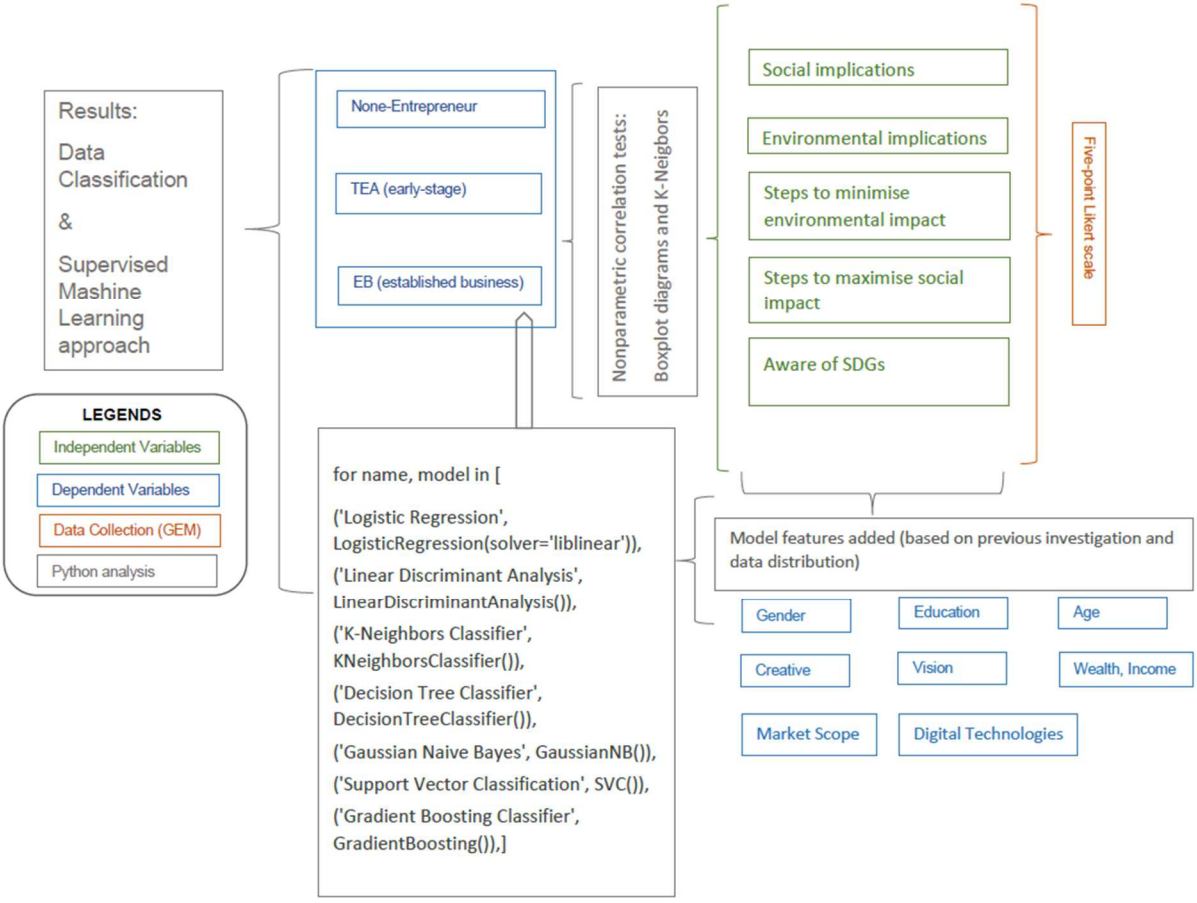

Figure 1. Research methodology with ML approach
Source: own elaboration.

RESULTS AND DISCUSSION

The gender, age, and educational attainment variables and SDG indicators had already been investigated in the GEM database (Krankovits *et al*., 2023). The vast majority (74.9%) of entrepreneurs are not aware of SDGs, but among them, it is rather likely (72.4%) that the entrepreneur identified any of the goals which are a priority for their business and defined a set of clear objectives, actions, and key performance indicators.

Table 4. Other attributes involved in the classification model

Statistics	gender	age	creativ	vision	HUreduc	consMOT2	consMKSC	consCPTECH2	SDG_soc	SDG_env	SDG_steps1	SDG_steps2	CONS_BUSO
mean	1.3724	42.5975	3.0311	3.8869	5.6919	3.1027	3.0685	1.7189	3.7272	4.1525	1.3641	1.6276	1.4523
std	0.4837	11.7023	1.8688	1.3344	2.3618	1.4742	1.1436	0.6902	1.3760	1.2324	0.4814	0.4837	0.4980
min	1.0000	18.0000	-2.0000	-2.0000	1.0000	1.0000	1.0000	-2.0000	1.0000	1.0000	1.0000	1.0000	1.0000
0.25	1.0000	33.0000	2.0000	3.0000	4.0000	2.0000	2.0000	1.0000	3.0000	4.0000	1.0000	1.0000	1.0000
0.50	1.0000	43.0000	3.0000	4.0000	5.0000	3.0000	4.0000	2.0000	4.0000	5.0000	1.0000	2.0000	1.0000
0.75	2.0000	52.0000	5.0000	5.0000	8.0000	5.0000	4.0000	2.0000	5.0000	5.0000	2.0000	2.0000	2.0000
max	2.0000	64.0000	5.0000	5.0000	10.0000	5.0000	4.0000	3.0000	5.0000	5.0000	2.0000	2.0000	2.0000
median	1.0000	43.0000	3.0000	4.0000	5.0000	3.0000	4.0000	2.0000	4.0000	5.0000	1.0000	2.0000	1.0000
iqr	1.0000	19.0000	3.0000	2.0000	4.0000	3.0000	2.0000	1.0000	2.0000	1.0000	1.0000	1.0000	1.0000
skew	0.5287	-0.0201	-0.9321	-1.2061	0.2430	-0.0470	-0.6602	-1.6157	-0.8385	-1.4330	0.5657	-0.5287	0.1920
kurtosis	-1.7241	-1.0407	-0.0604	0.8711	-1.4032	-1.4054	-1.1765	5.8343	-0.5512	0.9247	-1.6835	-1.7241	-1.9672

Source: own study.

Table 5. Correlation matrix between attributes

Variables	gender	age	creativ	vision	HUreduc	consMOT2	consMKSC	consCPTECH2	SDG_soc	SDG_env	SDG_steps1	SDG_steps2	CONS_BUSO
gender	1.0000	0.0159	-0.0220	-0.0457	0.0824	-0.0348	0.0158	0.0278	-0.0188	-0.0327	-0.0255	0.0075	-0.0533
age	0.0159	1.0000	-0.0476	-0.1801	0.0313	-0.1690	-0.3933	0.0855	-0.0372	-0.0216	-0.0600	0.0584	0.4149
creativ	-0.0220	-0.0476	1.0000	0.1651	0.0321	0.0934	0.0131	-0.0480	0.0102	0.0214	-0.1176	-0.1101	-0.0230
vision	-0.0457	-0.1801	0.1651	1.0000	-0.1000	0.1046	0.0779	0.0060	0.1189	0.0762	-0.0635	-0.1200	-0.1074
HUreduc	0.0824	0.0313	0.0321	-0.1000	1.0000	-0.0300	0.0097	-0.0857	-0.0131	-0.0630	-0.0483	-0.0315	0.0374
consMOT2	-0.0348	-0.1690	0.0934	0.1046	-0.0300	1.0000	0.1239	-0.0788	0.1746	0.1194	-0.0308	-0.0949	-0.1185
consMKSC	0.0158	-0.3933	0.0131	0.0779	0.0097	0.1239	1.0000	-0.0821	0.1392	0.0884	0.0924	-0.0440	-0.8968
consCPTECH2	0.0278	0.0855	-0.0480	0.0060	-0.0857	-0.0788	-0.0821	1.0000	-0.1563	-0.0301	-0.0135	0.0967	0.0803
SDG_soc	-0.0188	-0.0372	0.0102	0.1189	-0.0131	0.1746	0.1392	-0.1563	1.0000	0.4600	-0.2261	-0.2574	-0.1395
SDG_env	-0.0327	-0.0216	0.0214	0.0762	-0.0630	0.1194	0.0884	-0.0301	0.4600	1.0000	-0.3282	-0.1990	-0.0702
SDG_steps1	-0.0255	-0.0600	-0.1176	-0.0635	-0.0483	-0.0308	0.0924	-0.0135	-0.2261	-0.3282	1.0000	0.3198	-0.1115
SDG_steps2	0.0075	0.0584	-0.1101	-0.1200	-0.0315	-0.0949	-0.0440	0.0967	-0.2574	-0.1990	0.3198	1.0000	0.0318
CONS_BUSO	-0.0533	0.4149	-0.0230	-0.1074	0.0374	-0.1185	-0.8968	0.0803	-0.1395	-0.0702	-0.1115	0.0318	1.0000

Source: own study.

Distributions of TEA and EB were homogenous (Pearson correlation with p>=0.05) in the case of age and education. We may explain these results by the fact that entrepreneurs are generally older and have higher education than the total population, and in addition, they are mostly male (Csákné Filep *et al*., 2023). In our analysis, we fitted the variables to the machine learning model using statistical distributions (Table 4).

After the descriptive statistics (Table 4) and correlation matrix (Table 5), we plot the distribution for each variable on density diagrams and boxplot diagrams (Figure 2) for the target variable (TEA or EB).

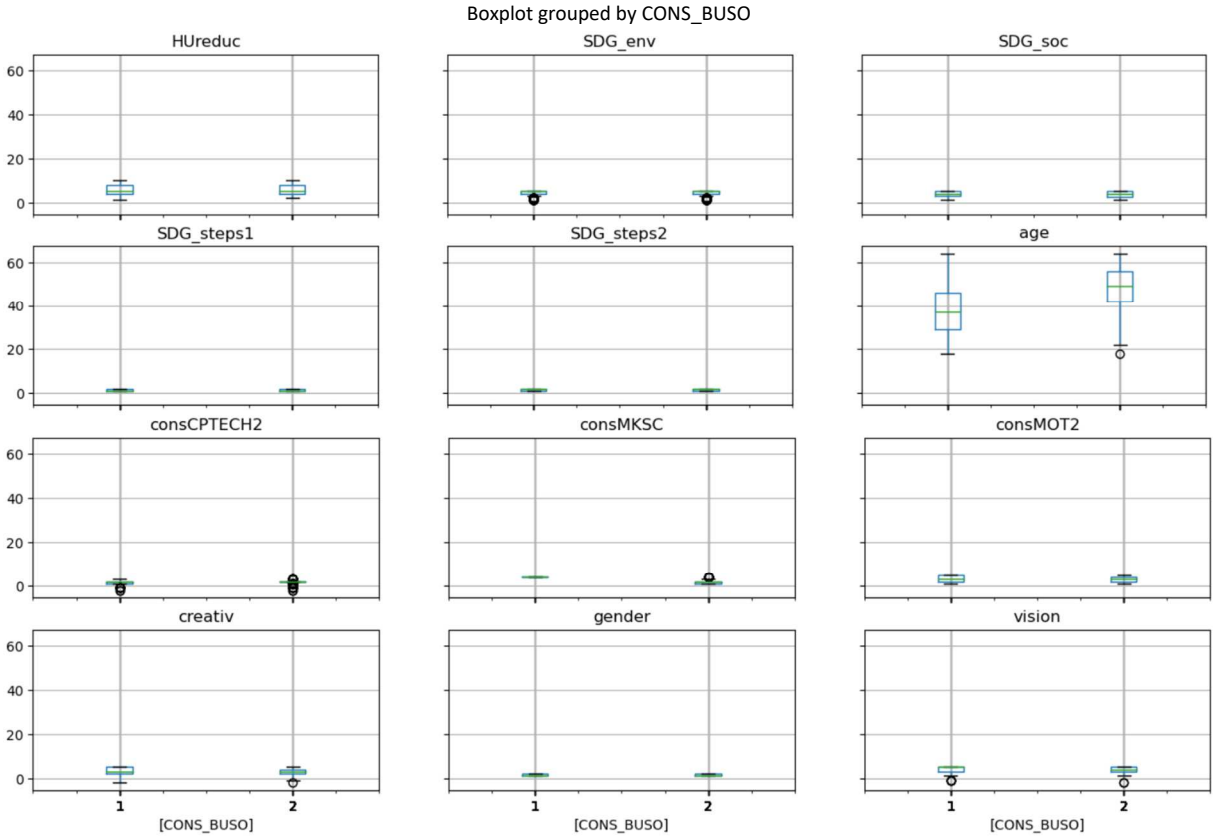

Figure 2. Boxplot diagrams for predictor variables
Source: own elaboration.

A density diagram provides a convenient way to explore the relationships between multiple variables in our dataset, making it easier to identify patterns, correlations, and potential outliers (Figure 3 and Figure 4).

The variance inflation factor (VIF) is a well-established metric for quantifying multicollinearity, a potential issue in regression models and other statistical analyses. Multicollinearity can lead to the distortion of estimated parameters and a reduction in the predictive accuracy of models (Table 6).

The elevated VIF value of consMKSC signifies its capacity to exhibit a robust linear relationship with other predictors, including the target variable itself (CONS_BUSO). Nevertheless, this observation does not negate its potential as a significant predictor. The presence of a substantial relationship between a target variable and a predictor is an anticipated feature of a robust model.

These results are only a suggestion for determining which variables are likely to play an important predictive role in the following models. The main diagonal clearly shows the distributions that can be used for classification (*i.e.*, age, gender, education), but the role of a variable may be important even if its distribution alone does not show encouraging signs. In the total sample, the average age of TEA entrepreneurs was 38.19 years and that of EB entrepreneurs was 47.98 years. Among TEA entrepreneurs, there were just under 4% more males (33.16%) than EB entrepreneurs (29.75%).

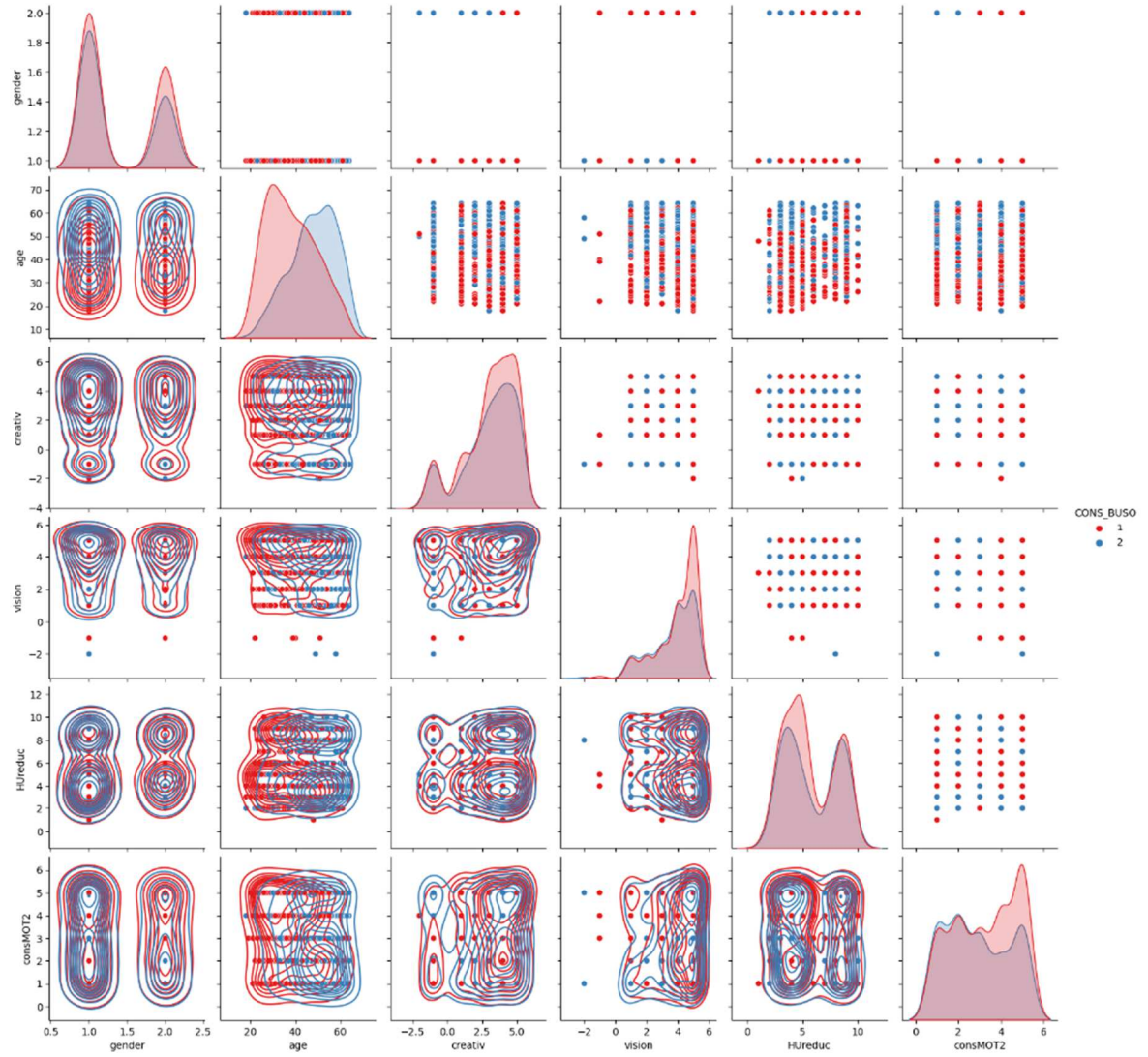

Figure 3. Density diagrams for predictor variables (1)
Source: own elaboration.

Table 6. Multicollinearity (VIF) of the parameters

Variable	VIF
gender	1.0249
age	1.2703
creativ	1.0588
vision	1.1002
HUreduc	1.0485
consMOT2	1.0787
consMKSC	4.2506
consCPTECH2	1.0562
SDG_soc	1.3971
SDG_env	1.3817
SDG_steps1	1.2708
SDG_steps2	1.1881
CONS_BUSO	5.4039

Source: own study.

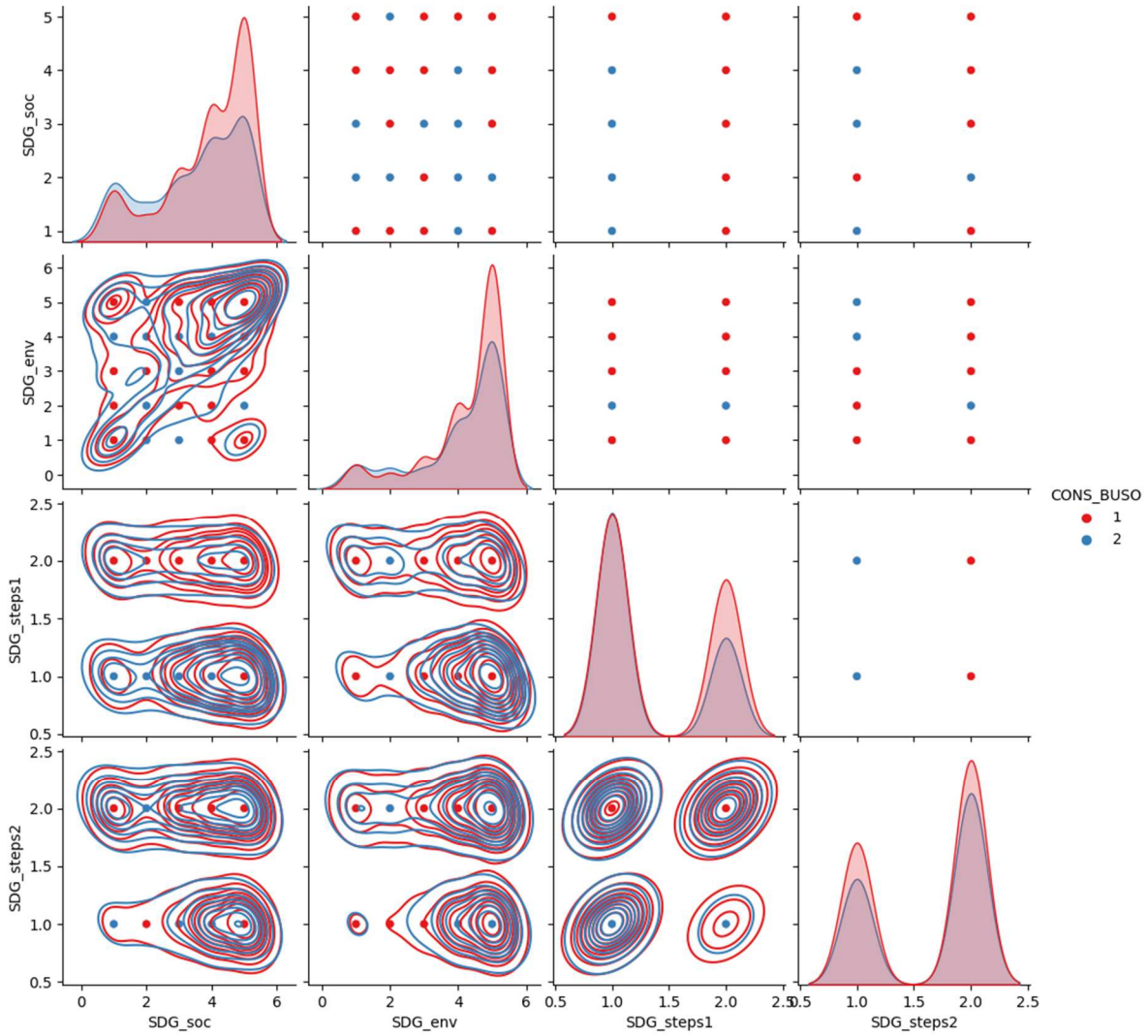

Figure 4. Density diagrams for predictor variables (2)
Source: own elaboration.

Results of Classification Algorithms

Below, we will briefly present the applicability of the applied algorithms in the enterprise data environment, as well as the implementation of the algorithms on GEM data and the results obtained.

As discussed in the method section, we tested a total of seven basic classification methods on the GEM data:

- Nearest neighbour (KNN);
- Linear discriminant analysis (LDA);
- Gaussian naive bayes (GNB);
- Logistic regression (LG);
- Support vector machine (SVM);
- Decision tree classifier (DTC);
- Gradient boosting classifier (GBC).

These supervised learning methods fit well with our selection database, as we had a training set with predefined and controlled outputs for TEA and EB enterprises.

K-nearest neighbour (KNN) classification is a widely used method in entrepreneurship databases due to its simplicity and effectiveness in predicting outcomes based on similar cases. Studies have ap-

plied KNN in various contexts within entrepreneurship, such as road risk assessment for accident prediction (Saranyadevi *et al*., 2019), predicting the penetration rate of tunnel boring machines (Xu *et al*., 2019), and analysing startup trends (Savin *et al*., 2023). The parameter settings configure the KNN classifier to make predictions based on the 5 nearest neighbours, with closer neighbours having more influence, using a KD-tree data structure for efficient search, and using the Euclidean distance metric. With default settings, the classification accuracy of the KNN algorithm was 84.13%, which has been improved to 85.71% with the changed parameters.

Linear discriminant analysis (LDA) is commonly used in business databases for classification tasks. It can be combined with feature selection methods like principal component analysis (PCA) and variable selection algorithms such as genetic algorithm (GA) to separate groups or samples within the database (Alves *et al*., 2023).

The LDA statistical model employs Bayes' theorem to achieve linear separation between classes. The efficacy of the model is optimised when utilising data that is free from contamination and exhibits a normal distribution, with equal covariance. While the model demonstrated a commendable performance in the normal setting, with an accuracy of 94.61%, further investigation was deemed unnecessary due to previous statistical analyses that demonstrated the absence of novel insights derived from linear correlations between data in the context of GEM data.

The Gauss-Naive Bayes (GNB) model is a probabilistic model also based on Bayes' theorem, assuming a normal distribution of characteristics. The characteristics are assumed to be independent of each other, a simplistic assumption that renders the model well-suited to simpler problems where the characteristics are nearly independent. The GNB model also performs well (98.86%), with only a fine-tuning parameter that can be used for variance smoothing. The Gaussian Naive Bayes (GNB) model does not utilise explicit weights, in contrast to linear models (*e.g.*, logistic regression), as GNB calculates probabilities based on the independence of the characteristics (naive assumption). Consequently, the GNB model does not provide direct variable weights. We did not investigate the first three methods in greater depth due to the article's length.

Table 7 shows the hyperparameter tuning for the models.

Table 7. Summarized accuracy and hyperparameters by classification models

Classification model	Default settings accuracy	Hyperparameter	Parameterized accuracy
Logistic Regression (LG)	97.62%	penalty='l2', C=10, solver='liblinear', max_iter=100, random_state=42	98.13%
Linear Discriminant Analysis (LDA)	94.61%		
K-Neighbors Classifier (KNN)	84.13%	n_neighbors=5, weights='distance', algorithm='kd_tree', leaf_size=30, p=2, metric='minkowski'	85.71%
Gaussian Naive Bayes (GNB)	98.86%		
Support Vector Classification (SVC)	91.39%	kernel='linear', C=10, gamma='scale', degree=3	98.44%
Decision Tree Classifier (DTC)	97.61%		
Gradient Boosting Classifier (GBC)	98.76%	n_estimators=100, learning_rate=0.1, max_depth=3, random_state=42	98.44%

Source: own study.

In the following part, we focus on the LG, SVC, DTC and GBC models, with the results presented in detail.

Logistic regression is a commonly used statistical method in entrepreneurship databases for classification purposes. It has been utilized in various studies to analyse factors influencing entrepreneurial activities (Urbano *et al*., 2013), predict business takeover intentions (Joensuu-Salo *et al*., 2021), and assess the likelihood of youth entrepreneurship (Damoah, 2020). Logistic regression has also been applied in healthcare settings to predict physical function upon discharge of older adults (Chu *et al*., 2023). Furthermore, it has been employed in research focusing on social entrepreneurship

Kachlami *et al*. (2017) and entrepreneurial attitudes Puga and García (2012). The method's efficiency in handling binary classification tasks makes it a valuable tool for understanding and predicting entrepreneurial behaviours and outcomes. The flexibility and interpretability of logistic regression make it a popular choice for analysing complex relationships within entrepreneurship databases.

With default settings, the classification accuracy of the logistic regression algorithm was 97.62%, which improved to 98.13% with the changed parameters. We used the logistic regression with parameter C=10 and a liblinear solver. Setting `C=10` instead of `C=1.0` (default settings) means reducing the regularization strength, which may lead to a more flexible model that fits the training data more closely. However, it also increases the risk of overfitting, especially if the model becomes too complex for the given dataset.

The LG algorithm is one of the few methods thanks to which we can look behind the model and determine the weight of the variables involved in the model.

Some key variables received more weight in the model, such as gender (0.6081), vision (0.3433), motivation (0.289), market scope (6.965), digital technology skills (0.3768), and SDG variables(Figure 5). We may explain this latter finding with the fact that it is much easier to find low or no-cost measures (*e.g.*, recycling, using more efficient devices, *etc*.) and even grants to implement investments reducing energy usage when a business fosters environmental friendliness, but it is not the case when attempting to maximise social impact (*e.g.*, employing disadvantaged people or even women with small children). The vast majority (74.9%) of entrepreneurs are not aware of SDGs, but among them, it is rather likely (72.4%) that the entrepreneur identified any of the goals which are a priority for their business and defined a set of clear objectives, actions, and key performance indicators. The model constructed the weights from this correlated SDG construct to maximize explanatory power.

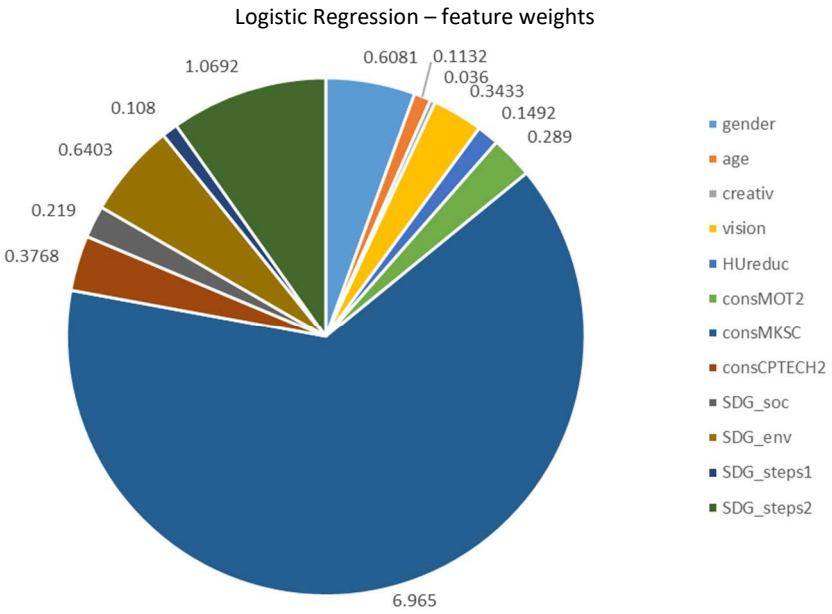

Figure 5. Feature weights in the logistic regression model
Source: own elaboration.

Support vector machine (SVM) classifiers have found significant utility in various business applications, particularly in database management. SVM, known for its ability to effectively categorize and analyse data, has been employed in diverse fields such as healthcare, finance, and e-commerce (Jameel, 2023). For instance, scholars have utilised SVM in the classification of heart rate variability for medical diagnostics (Ashtiyani *et al*., 2018), air quality monitoring systems (Sattar *et al*., 2019), and even in predicting hyperlipidemia (Lakshmi *et al*., 2018). The robustness of SVM lies in its optimization-based approach and its capability to incorporate various kernel methods, making it a versatile tool for businesses to extract valuable insights from their databases (Tuncer *et al*., 2020). One can achieve greater accuracy with the following parameters instead of the default settings.

The Gaussian kernel maps data into an infinite-dimensional space. The 'gamma' parameter affects the shape of the decision boundary. For 'rbf,' gamma determines how much influence a single training example has. Higher gamma values make the decision boundary more flexible and can lead to overfitting.

With default settings, the classification accuracy of the SVC algorithm was 89.13%, which has been improved to 98.44% with the changed parameters.

The SVM did not take gender and education variables into account in the model construction, but market scope and SDG variables were included in the decision, even if to a much lesser extent.

Decision tree classifiers, such as J48, are commonly utilized in entrepreneurship databases for their simplicity, interpretability, and performance in supervised learning (Cañete-Sifuentes *et al*., 2021; Obeidat *et al*., 2019).

These classifiers are valuable for understanding patterns within entrepreneurial datasets and providing clear insights essential for decision-making (Cañete-Sifuentes *et al*., 2021). Decision tree classifiers have demonstrated success in various domains including healthcare for disease classification, financial risk assessment, and consumer behaviour prediction in e-commerce applications (Idris & Ismail, 2021; Sharma & Sharma, 2019). Their adaptability and effectiveness make them a valuable asset in entrepreneurship databases for tasks like customer analysis and predicting loan defaults (Akanmu & Gilal, 2019; Subramanian *et al*., 2021).

The DTC performed well with the default settings (97.61%), but its real value comes from the fact that the decision tree model can be generalized, making the variables visible (Figure 6).

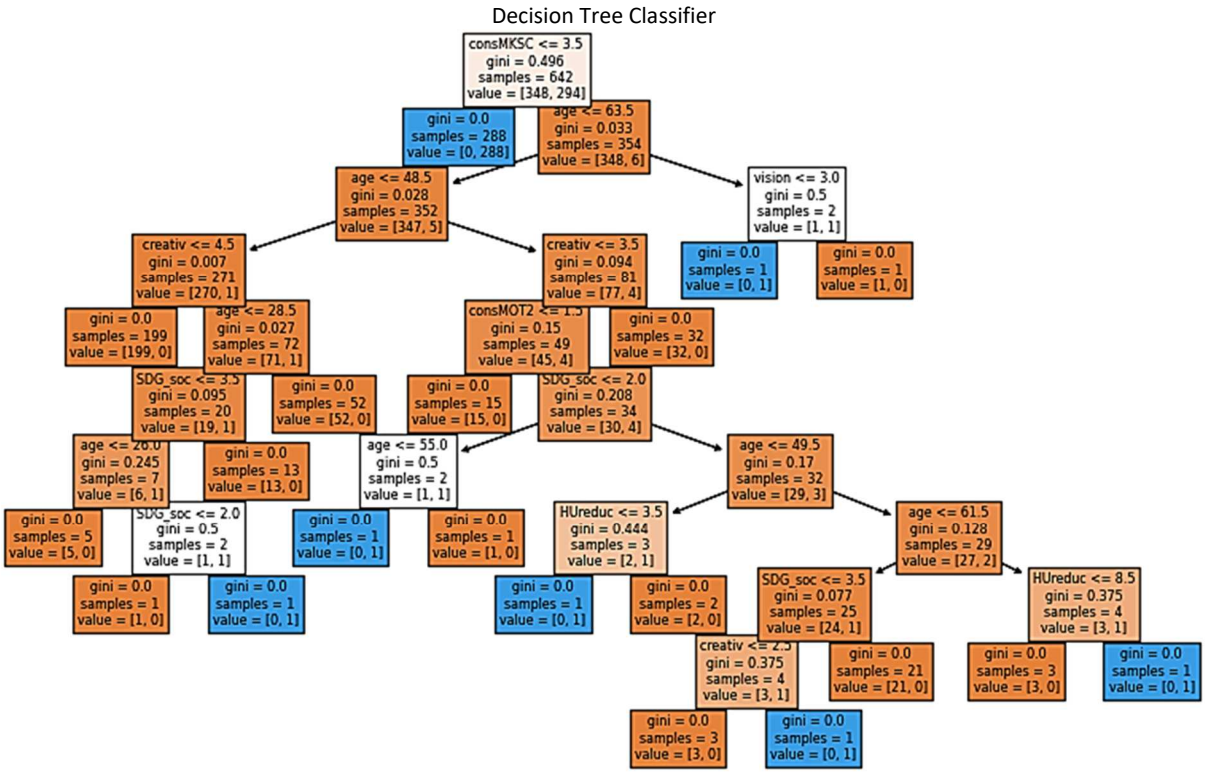

Figure 6. Feature roles in the DTC model
Source: own elaboration.

Gini impurity measures how impure the information in a node is. It helps determine which questions to ask at each node to classify categories effectively. The goal is to minimize Gini Impurity during tree construction.

The complexity of the decision tree is illustrated by the fact that even at the lower levels, the relationship with SGD variables, education and creativity are repeatedly mentioned. The left end of the decision tree is for more creative and younger entrepreneurs, the next branch on the left is for

less creative but more financially stable entrepreneurs. The top right branch is for older entrepreneurs with less SGD awareness but with career plans.

Gradient Boosting Classifier, a member of the Classification and Regression Trees (CART) family, is recognized for its ability to handle complex datasets and enhance prediction accuracy by iteratively reducing errors (Georganos *et al*., 2018). Recent advancements in Gradient Boosting have led to the development of Extreme Gradient Boosting (XGBoost), Light Gradient Boosting Machine (LightGBM), and CatBoost, further improving the algorithm's efficiency and scalability (Mienye & Sun, 2022). Businesses are increasingly utilizing Gradient Boosting for diverse tasks such as urban mapping, soil erosion prediction, and healthcare risk prediction models, highlighting its versatility and effectiveness across various domains (Jozdani *et al*., 2019; Patel *et al*., 2023; Wang *et al*., 2023). The adaptability of gradient boosting to ensemble learning approaches and its robustness in handling imbalanced data make it a valuable asset for businesses seeking precise and reliable insights from their databases (Malek *et al*., 2023; Muhathir *et al*., 2023).

Like DTC, gradient boosting also uses decision trees for classification, but here there are several trees nested under each other. Fortunately, the weights of the variables in the model can be determined and displayed here.

Compared to LG, the weight of the other variables are orders of magnitude smaller (Figure 7), but the age variable is also prominent, as well as the SDG_soc-SDG step 2 pair.

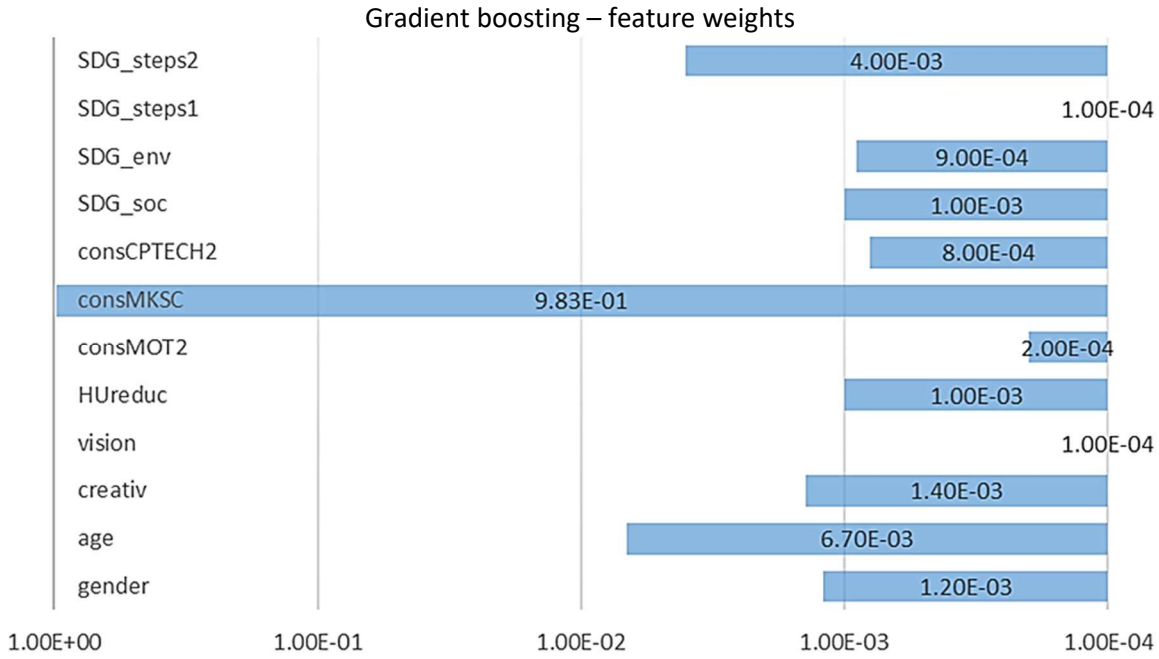

Figure 7. Feature weights in the gradient-boosting model
Source: own elaboration.

It is insufficient to employ merely the accuracy value for model comparison; specific values such as specificity (proportion of actual negatives correctly identified), sensitivity (proportion of actual positives correctly identified), precision (proportion of correct positive predictions), the F1-score (harmonic mean of precision and recall, balancing their trade-off), error rate (proportion of incorrect predictions)and Cohen's kappa (measures inter-annotator agreement, adjusting for chance agreement) must also be taken into consideration (Table 7). Table 9 presents the confusion matrix of the models.

For both hypotheses, it was important to apply new machine learning methods to the GEM database that would allow exploring deeper relationships in the data than with traditional statistical methods. The analysis used supervised learning on a small sample (964 items), which is why the inclusion of additional annual data, and the prior identification of more potential variables would be necessary for a better understanding. With a more thorough methodological analysis, the DTC or Gradient methods

can be further explored and if not the more accurate result (because it is above 98%), the goal may be to understand why these variables are the determinants.

Table 8. Accuracy and metrics for the models

Classification model	Accuracy	Sensitivity	Specificity	Precision	F1-score	Error Rate	Cohen's Kappa
Logistic Regression (LG)	0.9813	1.0000	1.0000	0.9677	0.9836	0.0186	0.9620
Support Vector Classification (SVC)	0.9844	1.0000	1.0000	0.9729	0.9863	0.0155	0.9683
Decision Tree Classifier (DTC)	0.9813	0.9944	0.9944	0.9728	0.9835	0.0186	0.9620
Gradient Boosting Classifier (GBC)	0.9844	1.0000	1.0000	0.9729	0.9863	0.0155	0.9683

Source: own study.

Table 9. Confusion matrix

Models	Actual	Predicted		Recall	Error rate
		C1	C2		
LG	C1	180	0	1.00	0.00
	C2	6	136	0.96	0.04
	Precision	0.96	1	NaN	NaN
SVC	C1	180	0	1.00	0.00
	C2	5	137	0.96	0.03
	Precision	0.97	1	NaN	NaN
DTC	C1	179	1	0.99	0.01
	C2	5	137	0.96	0.03
	Precision	0.97	0.99	NaN	NaN
GBC	C1	180	0	1.00	0.00
	C2	5	137	0.96	0.03
	Precision	0.97	1	NaN	NaN

Source: own study.

We subjected hypothesis H1 to empirical testing using supervised machine learning (ML) classification algorithms. During the model construction process, the algorithms demonstrated an exceptional capacity for identifying variables that can effectively determine the status of enterprises (TEA or EB), exhibiting a remarkable level of accuracy of 98%. As hypothesis H1 was accepted, we can state that the characteristics of early-stage and established enterprises are different. Although variables in the final models may differ in each method, the models provide impressive explanatory power, which means that we may explain the distinction between the two entrepreneurial phases with different variable sets. This finding suggests that entrepreneurs are evolving over time and thus, incentives and policies should also reflect these differences. However, as the weights identified are vehicles of purely mathematic modelling, explaining their exact meaning needs further research.

We could partially confirm hypothesis H2, as we can determine the entrepreneurial phase with above 90% accuracy with only six out of the seven methods tested. However, the KNN method also provides fairly good accuracy as its parameterized accuracy also lies at 85.71%. Conventional methods failed to determine the characteristics of entrepreneurs, so this finding has implications primarily for researchers. First, the results of machine learning techniques are encouraging even in the case of rather small datasets (n=964) in classifying entrepreneurs based on their attributes. Second, one can replicate modelling using the data of another country or even countries.

CONCLUSIONS

In Central and Eastern European countries, such as Hungary, the establishment of businesses faced substantial constraints during the decades of socialism. Consequently, this region experiences a nota-

ble lack of entrepreneurial experience as well as academic and policy-related knowledge about businesses. This underscores the importance of research aimed at enhancing our understanding of the region's businesses and providing a foundation for comprehending their life cycles and behaviours.

We tested seven methods and identified those that performed well on the Global Entrepreneurship Monitor (GEM) data. Specifically, four methods – logistic regression (LG), support vector machine (SVM), decision tree classifier (DTC), and gradient boosting classifier (GBC) – were highlighted, with the variables used in the models explicitly defined. These methods present opportunities for further refinement and testing on larger samples. The practical significance of our work lies in the confirmation of a deeper relationship in the data beyond statistical correlations, offering concrete insights into these patterns.

The machine learning aspect of the research demonstrates the capability to classify businesses as early-stage entrepreneurs (TEA) or established businesses (EB) based on the examined data. Importantly, we employed supervised learning methods, achieving an accuracy exceeding 98% in distinguishing between TEA and EB entrepreneurs using the training data in the GEM database. The research is replicable, as the process for separating the test and training datasets has been clearly outlined.

Our findings show that the characteristics of early-stage and established businesses differ, and through the application of machine learning methods, it is possible to determine the category to which a business belongs.

This study also identifies several promising directions for future research. Firstly, the application of machine learning techniques to uncover deeper patterns across countries holds considerable potential for gaining a nuanced understanding of entrepreneurship in Central and Eastern Europe. Such techniques could reveal latent trends and interconnections that shape the region's entrepreneurial landscape. Furthermore, analysing additional datasets could strengthen the robustness of the current findings, offering a more comprehensive perspective on entrepreneurial behaviour. Extending the analysis to other countries would provide comparative insights, broadening our understanding of how contextual factors influence entrepreneurship across diverse regions. These future research directions could significantly advance knowledge in the field and support evidence-based policymaking and practice.

A key limitation of this research is that it relies on data collected through a pre-designed questionnaire, the content of which could not be modified by the researchers. This limitation restricts the ability to incorporate additional criteria for distinguishing businesses, as highlighted in the existing literature.

The findings of this research have practical implications for enterprise development professionals, as they demonstrate that one can effectively achieve business classification and categorization using machine learning methodologies. In Hungary's entrepreneurial ecosystem, which predominantly consists of micro, small, and medium-sized enterprises, segmentation is critical for providing targeted support. Segmentation enables policymakers to identify and prioritize specific groups for support and, based on the unique characteristics of these groups, to implement tailored legislative changes and support programs designed to meet their specific needs.

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The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Application of technology to empower women in social entrepreneurship: A review

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ABSTRACT

Objective: As digital innovation and adoption grow, women entrepreneurs have more chances than ever to launch their companies and support them in realizing their full potential. Technology makes it easier for women to access resources and their market and thus enables them to expand inclusively in the business sector. This research, which is based on the transformational learning theory, shows how technology adoption helps women entrepreneurs develop and run their companies more successfully than they have in the past.

Research Design & Methods: To provide an overview of the influence of digital technology adoption and the expansion of women's social entrepreneurship on the socio-economic stability of business operations, this study offers a comprehensive assessment of the literature with the help of qualitative study, encompassing 159 research papers published between 1993 and 2023. The purpose of the study is to explain how digital adoption affects female entrepreneurs. Using PRISMA, we implemented a comprehensive key search technique in the SCOPUS database.

Findings: Technology significantly boosts women's participation in social entrepreneurship, as it allows them easier access to digital resources, funding platforms, or networks than men. It also helps in developing skills and fosters cooperation. Moreover, it easily removes long-standing obstacles. These transformations allow women not only to be more innovative and to scale their ventures up in size but also to have an area-wide social and economic benefit.

Implications & Recommendations: Technology can bridge gender gaps in entrepreneurship. It gives women greater access to resources, training and networks. Suggestions include creating digital literacy programs, increasing the flow of capital through technological platforms and nurturing online communities that welcome women social entrepreneurs. This is not just a matter of promoting women-led businesses. It applies equally to the practice of sustainable development.

Contribution & Value Added: In social entrepreneurship, technology makes it easier for women to access resources, networks, and education. Theories like empowerment, social capital, and human capital illustrate how new media drives empowerment, and promotes cooperation among women and improved skills. Businesses grow faster as a result of diffusion of innovation, a process that means more women can engage in production and consumption activities which change the nature of economic society.

Article type: literature review

Keywords: digitalization; women; social entrepreneurship; technology transformation

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INTRODUCTION

As a result of the digitalization of information, learning has taken on a whole new meaning. This process has demonstrated the importance of transformative learning theory. The use of technology and the internet has become a medium for these changes transformative learning theory emphasizes the change of perspective systems (Dobrilovic *et al*., 2021). Thus, it is possible to share resources, increase

motivation, and facilitate reflection and social interaction. Entrepreneurship in knowledge building becomes increasingly dependent on social projects. Innovation and teamwork make entrepreneurship. Social responsibility can facilitate actions for productivity. The past studies describe the transformative learning that women entrepreneurs experience as they move through their careers and note how personal experience and social interaction shape not only the conditions under which their businesses begin but also what they will come up with in life. It stresses the importance of support networks, guidance from older businesses, involvement in communities and further work in propagandizing good news wherever possible. On the whole, all this empowers women so they can find ways to face difficulties and create their success path (Neergaard *et al*., 2021).

As adults in particular, we are especially aware that we can construct knowledge by transforming our experiences and beliefs in a new way. It has been demonstrated that transformative learning theory can serve in practice through the study of new learning contexts and tools by experimenting with new roles and new learning contexts (Isomottonen & Nylen, 2019). To make behavioural changes in society, social entrepreneurship is a major example of this. We may see transformative learning through social entrepreneurship. There is a sense that technology succeeds in bridging the gap between social entrepreneurship and how we can enhance it through transformative innovation (Avelino *et al*., 2019).

We propose a new focus on transformational innovations is proposed, broadening the current focus on socio-technical innovations in transition studies. A technological innovation may be included, but the concept of providing basic needs in new ways is more broad and can include everything from energy, food, mobility, housing, and finance. We can gain a deeper understanding of the broader societal context if we consider several 'non-technological' innovations in addition to those relating to technology. Having engaged in so many of these initiatives that focus on transformative innovation, a new conceptual reflection also emerged on how these alternative practices and activities are developed and diffused to challenge incumbent societal regimes through the development and diffusion of these mechanisms, patterns, and processes.

Technology is increasingly becoming a powering force that breaks down walls and empowers women, notably in the social enterprise arena. Technology has been a driving force for change in social entrepreneurship. The importance of diversity and equality in business is now appreciated. Consequently, women have opportunities for innovation previously unimagined (Gochhait *et al*., 2022). Women in social entrepreneurship are using technology to address old problems and create new possibilities. With it, they can earn while accessing markets that were once closed off to their gender (Dutot & Horne, 2015), increase educational opportunities and networking channels, find ways to gain money, and establish businesses online (Stahl *et al*., 2023). Women are both learning about online platforms and connecting with other mentors and partners all over the world through this medium. Besides, they are also able to share ideas, gain support and establish a solid network of backing through social media and online communities (Laxmi *et al*., 2023). Technology has changed the funding scene for women in social entrepreneurship. Crowdfunding platforms provide an alternative to traditional sources of finance for women-led businesses, and they democratize access to capital. E-commerce and digital marketing have helped women's social enterprises reach a wider audience. They now remove geographical barriers on marketplaces themselves so that women can sell their products and services globally. Digital marketing efforts are also able to raise awareness and attractiveness more effectively than traditional media (Stahl *et al.,* 2023). Entrepreneurs can use data analytics and digital tools to study and make informed decisions on the impact of their social initiatives. A more efficient method of monitoring and evaluation will mean that resources are used to maximize output, rather than wasted or unavailable for certain necessary improvements. Women can also manage to accomplish other work thanks to technology that allows remote work of the entrepreneurial kind. By casting infeasible methodologies for the social concerns, one seeks to address, women can scale up their businesses more easily (Dutot & Horne, 2015). Once they have found a durable model that works and cuts out unnecessary routines, they will be able to feed off a larger audience. As a result of technology, women in social entrepreneurship are transforming into indispensable ally's, who can overcome bar-

riers and make their voices heard in the world market. Addressing gender-specific challenges, scalability, and sustainability are the three main research directions of this report. Key challenges include access to digital tools and the scalability of tech-driven models (Rosca *et al*., 2020b).

RQ1: Analyses the evolution of academic literature on technology and social entrepreneurship has developed.

RQ2: Identifies challenges women face in using technology for social entrepreneurship.

RQ3: Proposes future research directions with research themes to address these gaps.

The present study addresses the original insights on the application of technology to empower entrepreneurs in social entrepreneurship by analysing 159 articles from the Scopus dataset using the PRISMA methodology. According to this study, employing technology to empower women in social entrepreneurship has the potential to greatly improve inclusion while overcoming several challenges. Even with these developments, women continue to face substantial challenges when attempting to use technology for their commercial ventures. The following critical challenges require addressing: the digital gender gap; cybersecurity; a lack of representation in tech development; gaps in digital literacy; sociocultural barriers; and a lack of access to finance platforms. Despite this, technology provides practical solutions to these issues and strengthens women's social capital impact. Programs that promote digital literacy, accessible technology, and secure online settings might help to reduce the digital gender gap. In addition to mentoring programs, encouraging women to pursue entrepreneurship and technology development contributes to a more diverse and inclusive atmosphere. Furthermore, employing digital media for community-based awareness efforts has the added benefit of debunking misconceptions and establishing a positive environment for women in technology and business.

The rest of the study is structured as follows. The next part will outline the literature review. The material and methods part will detail the systematic literature review (SLR) procedure, followed by the results section including the study's findings. We will present the study's theoretical and practical consequences after the discussion and conclusion. The final section will address the study's shortcomings and make further research suggestions.

LITERATURE REVIEW

The adaptation of technology in social entrepreneurship has long been a topic of vigorous research, especially discussing the implications on women entrepreneurs. We designed the literature review section of this work to provide a comprehensive overview of the current understanding regarding how technology aids in enhancing women's performance as social entrepreneurs by highlighting some key streams, trends and empirical evidence.

Research on tools to increase the skills and capacities of women entrepreneurs in social entrepreneurship constitutes another significant area. Previous studies, like (Brush & Cooper, 2012; Duflo, 2012), advocated giving women additional access to entrepreneurial education but also mentorship. Banerjee begins by probing the field of entrepreneurial competences, pointing at the imagination and knowledge necessary to adeptly find out opportunities in using human resources (HR), social capital pooling with other organizational partners or financial. This, the researchers say: 'shine a light on how online learning platforms can support development and creation of virtual incubators; are instrumental in structurally providing mentorship to narrow obvious skills gap between men and women, more so among women entrepreneurs.'

The use of technology to further boost skills has been built on these findings in recent studies. As an illustration, Gupta and Etzkowitz (2021) studied the utility of mobile apps including running gamified learning platforms that engage thousands of women entrepreneurs in experiential processes. The results of their research revealed that the interactive and personalized way in which these platforms delivered learning helped women to better understand some of the broader social entrepreneurship concepts, thereby helping them navigate through this complex industry.

The nature of technology for marketing and e-commerce activities among women social entrepreneurs is another critical theme that the literature underscores. Initial studies (Shukla & Sharma, 2017;

Rahman *et al.,* 2018) have indicated that social media platforms along with e-commerce websites are greatly facilitating women to make their ventures in reach and promote them among prospective customers. The previous studies focused on whether influencer marketing campaigns helped to increase brand exposure and customer engagement of women entrepreneurs. The research revealed strategic partnerships with influencers enabled women to access niche markets and develop genuine connections along their customer journey, leading to increased sales and long-lasting brand advocates.

Tyrväinen *et al.* (2020) also researched how omnichannel retail and personalized marketing strategies could enhance customer experience by boosting conversion rates of personalized luggage or cashmere products for women's enterprises committed to social causes. Therefore, through data analytics and customer understanding, they could provide personalized shopping experiences in addition to product recommendations right at the point of sale. With multiple touchpoints, this has greatly improved customer satisfaction and loyalty while also offering opportunities for repeat purchases.

Regarding the women entrepreneurs, financial inclusion remains a serious problem which technology has a role to play in solving. Previous research conducted by (Bonin *et al.,* 2021; Duflo, 2012) investigated the effect of digital payment solutions and microfinance platforms in improving women's access to credit. These papers stress technology has the potential to democratize access to capital and financial services, thereby promoting economic empowerment and inclusion for women entrepreneurs. More recent scholarships have extended the analysis to use technology to innovate in financial inclusion methods. Isaacs *et al.* (2022) studied how blockchain technology and decentralized Finance (DeFi) platforms could be used to facilitate peer-to-peer lending and crowdsourcing for women entrepreneurs. Their findings suggested that blockchain-based solutions were open about the true state of things, safe and efficient in financial transactions – all important from the standpoint of serving women efficiently as they sought capital more expensive to obtain through other means.

Similarly, Isaacs *et al.* (2022) studied the role of fintech innovations, such as digital loan platforms and alternative credit scoring approaches in helping women entrepreneurs get funding. It was here that these platforms truly came into their own. Using data science and machine learning algorithms with an aim at women, they provided tailored financial products and services specifically aimed towards female clients according to their situations large or small. This study points out the power of financial technology to lead small and mid-sized businesses into the mainstream. A future of fiction where fintech is commonplace and women entrepreneurs still dream of.

With the advent of big data and analysis, researchers have turned to technologies that allow them to do just that--employ these methods for measuring social impact. Earlier research (Nicholls & Cho, 2010; Mair & Martí, 2006) stressed both the importance of evidence-based decision-making and how one might measure outcomes to guide social change. These works also pointed out that data analytics tools and impact assessment approaches could inform us about the efficacy and sustainability of social entrepreneurial activities. Building on these earlier works, recent investigations have delved into advanced analytics methods and models for socially oriented entrepreneurship. Bickley *et al.* (2014) looked at how machine learning algorithms and natural language processing techniques could be put to use on non-structured data sources such as social movement feeds, web news commentary or reviews: these technologies successfully demonstrated the benefit of data coming from women-led social business enterprises showing their social, environmental and economic impact also.

In addition, Spiess-Knafl (2022) discusses how blockchain technology and distributed ledger systems can be harnessed to improve transparency, traceability and accountability in the measurement of impacts. For example, by recording data of transactions and impact on an immutable distributed ledger, blockchain-based solutions offered proof positive to stakeholders of social benefits. This won them trust and added much-needed credibility to social entrepreneurship development efforts. These studies pointed to the transformative potential of blockchain technology in completely changing impact measurement and promoting accountability, as well as generating greater levels of transparency in the social sector. This comprehensive literature review serves to outline all of the different ways technology can assist women involved in social entrepreneurship, from skill-building and digital marketing to access to finance plus impact measurement. To synthesize previous and current research

findings, this review offers valuable insights into the opportunities and challenges inherent in leveraging technology for women's empowerment in social entrepreneurship. Forty four percent of the analysed papers were listed under the following categories: the business management domain followed by economics, and economics studies 21.8%. The social sciences domain has contributed 15.4% of research papers and arts and humanities contributed 1.5% of the selected documents. Interestingly science domains such as computer science, decision science, agriculture, chemistry, and material science also have contributed significantly in the area of women entrepreneurship as illustrated in Figure 1.

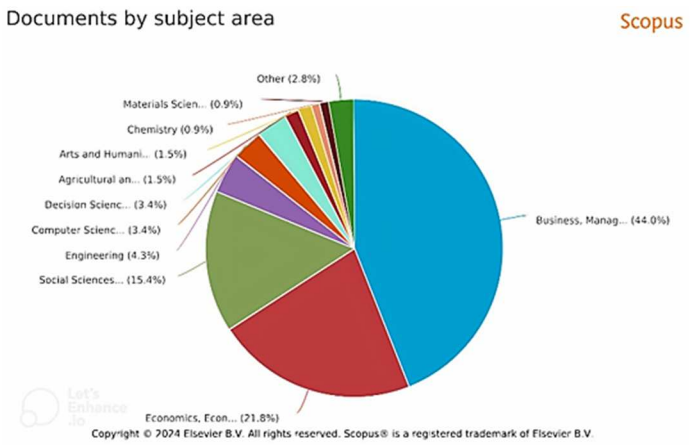

Figure 1. Publication by domain
Source: own elaboration.

Based on our dataset the top 10 contributing organizations are depicted in Figure 2. The most active organization in the field of social women entrepreneurs with technology adoption is the University of Johannesburg followed by the University of Ottawa. Only one institution from India Birla Institute of Technology and Science was in the top 10 most contributing organizations globally.

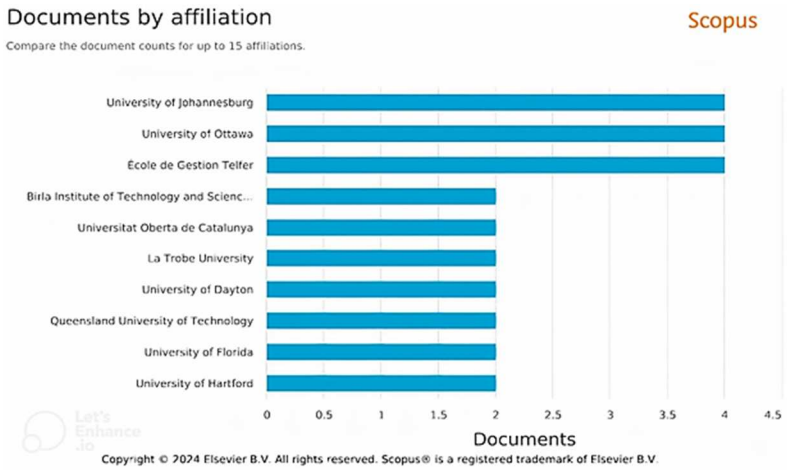

Figure 2. Publications by organization
Source: own elaboration.

The most prolific author who contributed most to the concept of women entrepreneurs with technology adoption is Orser B. followed by Riding A. The top 10 authors that contributed to the concept of technology adoption by women entrepreneurs are depicted in Figure 2. We found only one author from India in the top 10 prolific authors list depicted in Figure 3.

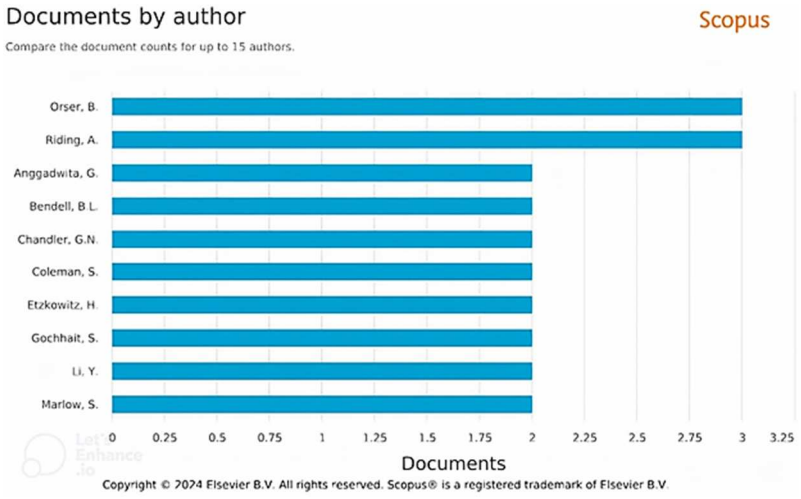

Figure 3. Publications by authors
Source: own elaboration.

The United States was top among the countries that contributed to the concept of technology and women's entrepreneurship. Figure 4 depicts the top 10 countries that published papers in the research area. India was the second most contributing country with 26 papers followed by the United Kingdom with 15 papers in the third position.

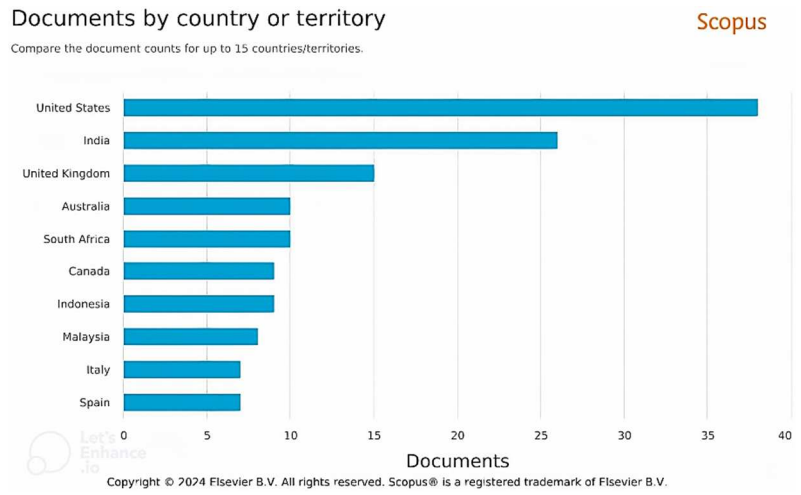

Figure 4. Publications by country
Source: own elaboration.

MATERIALS AND METHODS

This research study undertook a methodical literature analysis to aid in the organization of scholarly output about the connection between technology, women, and entrepreneurship. In this regard, we used the Scopus database, which is regarded as the largest collection of scientific literature at the moment and is well-known in the scientific world with over 27 million abstracts. The search for the articles on the Scopus database was continued during February, 204 for the articles published during 1993-2023 were included in the study. The timeframe from 1993-2023 was selected because that period has seen significant research in the field.

The choice of the 1993-2023 period for this study was made primarily for two reasons. First of all, this era is notable for the rise in women's entrepreneurship since it is marked by a growing digitization of traditional business models. The traditional business models have seen an unparalleled

metamorphosis over the past twenty years, propelled by technological breakthroughs and innovative digital strategies. Technological advancement has significantly changed the landscape of service delivery, making now a crucial time to examine women's entrepreneurship, socio-economic capability as well as technology or digital adoption as an enabler. This period witnessed unprecedented growth and transformation in the digital business models and application of various digital platforms. The adoption of these technologies led to growth and size in women's entrepreneurship. Second, a two-decade study provides a strong temporal scope that enables an in-depth examination of trends, advancements, and results. This timeline guarantees weight to present and future applications in digital business in addition to providing a historical perspective.

We employed the following criteria to select the significant research articles for our study focuses on (1) studies focus on the role of technological tools in enhancing the skills and capacities of women entrepreneurs in social entrepreneurship, (2) the adoption of digital technologies to foster women's entrepreneurship c) technology as an enabler for social entrepreneurship (3) articles published between 1993-2023 (4) articles related to women entrepreneurship with any other digital model.

Furthermore, we employed the following exclusion criteria: (1) Articles other than English language (n=12); (2) Documents not in the subject area of business, management, accounting, economics, econometrics, and finance (n=146), (3) Documents which are book chapters, conference papers, review of books(n=102), (4) Documents not published during study period i.e., 1993-2023(n=5), (5) Articles not focused on design, development, adoption or uses of technology/digital in women entrepreneurship, (6) Articles not related to the research study. The inclusion and exclusion criteria-based detailed study selection procedure is depicted in Figure 5 via a PRISMA flow diagram. A total of 560 research studies were located after searching through the official scholar database. Initial steps in the article selection process involved removing 12 articles published in non-English and eliminating an additional 5 articles that were not published between 1993 and 2023. In the subsequent screening phase, papers were chosen according to their title, abstract, and subject area published. We removed 146 articles that were not in the fields of business, management, accounting, economics, econometrics, and finance. The search phrases that were chosen comprised the terms 'women' and 'entrepreneur∗,' utilizing the Boolean connector 'AND' and adding the search field 'all fields' without any time margins. A total of 560 publications published between 1993 and 2023 were found as a result of the bibliographic search, which concluded in February of 2024.

Four key topics were taken into consideration and are depicted in Figure 5. To extract the essential traits and significant evidence from the chosen articles in a methodical process. With the aid of these three themes, the sorts of data acquired from the examined papers can be further analysed. The following is a brief discussion of the themes.

1. Thematic Association: Using keywords based on the study by considering the titles and keywords of the articles, the theme's association and the significance of the reviewed articles were examined.
2. Publication Profile: The publication profile specifies the year that the reviewed articles were published as well as the kind of papers that were reviewed.
3. Major Research goals: This subject modified the dominant theories of the papers included in three different themes that are emphasized on developed views about technology with digital capability to create a social entrepreneur-based perspective, adequacy/ managing risk associated with the use of new technology and potentiality for change-related discussion.
4. Study context: The research articles selected are from different countries. Technology and social entrepreneurship have been an increasingly discussed topic among academics over the past few years, primarily around how technology can enable women entrepreneurs. This section presents a comprehensive summary of the extant literature on technology for women in social entrepreneurship and includes main themes, trends and empirical findings.

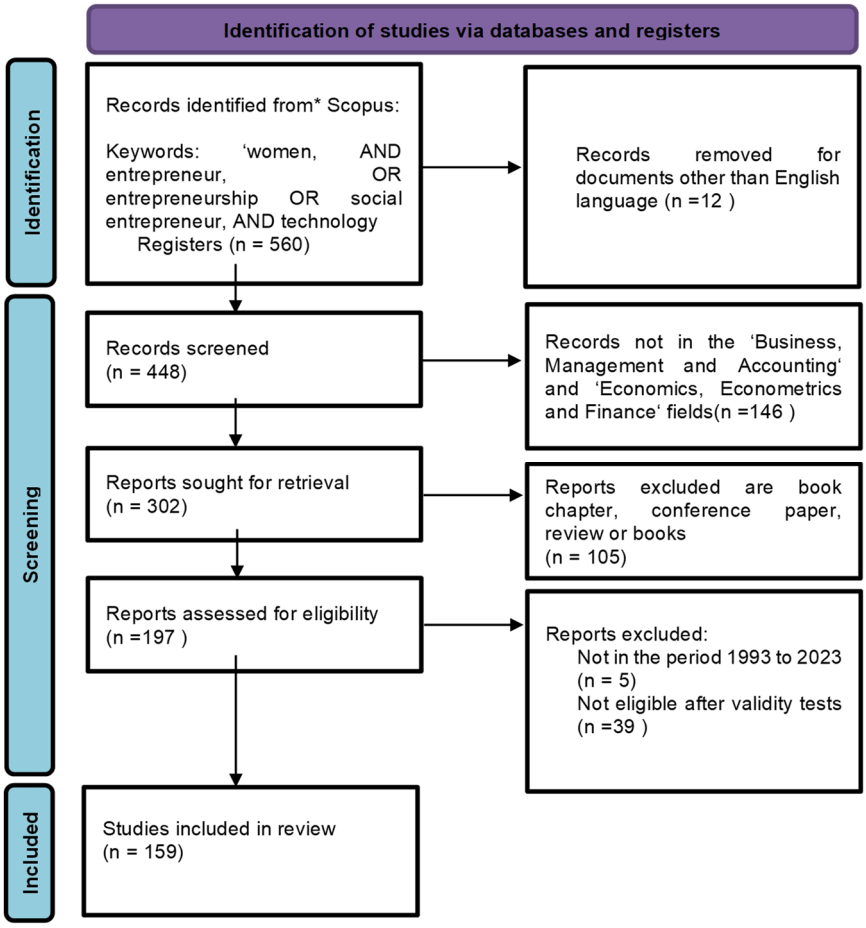

Figure 5. PRISMA flow diagram of the paper selection process used in the present study
Source: own elaboration.

DISCUSSION

The findings from this review of systematic literature, including 159 articles published between 1993-2023 which focused on the application of technology to empower women in social entrepreneurship, show that digitization has increasingly permeated the entrepreneurial landscape. This shift presents new opportunities and growth points, especially for women engaged in social entrepreneurial endeavours. The systematic review aims to comment on the findings of research data about women entrepreneurs' perception of digitalization in the social entrepreneurship context. As a result, three dominant themes emerged.

Perception of Digitalization: This theme illustrates how women entrepreneurs perceive digitalization in their business activities. Their attitudes and beliefs shape their willingness to use technology, underlying aspects of transformative learning theory where they simply understand from exposure and practice on the part of digital tool used how things will work out. It is an empirical type of experiential learning theory in which women in the field change not only themselves but also those around them who depend upon their work of livelihood (Avelino *et al.,* 2019).

Capacity Enhancement through Technology Adoption: The second theme highlights that technology adoption greatly enhances the capacities of women in social entrepreneurship. This matches transformative learning theory by indicating how new knowledge and skills acquired through digital technologies empower women to overcome barriers in their lives as entrepreneurial people (Crittenden *et al.,* 2019; Kang, 2022).

Transformation of Lives through Technology: The third theme looks at how technology changes the lives of women entrepreneurs. This transformation manifests itself in better business practices,

greater access to resources, and making social change possible. It follows transformative learning theory in demonstrating that as they integrate technology into their entrepreneurial journeys, women produce fundamental changes both to who they are and what they can do for society around them (Brush & Cooper, 2012; Gupta & Etzkowitz, 2021).

To sum up, technology both empowers women in social entrepreneurship and brings them into the transformative process of learning. It lets them move and grow. Figure 6 presents the categorization of these themes.

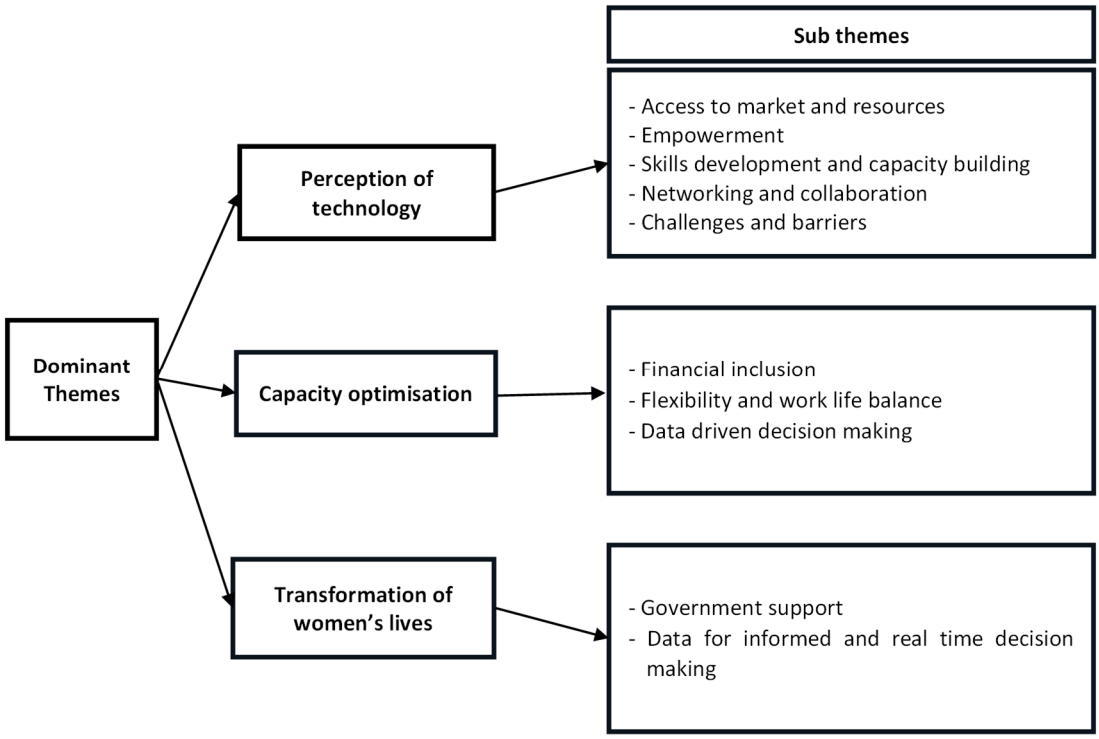

Figure 6. Classification of research themes
Source: own elaboration.

Several studies (Pugalia & Cetindamar, 2022; Seigner & Milanov, 2023; Segares, 2022; Bendell *et al.,* 2020) indicate that women's perception of digitalization as a tool for social entrepreneurship expands their reach (access to market and resources). Through digital platforms, social media, and online marketplaces, women can access broader markets and tap into previously inaccessible resources. Extant research (Brahem & Boussema, 2023; Cho *et al.,* 2020; Gupta & Etzkowitz, 2021; Kang, 2022) also shows that women entrepreneurs perceive digitalization as a tool to overcome traditional barriers to market access, especially in regions with limited infrastructure or cultural constraints. Women can grow their enterprises and diversify their sources of income due to access to a larger market. Moreover, women who engage in social entrepreneurship view digitization as a source of empowerment and increased control over their businesses. Through digital platforms, women can independently decide on product creation, marketing tactics, and business operations (Baruah, 2015; Ezzedeen & Zikic, 2012). Digitalization empowers women to question societal norms and preconceptions, as evidenced by interviews and qualitative studies (Eriyanti *et al*., 2023; Khoo *et al*., 2024; Mukhopadhyay & Ianole, 2021). The review also demonstrates how women consider digitalization as a tool for capacity building and skill development (Ughetto *et al.,* 2020; Welsh *et al*., 2021). Women entrepreneurs can enhance their skills thanks to digitalization. Through digitalization, women can improve their entrepreneurial competence through easy-to-access online courses, webinars, and tutorials. Women see digital platforms as valuable resources for learning technical skills, including data analysis (Irfan & Salam, 2020). Digital tools also help women stay current with industry trends and best practices, which promotes their professional development and flexibility (Haddad *et al*., 2023). The literature review shows that

social media groups and online forums give women access to mentors and potential partners. For instance, Mamabolo and Lekoko (2021) and Williams *et al*. (2020) show that digital networks improve women's credibility and visibility in the entrepreneurial ecosystem. Notwithstanding the advantages of digitalization for female entrepreneurs, the review highlighted cybersecurity concerns, limited access to technology worldwide, and digital literacy (as a dimension of the digital divide) as barriers to the successful adoption of digital social enterprises.

According to the articles reviewed, women view technology as a tool that helps them optimize their business capabilities (Tiwari & Goel, 2017; Ukpere *et al*., 2014; Vong *et al.*, 2014). The literature indicates that technology has facilitated women entrepreneurs' access to finance. Even in areas with restricted access to traditional banking infrastructure, women are now able to perform their financial obligations with ease and security, credit to digital banking and mobile money payment systems (Adbi & Natarajan, 2023; Ukpere *et al.,* 2014; Vong *et al.,* 2014). This development grants women financial independence and the power to invest in their businesses. Digital wallets and mobile money platforms offer a practical and safe means for women entrepreneurs in sub-Saharan Africa to accept payments, handle their money remotely, and perform financial transactions (Kedir & Kouame, 2022). According to Malaquias and Fernandes Malaquias (2022) and Olsson and Bernhard (2021), digital lending platforms and peer-to-peer lending networks are alternative sources for women entrepreneurs who might have trouble obtaining traditional credit facilities because they lack credit history or collateral. Moreover, extant studies show that digital communication tools and remote work technologies provide women the flexibility and better work balance (Prabhu *et al.,* 2023). Women can leverage the internet to effectively run their businesses while juggling other obligations like housework and childcare. Digitalization tools like cloud-based collaboration platforms and project management tools are advancing gender equality and inclusivity in entrepreneurship. Studies like Crittenden *et al.* (2019) and Swartz *et al*. (2022) indicate that technology has enhanced women entrepreneurs' data-driven decision-making.

Extant research (Ayodele Ajani *et al.,* 2021; Kala Kamdjoug *et al.,* 2021; Mishra *et al.,* 2023; Olsson and Bernhard, 2021; Sardar *et al.,* 2019) demonstrates the transformative impact of technology in empowering women entrepreneurs. These findings emphasize the advantages and draw attention to the many difficulties women encounter while using technology to create a positive social impact. According to (Kala Kamdjoug *et al*., 2021; Neumeyer *et al.*, 2019) the role of the actors in the entrepreneurial ecosystem, such as governments, regulatory frameworks, accelerators and incubators, is crucial to women's transformative success. Irwin *et al.* (2023) and Kaningini *et al.* (2023) have demonstrated how data is crucial for strategic entrepreneurship decision-making. Accurately measuring the social impact of businesses is made possible for women entrepreneurs by tools and platforms that provide robust data analytics. This is essential for drawing in funding and expanding business.

CONCLUSIONS

The advancement of crowdfunding platforms, in conjunction with intuitive user interfaces and instructional materials, augments the financial accessibility of projects headed by women. Furthermore, women can create and grow their social businesses thanks to the incorporation of cutting-edge technologies like blockchain and artificial intelligence, as well as programs that provide access to these technologies. It is critical to keep an eye on developing secure and encouraging digital environments for women as technology advances, addressing issues with online harassment and exploitation. For women to use technology as a powerful weapon for empowerment, to tear down obstacles, and to unleash potential in social entrepreneurship, governments, organizations, and communities must work together. In summary, despite ongoing obstacles, technology use continues to be a powerful tool for empowering women in social entrepreneurship. We can create a more equal and inclusive environment where women can fully fulfil their potential as influential and creative leaders in the social impact sector by addressing the gaps and utilizing technology's revolutionary potential comprehensively.

Future research could explore the conceptual domains of digital literacy disparities, restricted technology availability, and cybersecurity issues, which present substantial challenges to successful women entrepreneurs in digital social ventures. Furthermore, upcoming studies may develop approaches to

address hindrances that transcend into the digital sphere, where gender prejudices may endure within online platforms and market settings. Recommendations for strengthening digital literacy programs that aim to improve women's digital abilities can help them use technology more effectively with the help of governments in developing policies that encourage fair access to technology and help women in social entrepreneurship. With the help of social media platforms, networking opportunities might help women create networks and generate funding sources, especially in undeveloped areas. While technology has the potential to alter women's social entrepreneurship, resolving these restrictions is critical to creating an inclusive entrepreneurial environment.

The review implies that technology can bridge gender gaps in entrepreneurship. It gives women greater access to resources, training, and networks. Suggestions include creating digital literacy programs, increasing the flow of capital through technological platforms and nurturing online communities that welcome women social entrepreneurs. This is not just a matter of promoting women-led businesses. It applies equally to the practice of sustainable development.

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Use of Artificial Intelligence

All content has been reviewed and finalized by the authors to ensure accuracy, originality, and alignment with the intended purpose and free of AI/GAI usage

Conflict of Interest

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Digital competence and digital entrepreneurial intention: A social cognitive approach

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ABSTRACT

Objective: This article aims to investigate how digital competence moderates the relationship between entrepreneurial education and digital entrepreneurship intention among university students within the framework of social cognitive career theory.

Research Design & Methods: We employed a quantitative approach, utilising a structured questionnaire to collect data from 327 university students over two months. We analysed the data gathered from a diverse sample of students across different academic years using partial least squares structural equation modelling (PLS-SEM) to test the proposed hypotheses and examine the moderating effect of digital competence on the relationships between entrepreneurial education, self-efficacy, outcome expectations, and digital entrepreneurship intention.

Findings: Digital competence has a dual moderating effect on digital entrepreneurship intention. It positively moderates the relationship between outcome expectations and entrepreneurial intention, enhancing students' confidence in achieving entrepreneurial success. However, it negatively moderates the link between self-efficacy and intention, suggesting that high digital competence may reduce reliance on educationally developed self-efficacy. These findings underscore the nuanced role of digital competence in shaping entrepreneurial intention, challenging the conventional assumption that higher competence unilaterally strengthens entrepreneurial drive.

Implications & Recommendations: The study's limitations include a relatively small sample size and a focus on the role of entrepreneurial education without exploring the mediating effects of cognitive structures like self-efficacy and outcome expectations. Future research should consider larger samples and examine other contextual factors, such as cultural and environmental influences on digital entrepreneurship intention. Educational programs should integrate real-world experiences, adapt content to students' digital competence, and focus on the entrepreneurship intention process while allowing students to self-develop.

Contribution & Value Added: This study is the first to explore the moderating role of digital competence within the social cognitive career theory framework on forming digital entrepreneurship intention among university students. This study advances theoretical understanding and offers practical insights for enhancing digital entrepreneurship education by revealing how digital competence interacts with self-efficacy and outcome expectations. These findings have broader implications for academia and policymakers, emphasising the need for adaptive educational approaches that align with the evolving digital landscape.

Article type:	research article
Keywords:	digital competence; digital entrepreneurship intention; entrepreneurial education; self-efficacy; outcome expectation
JEL codes:	L26, M13

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INTRODUCTION

Student entrepreneurial intention is a concept of significant interest because it reflects the potential of the younger generation to become entrepreneurs (Listyaningsih *et al.*, 2023). Consequently, entrepreneurial education has grown substantially to meet the demand for student training (Dabbous &

Boustani, 2023). In the current landscape, where technology plays a pivotal role in the economy, entrepreneurial education (EE) has gained prominence as digital entrepreneurship becomes an increasingly attractive career path (Wibowo *et al.*, 2023). It encompasses a range of programs and courses designed to impart knowledge and skills related to digital entrepreneurship, combining theoretical instruction with practical exposure to entrepreneurial activities (Wibowo *et al.*, 2023). This approach enhances students' attitudes, thinking, and digital entrepreneurship intention (DEI). Given the distinct characteristics of digital entrepreneurship, EE also focuses on providing work-based learning experiences to facilitate a smoother transition from education to career (Dabbous & Boustani, 2023). However, while the impact of education on fostering traditional entrepreneurial intention remains a topic of debate (Pham & Le, 2023), the influence of EE on DEI is even less clear, as technology has altered many of the traditional measures of entrepreneurial intention. Therefore, investigating the relationship between EE and DEI is crucial for advancing entrepreneurial research in the digital era.

Social cognitive career theory (SCCT) is one of the leading theories in explaining behavioural intentions, especially in career choice and entrepreneurship (Duong *et al.*, 2024). This theory emphasises the role of personal, environmental, and behavioural factors in starting a business (Vu *et al.*, 2024). The two core elements of SCCT are self-efficacy and outcome expectation. Self-efficacy strongly influences whether an individual dares to perform a behaviour, while outcome expectation determines the level of motivation by predicting the benefits or consequences of that behaviour (Ip *et al.*, 2021). Since EE is not only a contextual effect but also represents an individual's learning experience, SCCT is the perfect choice when assessing the relationship between EE and entrepreneurial intentions in general because it presents a full basis to explain these interactions. In addition, this is an addition to the theoretical system when there is little research applying SCCT to explain entrepreneurial intention in the context of digitalisation.

Unlike traditional startups, digital entrepreneurship has flourished during rapid technological advancement that coincided with the rise of mass media (Leong *et al.*, 2022). As a result, students are not solely reliant on formal EE to engage in startups (Nguyen & Nguyen, 2024). Instead, they can independently self-study, acquire, and develop business skills (such as digital marketing, e-commerce, etc.) and management knowledge (such as information systems management, customer relationship management, etc.) (Dabbous & Boustani, 2023). The Internet makes accessing and acquiring this knowledge relatively easy, and as students develop these skills, they build digital competence (DC) to a significant level (Pedaste *et al.*, 2023). Elnadi and Gheith (2023) emphasised that DC is a crucial factor in the success of digital entrepreneurs. DC represents an individual's capability and understanding of effectively applying digital skills to the startup process (Majeed & Hamed, 2023). For undergraduate students, DC significantly influences how information from EE is processed, leading to changes in internal psychological interactions and DEI (Triyono *et al.*, 2023). At the same time, higher DC helps students gain more self-confidence while promoting optimistic expectations about entrepreneurship and enhancing DEI.

Despite its importance, the role of DC has not been thoroughly investigated (Elnadi & Gheith, 2023). Most research has focused on the education outcomes of DEI (Dabbous & Boustani, 2023; Wibowo *et al.*, 2023) but ignored the individual's inherent capacity in forming DEI. Secondly, scholars argue that DC is the result of EE (Mawson *et al.*, 2023), while the arguments here clearly show that DC is primarily formed from the individual's will to develop. Therefore, DC in this study separates EE (external source of capacity stimulation) and DC (internal source of capacity) to specify the influence of these two constructs on DEI. Thirdly, when approaching SCCT, ability only plays the role of the source of subjective cognition (self-efficacy and outcome expectation). In other words, it only describes a unidirectional causal relationship and ignores the subsequent influence of ability in transforming from cognition to intention (Bachmann *et al.*, 2024). This study addresses this gap by exploring the moderating effect of DC on the relationships between EE, subjective cognition, and DEI, thereby offering a more comprehensive understanding of these dynamics. This is a powerful addition to SCCT, as no studies have examined the role of DC as a moderating factor in shaping individual cognition related to DEI. Based on that, we formulated the following research questions (RQs):

RQ1: Based on the SCCT framework, do university students' subjective cognitive constructs significantly influence DEI?

RQ2: Does EE significantly influence university students' subjective cognitive constructs?

RQ3: Does DC significantly moderate the relationships between subjective cognitive constructs and DEI?

This article is structured into five main parts. The first part introduced the research context, highlighted the importance of studying DC in digital entrepreneurship, and identified the study's main objectives. The second, theoretical foundation, will present an overview of the underlying theories and previous studies on digital competence, entrepreneurial education, and digital entrepreneurship intention. The methodology will describe the method used in detail, including the research design, survey subjects, and data collection process. Finally, we will present the results of the data analysis, test the research hypotheses, and discuss them. Finally, the conclusion will summarise the main findings, provide practical implications, and suggest future research directions.

LITERATURE REVIEW AND HYPOTHESES DEVELOPMENT

Digital Entrepreneurship Intention

Currently, there are very few specific definitions to explain DEI. Many scholars identify DEI with e-entrepreneurial intention (Mohammed *et al.*, 2023) or even attach traditional entrepreneurial intention to digital entrepreneurship instead of describing its characteristics (Nguyen *et al.*, 2024a). It was not until the study of Xin and Ma (2023) that the literature considered DEI to have its definition when they described it as a mental state that motivates individuals to conduct entrepreneurial activities and create digital value. Based on that, Duong *et al.* (2024) proposed a more precise concept: the intention to pursue entrepreneurial activities in the digital space, taking advantage of technology platforms to practice entrepreneurial behaviour. When approaching entrepreneurship in students, entrepreneurship is considered a career choice. Therefore, according to Vu *et al.* (2024), DEI 'refers to the cognitive predisposition of an individual to actively opt for and pursue a career in digital entrepreneurship.' Combining perspectives, as viewed in this study, DEI constitutes a state of mind geared toward pursuing digital entrepreneurship as a career choice through establishing a business on a digital technology platform and creating digital value.

Social Cognitive Career Theory

Social cognitive career theory (SCCT) is the leading theory representing the process of forming general career behaviour and entrepreneurial behaviour (Cui & Gu, 2024). It describes career behaviours through two aspects, including endogenous psychological interactions and the mechanism of environmental influence on individual cognition. Two core psychological constructs, self-efficacy (representing the assessment and belief in the individual's ability when performing a behaviour) and outcome expectation (the consequence that the individual believes can occur when performing a behaviour), will interact with each other to balance the individual's ability and desire, thereby determining the ability to form behaviour (Ip *et al.*, 2021). At the same time, the environment will continuously intervene in these interactions and affect behavioural intention (Chiu *et al.*, 2023). This combination makes SCCT superior to other theories in representing long-term psychological constructs instead of short-term motivations (such as the attitude of Ajzen, 1991), as well as deepening the relationship between people and the environment.

Hypothesis Development

Self-efficacy refers to an individual's perception of their ability to apply personal competencies to perform specific behaviours (Wardana *et al.*, 2024). Yeh *et al.* (2021) define self-efficacy as a 'belief in her/his own ability to accomplish a goal or outcome.' Similarly, entrepreneurial self-efficacy is the degree of confidence in one's ability to execute entrepreneurship-related tasks (Pham *et al.*, 2023a). Self-efficacy encompasses an individual's orientation and attitude towards entrepreneurial behaviour, making entrepre-

neurial intentions more concrete (Saoula *et al.*, 2023). According to SCCT, the more efficacious an individual performs a behaviour, the stronger the intention to execute it (Vu *et al.*, 2024). Therefore, high self-efficacy enhances individuals' confidence in their ability to undertake entrepreneurial actions and reinforces their entrepreneurial intentions (Pham *et al.*, 2023a). This relationship is evident in the studies by Yousaf *et al.* (2022) and Wardoyo *et al.* (2025). The study proposes the following hypothesis:

H1: Entrepreneurial self-efficacy positively impacts DEI.

Outcome expectation refers to an individual's beliefs about the possible outcomes of a particular action, including both the benefits and consequences of performing that behaviour (Luc, 2024). In entrepreneurship, outcome expectation reflects what an individual expects to achieve when engaging in entrepreneurial activity (Ilonen & Hytönen, 2023). During the decision-making process, individuals evaluate the behaviour's perceived value and feasibility. Individuals are more inclined to pursue the behaviour when anticipated outcomes are favourable. Blaese *et al.* (2021) assert that when the expected benefits of entrepreneurship surpass those of traditional paid employment, individuals are more likely to develop entrepreneurial intentions. Moreover, SCCT shows that outcome expectation is the motivation that urges individuals to pursue behaviours to achieve positive values. Luc (2023) demonstrated that higher outcome expectations significantly enhance entrepreneurial intentions. Lee Chin and Lee Chee (2024) and Zaman *et al.* (2024) also support this positive relationship. Accordingly, we hypothesised:

H2: Outcome expectation positively impacts DEI.

Entrepreneurial education encompasses all programs, courses, and educational activities designed to develop entrepreneurial competencies, aiming to instil in students the essential knowledge, skills, attitudes, and mindset required to embark on entrepreneurial ventures (Khalil *et al.*, 2024). This educational approach is instrumental in fostering students' motivation and intentions to pursue entrepreneurship by providing practical tools and insights into the entrepreneurial process (Chahal *et al.*, 2024; Wardana *et al.*, 2020). Beyond merely imparting knowledge, entrepreneurial education seeks to nurture a proactive mindset and the ability to identify and exploit opportunities, which are critical traits for successful entrepreneurs.

According to SCCT, contextual factors such as education significantly influence the development of individual cognitions, including self-efficacy and outcome expectations (Adebusuyi *et al.*, 2022). Mainly through targeted learning experiences, education plays a fundamental role in enhancing an individual's self-efficacy, which is the belief in one's ability to succeed in specific tasks (Wu *et al.*, 2022). By delivering a concrete and specific competency framework, education empowers individuals to develop the confidence needed to navigate the complexities of entrepreneurship effectively (Pham *et al.*, 2023a). Furthermore, educators play a crucial role in developing students' opportunity recognition skills by sharing successful entrepreneurial stories, fostering aspirations for achievement, and guiding students to envision the future of entrepreneurial behaviour. Consequently, it shapes students' outcome expectations, leading to a stronger entrepreneurial intention, as evidenced by studies conducted by Pham *et al.* (2023a) and Otache *et al.* (2024):

H3: EE positively impacts entrepreneurial self-efficacy.

H4: EE positively impacts outcome expectations.

Digital competence represents an individual's capability to develop attitudes, knowledge, and skills related to digital platforms, enabling them to achieve their goals effectively (Bachmann *et al.*, 2024). This competence is a crucial asset in the technology-driven era, offering entrepreneurs a competitive edge when entering the market (Nguyen *et al.*, 2024b). This study examines DC through the lens of ability outlined in SCCT, which significantly impacts the development of self-efficacy and outcome expectations. Specifically, individuals with high DC are more confident in the potential success of their startups, anticipating that their strong digital skills will facilitate the creation and operation of a business. This optimism is expected to enhance DEI.

Furthermore, DC significantly strengthens self-efficacy, which is the belief in one's capacity to achieve specific goals (Wardana *et al.*, 2020). Higher DC levels enhance individuals' confidence in their ability to succeed and serve as a critical motivator by promoting a more optimistic outlook on their entrepreneurial

endeavours (Triyono *et al.*, 2023). Moreover, individuals with strong DC tend to have a more accurate and comprehensive understanding of their abilities (Triyono *et al.*, 2023). This awareness allows them to set realistic expectations and avoid the dangers of overconfidence, thereby improving their chances of sustained success in digital entrepreneurship. Based on these considerations, we hypothesised:

H5: DC positively moderates the relationship between self-efficacy and DEI.

H6: DC positively moderates the relationship between outcome expectations and DEI.

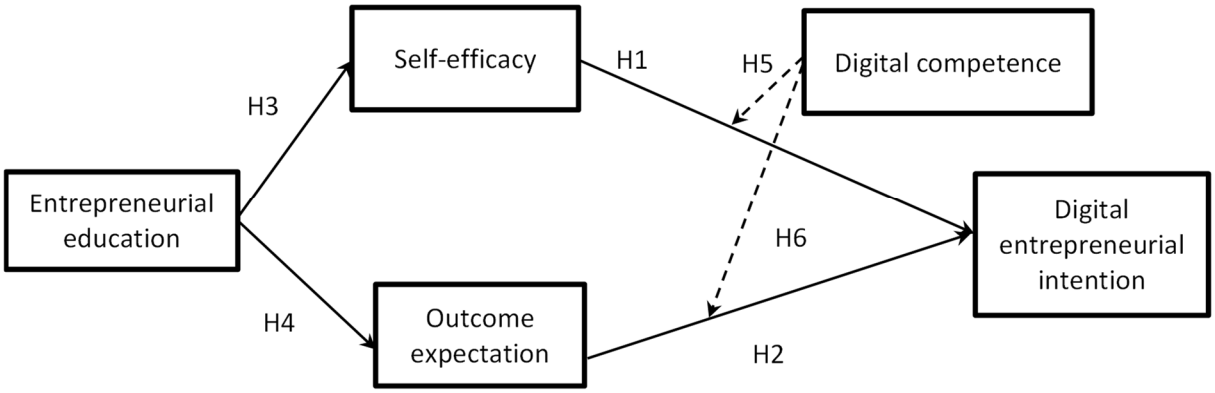

Figure 1. Research model
Source: own elaboration.

RESEARCH METHODOLOGY

Data Collection

Based on the proposed research model, we carefully selected measurement scales for each construct from established studies to ensure validity and reliability. We adopted the scale for entrepreneurial education (EE) from the work of Saoula *et al.* (2023), providing a robust framework for assessing how educational interventions influence entrepreneurial competencies. For self-efficacy (SE) and outcome expectation (OE), we derived the scales from Pham *et al.* (2023a) and adopted DEI from the research of Pham *et al.* (2023b), offering well-validated tools for capturing these constructs' impact on entrepreneurial intentions and behaviours. We measured DC using the Triyono *et al.* (2023) scale, accurately reflecting individuals' abilities to navigate and leverage digital platforms effectively.

We used a convenience sampling method to gather data, targeting a sample that was easily accessible and willing to participate in the study. We used a Likert scale for all observed variables, ranging from 1 (strongly disagree) to 5 (strongly agree), allowing for a nuanced understanding of respondents' attitudes and perceptions. Moreover, the final section of the questionnaire collected demographic information, which provides insights into the characteristics of the sample population and allows for further analysis based on demographic variables.

We constructed the questionnaire using Google Forms, providing a user-friendly platform for respondents and ensuring ease of data collection. This study emailed the link to students with a greeting, a description of the content, the survey purpose, and a commitment to confidentiality. Respondents answered filtered questions stating that they were students studying at a university in Vietnam and had completed at least one business-related training course. Finally, after completing the survey, they received some foreign language learning materials as a thank-you note.

The study collected responses from 327 participants, comprising 183 females (56%) and 144 males (44%). Regarding fields of study, 51.07% of students were from economics and business, 18.65% from social sciences and humanities, and 30.28% from natural sciences and engineering. Most participants were enrolled in public universities (65.75%), while 34.25% studied at private institutions. Moreover, 47.71% of students had a family business background, whereas 52.29% did not. Table 1 presents detailed demographic information.

Table 1. Sample description

Category		Frequency	Percentage (%)
Gender	Female	183	56.00
	Male	144	44.00
Students	First-year	98	29.97
	Second-year	87	26.61
	Third-year	89	27.22
	Final-year	53	16.20
Majors	Economics – Business	167	51.07
	Social sciences and Humanities	61	18.65
	Natural sciences and engineering	99	30.28
Type of university	Public	215	65.75
	Private	112	34.25
Family business background	Yes	156	47.71
	No	171	52.29

Source: own study.

Data Analysis

We utilised the partial least squares structural equation modelling (PLS-SEM) technique and executed it using SmartPLS 4 software. This analytical approach involves two primary stages: evaluating the measurement and structure models.

In the first stage, we evaluated the measurement model through several essential criteria. We tested the scales' reliability using Cronbach's α (CA) and composite reliability (CR). Next, we determined the convergence of the scales using the average variance extracted (AVE) and outer loading (λ). To ensure the discrimination between variables, we applied the heterotrait-monotrait ratio (HTMT), requiring that HTMT be less than or equal to 0.85.

In the second stage, we tested the structural model to assess the validity and strength of the relationships between the constructs. We assessed multicollinearity using the variance inflation factor (VIF). We measured the explanatory and predictive ability of the model using the coefficient of determination (R^2) and the Q^2 coefficient. Finally, we checked the research hypotheses and the impact relationships between variables using the bootstrapping method with a sample size of 5000 to determine the path coefficient and test statistical significance. The quantitative analysis followed the procedure proposed by Hair *et al.* (2019).

In the first step, we checked the Cronbach's α (CA) and composite reliability (CR) of the scale. According to Hair *et al.* (2017), CA > 0.6 and CR > 0.7 ensure the scale's reliability. As shown in Table 2, the outcome expectation scale had the lowest CA and CR values of 0.783 and 0.860, respectively. Therefore, the scale ensured reliability. Next was the assessment of outer loadings. Hair *et al.* (2017) state that outer loadings must be greater than or equal to 0.7. Based on Table 2, all outer loadings were more significant than 0.7. The average variance extracted (AVE) values were all greater than 0.5, meeting the conditions specified by Hair *et al.* (2017). The outcome expectation scale had the lowest AVE value at 0.606.

This study used the heterotrait-monotrait ratio of correlations (HTMT) matrix to assess discriminant validity. As shown in Table 3, all values were less than 0.85 (Hair *et al.*, 2019), thus meeting the conditions for discriminant validity as proposed by Hair *et al.* (2019).

Table 2. Reliability tests summary

Construct	CA	CR	AVE	Item	λ
DC	0.862	0.900	0.644	I realised the need to improve my knowledge of digital technology continuously	0.809
				I can access digital applications or programs for work or daily activities	0.791
				I can develop and manage social media for business or personal activities	0.796
				I can develop innovative new products or services using digital technology	0.820
				I can evaluate and analyse information from various digital sources	0.797
DEI	0.846	0.891	0.643	My professional goal is to become an entrepreneur on digital platforms	0.792
				I have very seriously thought of starting a digital business	0.767
				I am determined to create a digital business in the future	0.749
				I will make every effort to start and run my own digital business	0.815
				I am ready to do anything to be an entrepreneur on digital platforms	0.810
EE	0.805	0.865	0.644	Knowledge about the entrepreneurial environment	0.741
				Greater recognition of the entrepreneur's figure	0.780
				The preference to be an entrepreneur	0.769
				The necessary abilities to be an entrepreneur	0.751
				The intention to be an entrepreneur	0.705
OE	0.783	0.860	0.606	Digital entrepreneurship will help me become an independent person	0.789
				Digital entrepreneurship will help me improve my income	0.788
				Digital entrepreneurship gives me a higher status	0.807
				Digital entrepreneurship helps me to be respected by others	0.728
SE	0.871	0.903	0.608	I am confident in digital entrepreneurship	0.799
				I can control the creation process of digital entrepreneurship	0.793
				I know the necessary practical details for digital entrepreneurship	0.760
				I would have a high probability of succeeding in digital entrepreneurship	0.757
				Digital entrepreneurship would be easy for me.	0.805
				I can become a digital entrepreneur when I want	0.763

Source: own study.

Table 3. HTMT

Construct	DP	DEI	EE	OE	SE
DP	–	–	–	–	–
DEI	0.763	–	–	–	–
EE	0.666	0.650	–	–	–
OE	0.767	0.659	0.743	–	–
SE	0.787	0.661	0.761	0.817	–

Source: own study.

Evaluating the Structure Model

Table 4. VIF and R^2

Concept	VIF (min-max)	R^2
DC	1.774 – 1.978	–
DEI	1.605 – 2.009	0.483
EE	1.356 – 1.671	–
OE	1.315 – 1.729	0.355
SE	1.749 – 2.009	0.413

Source: own study.

After evaluating the measurement model, we proceeded to assess the structural model. Firstly, the variance inflation factor (VIF) had to be below 3 to reflect the relationships accurately. As shown in Table 4, all VIF values were less than 3, meeting the requirement according to Hair *et al.* (2020).

Moreover, we also had to perform testing for common method bias (CMB), which is a phenomenon that explains the variation in research data due to the common measurement method rather than the variables that the process is intended to measure. Noteworthy, CMB can lead to bias in parameter estimates of the relationship between two factors in a model. This bias can increase or decrease the estimate of the relationship between the two factors (Antonakis, 2017). Kock (2017) suggested that if VIF < 3.3, CMB does not substantially impact the results of data analysis. According to Table 4, the largest VIF is 2.009, which satisfies the above condition. Moreover, the R^2 value is 0.483, indicating that the model explains 48.3% of the formation of DEI.

Discussion

Testing the structural model with bootstrap (N=5000) shows that all hypotheses are significant at 95% (P_value<0.05). Firstly, DEI is significantly influenced by SE (β=0.170) and OE (β=0.147). According to SCCT, high SE is a prerequisite for behavioural solid intention (Neneh, 2022). In parallel, the more optimistic and specific the visualisation of entrepreneurial outcomes through OE is, the more solidly based and stronger DEI becomes (Luc, 2023). Thus, we accepted H1 and H2. Continuing with the role of education on individual cognition, EE strongly affected SE (β=0.642). Individuals who received EE had higher SE and enough self-confidence to perform entrepreneurial behaviour (Wardana *et al.*, 2020). Next, EE positively affected OE (β=0.596), indicating that EE plays a vital role in shaping students' expectations towards entrepreneurship (Otache *et al.*, 2024). Hence, we accepted H3 and H4.

Digital competence showed a solid moderating effect on the relationship between individual cognition and DEI. Specifically, digital competence positively moderated the relationship between OE and DEI (β=0.178). Under the influence of digital competence, individuals can better understand themselves, increase their confidence, and have a deeper understanding of what they want to achieve (Bachmann *et al.*, 2024). We accepted H6. Surprisingly, digital competence negatively moderated the relationship between SE and DEI (β=-0.144). Accordingly, we rejected H5. See the summary results in Table 5.

Table 5. Hypothesis testing

Hypotheses		β	p-value	Result
H1	SE -> DEI	0.170	0.006	Accepted
H2	OE -> DEI	0.147	0.013	Accepted
H3	EE -> SE	0.642	0.000	Accepted
H4	EE -> OE	0.596	0.000	Accepted
H5	DP x SE -> DEI	-0.144	0.023	Rejected
H6	DP x OE -> DEI	0.178	0.008	Accepted

Source: own study.

The test results have demonstrated that EE powerfully shapes SE and OE, stimulating and constraining DEI simultaneously. According to Vu *et al.* (2024), higher SE makes individuals more optimistic about their entrepreneurial tasks, promoting stronger entrepreneurial tendencies. Moreover, SE helps students reduce fear and gain confidence when starting a business. This result is consistent with Yousaf *et al.*'s (2022) and Wardoyo *et al.* (2025) findings. Similarly, OE manifests expectations when performing entrepreneurial behaviour, which is also the desire that individuals pursue. The results of Lee Chin and Lee Chee (2024) and Zaman *et al.* (2024) also demonstrate and agree with this view.

Next, EE showed a significant impact on SE and OE. Wardana *et al.* (2020) and Otache *et al.* (2024) also demonstrate that EE helps students better visualise entrepreneurial tasks, making a more objective assessment of their abilities. Similarly, through EE, scholars view students' expectations in a more scientific and grounded way to limit unrealistic entrepreneurial goals (Listyaningsih *et al.*, 2023). Further analysis shows that EE tends to stimulate SE more than OE. This result is consistent with Cui and Gu (2024) and Duong *et al.* (2024), because they believe that EE is mainly designed to train entrepreneurial capacity. However, the slight difference between these two relationships shows the balance in the content of EE in Vietnam. Therefore, universities should invest more in student experiential activities. Practical entrepreneurial activities create a balance between self-efficacy and outcome expecta-

tion. Exposure to reality creates an environment for students to apply knowledge and evaluate their capacity. Accordingly, this study once again demonstrates the vital role of EE in shaping students' perceptions of entrepreneurship and promoting entrepreneurial intentions (Thomas, 2023).

DC positively moderates the relationship between OE and DEI. High DC makes students more confident in their ability to achieve entrepreneurial achievements. As SCCT stated, more substantial competence leads to individuals believing in the likelihood of future behaviour success (Lent *et al.*, 1994; Cui & Gu, 2024). Understanding digital skills helps students better assess expectations and filter goals that are more suitable for their abilities (Zhao *et al.*, 2021). Because of the influence of the same culture, most OEs generated from EE will be compatible with the general social expectations of becoming entrepreneurs (Pham *et al.*, 2024). Therefore, while the relationship between SE and DEI is weakened, OE is strongly stimulated and promotes students' entrepreneurial aspirations. Combining these results creates a new understanding of students' entrepreneurial thinking. Accordingly, the program needs to create more autonomous spaces for students to practice their abilities, promote self-learning, and develop themselves in a direction that suits them. From this perspective, lecturers also play a good role in guiding and suggesting instead of using the traditional passive educational method.

The surprising finding of this article is that DC negatively moderates the relationship between SE and DEI. This unexpected finding contradicts the view of Triyono *et al.* (2023) because DC makes individuals more confident in their abilities and more optimistic about future expectations, thus stimulating entrepreneurial intention. Elnadi and Gheith (2023) also reported that DC promotes innovativeness and alertness, which are vital in promoting DEI in their research. However, programs provide few opportunities for hands-on learning, so students lack experience and market awareness (Kabonga & Zvokuomba, 2021). In contrast, DC is formed from learning and personal development, and they trust their experiences more than theoretical visualisation (Yin *et al.*, 2022). Students do not have enough experience and resources to combine many advantages. Therefore, in the early stage, focusing on DC makes them pay less attention to EE. Consequently, higher DC leads to less dependence on SE generated by EE. In addition, DC and EE can only be balanced when individuals have enough awareness and determination in their entrepreneurial orientation. Thus, in the short term, DC will cause SE to decrease and lead to lower DEI. Therefore, in this context, negative DC regulation is not a negative influence, but it is the way individuals automatically balance ability and self-efficacy. This result contradicts most previous studies, showing that higher competencies lead to higher entrepreneurial tendencies (Somia *et al.*, 2024) or entrepreneurial behaviour (Narmaditya *et al.*, 2024). This exciting result also broadens Generation Z's understanding of the entrepreneurial mindset.

CONCLUSIONS

Building on the SCCT, this study explores the relationship between EE and university students' DEI. Unlike previous research, which often directly linked EE to the creation of DEI (*e.g.*, Pham & Le, 2023), this study focuses on how EE influences the cognitive structures of individuals, leading to the formation of DEI. This study proved that SE and OE significantly influence DEI. At the same time, EE enhances SE and OE. Hence, we answered RQ1 and RQ2 and deeply explained the mechanism of the concepts. Next, we also encountered interesting findings with regard to RQ3. We found that DC positively moderates the relationship between outcome expectations and DEI, aligning with educational program designers' broader social expectations. However, as students often lack practical experience, DC can reduce their reliance on EE, negatively moderating the relationship between self-efficacy and DEI. These findings offer valuable insights for both theoretical understanding and practical applications within digital entrepreneurship systems. Thus, we fulfilled all the objectives.

Theoretical Implications

Following the trend of digital entrepreneurship, this is one of the few pioneering studies that applied SCCT to explore entrepreneurial intentions in a digital context. Accordingly, this study brings some crucial contributions to entrepreneurship theory. Firstly, this article has approached EE as a representative factor for both objective impacts and subjective perceptions. This perspective more clearly

demonstrates the connection between people and the environment and better promotes the core idea of SCCT. In parallel, to our best knowledge, in the past five years, scholars have only assessed the relationship between EE and SE (*e.g.,* Yeh *et al.*, 2021; Soomro & Shah, 2022; Oulhou & Ibourk, 2023; Al-Qadasi *et al.*, 2024). This is a rare study that fully revisits the two core constructs of SCCT and provides a more comprehensive view of these relationships.

The second contribution is to explore the moderating role of DC on the relationship between SCCT and DEI. DC is how this study visualises the source of self-efficacy and outcome expectation according to the SCCT framework and evaluates how DC further intervenes in transforming cognition into intention. The analysis further highlights the possible conflict between information dimensions (Xu & Allan, 2024). In the context of technological development, EE is no longer the only approach to entrepreneurship courses (Leong *et al.*, 2022). Based on the result, this article confirmed the more decisive influence of technology on human thinking, especially in entrepreneurship.

Finally, the study has explained the self-balancing and neutralising mechanism in individuals' entrepreneurship perception when DC and EE disagree, thereby changing the relationship between SE and DEI. This finding shows that negative influence does not mean adverse outcomes but may be a stage of information regulation and restructuring in cognition. It also opens new and unique approaches to how scholars and educators approach student entrepreneurship.

Practical Implications

The results also provide a foundation for proposing managerial implications aimed at helping educators more effectively promote DEI. Firstly, EE must update and equip students with digital skills and acumen to strengthen their business capabilities in a globalised context. Simultaneously, educational programs should prioritise creating opportunities for students to gain real-world business experience (Wasim *et al.*, 2024). Transforming entrepreneurial intention into natural behaviour requires significant expertise, making work-based learning a critical component (Wasim *et al.*, 2024). Such experiences allow students to accumulate the necessary knowledge and skills, thus better preparing them for future entrepreneurial endeavours (Dabbous & Boustani, 2023). Therefore, a close connection between universities and businesses is necessary. Universities should optimise policy support to expand student support resources. Moreover, educators must acknowledge the growing strength of students' DC. EEs should adjust their approach by blending comprehensive teaching content with customised material to address this. If DC and EE content are not well-aligned, students may become distracted and lose direction without timely support.

Moreover, universities must focus on the entire process of DEI formation rather than merely concentrating on the initial stages of awareness-building, such as self-efficacy and outcome expectations (Vuorio *et al.*, 2023). While EE plays a significant role in shaping self-efficacy and outcome expectations, the direct impact of these constructs on DEI is notably lower (as indicated in Table 5). This suggests that the practical application of knowledge gained through EE is insufficient, potentially destabilising DEI if the influence of EE is not thoroughly integrated. Finally, it is essential to respect and nurture students' capacities by allowing them the space to develop their abilities rather than confining them strictly to the framework of the training program (Wardana *et al.*, 2020). Therefore, this article aims to provide educators and scholars with a more nuanced perspective on the interplay between EE and DEI.

Limitations and Future Research

Although the study has contributed to the DEI theoretical system, some limitations remain. Firstly, the time limit made us stop at a sample size sufficient to apply the SEM. However, the small sample reduced the generalisation level, and the representativeness was not high. Therefore, future studies should develop a larger sample size to examine DEI formation better. Secondly, the study did not analyse the mediating effect of EE on DEI through endogenous cognitive structures (SE and OE). Future research should explore how cognition mediates the interaction of objective influences on DEI. In addition, this study focused too profoundly on the mechanism of education. Other contextual factors, such as business environment, culture, or barriers, may intervene in these relationships. These limitations, if overcome, would bring more profound results.

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Changes in enterprise potential in a circular economy: A comparative analysis of EU countries in 2013 and 2020

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ABSTRACT

Objective: The article aims to identify and assess the spatial disparity of entrepreneurship and its links to the circular economy (CE) at the EU country level and to identify the practical implications of these phenomena for economic and regional policies that support sustainable development.

Research Design & Methods: We employed literature analysis and statistical analysis. We used the TOPSIS method to create synthetic measures. We collected the empirical data by the spatial distribution of EU countries (including Eastern Bloc countries). The results of the analysis were presented in 2013 and 2020 (this is linked to the two programming periods of EU funds). It allowed for capturing the dynamic aspects of the studied phenomena and controlling the phenomenon of deviations related to the cyclical changes occurring in the economy.

Findings: Entrepreneurship is an important element of economic growth that impacts the social sphere, improves the quality of life, and creates new jobs. The interaction between entrepreneurship and the circular economy is multidimensional, highlighting the importance of both entrepreneurship and the circular economy. The research shows a positive change in both areas, both in terms of entrepreneurship, compared to earlier years. Depending on the country, the situation regarding entrepreneurship and the circular economy varied. Malta, the Czech Republic, and the Netherlands were in a better situation in the entrepreneurship aspect, while Italy, Spain, and Greece were in a weaker situation. In the case of the circular economy, countries with better performance included the Netherlands, Slovenia, and Italy, while Denmark, Portugal, and Greece were worse off. Poland experienced growth in the area of entrepreneurship, while the situation remained more stable in the area of the closed economy, which affected the country's position in the international ranking.

Implications & Recommendations: The obtained measures depend on the number and type of variables adopted for the study. Authorities can use this knowledge to assess the effectiveness of the development instruments and policy tools used so far. The results of the clustering can be the beginning of further in-depth research to determine which variables have had a decisive impact on the process of transformation and changes in the entrepreneurship area. Further empirical research is needed on the implementation of the CE, the relationship with the variables of demography, the financial situation, and environmental changes, as well as their impact on changes in the area of entrepreneurship. Actions taken in this aspect must be based on analyses that facilitate comparisons and on current information necessary for effective action.

Contribution & Value Added: The study makes international comparisons between the studied areas, i.e., entrepreneurship and CE. The value of the article is the set of variables and the results of the analysis presenting the indicated relationship in the EU countries, with an indication of the Eastern Bloc countries in 2013 and 2020. It is an important stimulus in the discussion on strengthening the effectiveness of CE implementation in the conditions of a country and its impact on entrepreneurship changes.

Article type:	research article
Keywords:	Entrepreneurship; development potential; circular economy; multidimensional approach; synthetic measure; CRITIC-TOPSIS method
JEL codes:	E60, F63, L26, L31, Q01

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INTRODUCTION

The differentiation in regions' development levels is a natural phenomenon. It results from, among other things, access to factors of production, the scale and scope of resources use, the previous level of development or level of entrepreneurship, demographic aspects, the labour market, and infrastructure. Unbalanced growth dynamics means the parallel occurrence of stages of growth and stagnation resulting in multiple trajectories of change, creating a hybrid picture of transformations taking place in space.

In terms of regional development, we can analyze entrepreneurship from the point of view of individuals, businesses, or local government units. It is an important way of increasing economic performance and stimulating development, as well as empowering individuals (Olanrewaju *et al*., 2020; Poliakov *et al*., 2024; Bekzhanova *et al.*, 2024). It is considered a key component of job creation, economic growth, and innovation in regional development. High levels of entrepreneurship lead to sustainable economic growth and technical change (Apostu & Gigauri, 2023). However, the spatial distribution of entrepreneurship is uneven, as presented by Gao *et al*. (2022), which is an important determinant of regional economic disparities.

Among other things, natural conditions, communication accessibility, the distribution of large settlement centres, access to capital, infrastructure equipment, the level of economic activity, access to knowledge, and the policy of local government units determine the level of differentiation between regions and entrepreneurial activity. This is also due to the structural characteristics of the regions and the endogenic factors present in their area. Among the factors shaping a region's entrepreneurship, we find the demographic characteristics of the region, the regional labour market, the quality of human capital, housing stock, and infrastructure facilities (Audretsch *et al*., 2024; Andronicеanu, 2024). As defined by Awoa *et al.* (2022), raw material pensions increase incentives for profit-oriented activities, which impact the level of resource allocation and often undermine entrepreneurial dynamism. Medase *et al.* (2023) emphasize that entrepreneurial activity can promote the accumulation of resource annuity, which is a valuable asset for enterprise activity.

The transition to a circular economy (CE) should support competitiveness and innovation by stimulating new business models and technologies (Androniceanu, 2024; García-Agüero *et al*., 2024; Batlles-delaFuente *et al*., 2024; Androniceanu, 2025). The goal of this approach is to provide the conditions for creating more jobs while using fewer resources (Florek-Paszkowska & Hoyos-Vallejo, 2023). As Evans (2023) describes, the idea of a closed loop is to so-called incorporate sustainable thinking at every stage of. The goal of this approach is to provide the conditions for creating more jobs while using fewer resources. As Evans (2023) describes, the idea of a closed loop is the so-called incorporate sustainable thinking at every stage of working with a product or service. It represents a way of solving environmental problems and challenges, as well as a sustainable approach to society, the economy, and the environment. On the other hand, Cullen and De Angelis (2021) describe the circular economy as a shift toward a more economical industrial model in which economic growth is decoupled from the consumption of finite natural resources. It is a multifaceted phenomenon.

The article aims to identify and assess the spatial disparity of entrepreneurship and its links to the circular economy at the EU country level and to identify the practical implications of these phenomena for economic and regional policies that support sustainable development.

We collected the empirical data in the spatial context of all EU countries, including former Eastern Bloc countries. The results of the analysis were published in 2013 and 2020, *i.e.*, during the two periods of programming of EU funds. It allowed for capturing the dynamic aspects of the studied phenomena and controlling the phenomenon of deviations resulting from changes in economic conditions. We employed the literature analysis on the subject and a statistical, synthetic measure – according to the TOPSIS method, in the process of achieving the aim. Weformulated research questions to solve the problem: What is the spatial differentiation between entrepreneurship and CE in the EU countries?; How has the concentration and rate of change in entrepreneurship and CE changed?; To what extent does CE affect changes in entrepreneurship?

The article points to a gap in research on the interdependence between CE and entrepreneurship, which scholars usually analyse separately. The article highlights the uneven pace of CE implementation across EU countries, leading to differences in transformation between Western and Eastern European countries. The value of the article lies in the new analysis of variables and results that show how EU policies affect CE adoption and business competitiveness in different regions. The study highlights the need for a more balanced and coherent approach to CE implementation, taking into account the specificities of local markets and transformation challenges.

The article consists of five parts. The introduction described the problem's context and the study's significance. The second section will present a literature overview and the hypothesis development. The third section presents the research method used in the study. Subsequent sections include the main results, discussion, and summary.

LITERATURE REVIEW AND HYPOTHESES DEVELOPMENT

The circular economy has an important impact on entrepreneurship, creating new business opportunities, innovative models, and markets while increasing the operational efficiency of companies (Amin *et al.*, 2024). Early adopters of circular economy principles can reduce costs, improve competitiveness, and contribute to the creation of new jobs in sectors related to recycling, sustainable production, and green technologies. Integrating CE into business not only promotes sustainability but also encourages the development of new and innovative products and services, which has a direct impact on business dynamism.

According to a study by Sun *et al.* (2020) and Sutthichaimethee *et al.* (2024), achieving sustainable development goals requires addressing environmental, social, and economic issues, especially in the context of resource scarcity and population growth. In this context, entrepreneurship becomes an important tool for regional development. According to Trapp and Kanbach (2021), significant environmental degradation combined with technological advances has highlighted the importance of entrepreneurial opportunities. As Xie *et al.* (2021) indicate, it is the main driver of regional economic development.

Di Vaio *et al.* (2022) point to entrepreneurship as a driver of economic and social development. It is under increasing pressure to consider the impact of ever-increasing production, distribution, and consumption of products, as well as the number of wastes and resources. Furthermore, Endovitskaya *et al.* (2019) note that proponents of endogenous development recognize that entrepreneurship enables sustainable and long-term development. With the rise of consumerism, entrepreneurship can lead to environmental degradation, depletion of natural resource reserves, and constraints on future industrial production. The negative impacts of the linear model threaten the stability of economies. Therefore, we hypothesised that:

H1: The implementation of a circular economy in EU regions, including Eastern regions, supports the development of entrepreneurship, the creation of new business models, and the achievement of sustainable development goals, while stimulating regional economic growth and adaptation to a changing environment.

Moreover, it identifies the circular economy as a tool to support sustainable business development.

Cardoso Marques and Mendes Teixeira (2022), Gedvilaite and Ginevicius (2024) see the adoption of a circular economy as an opportunity to reduce the problem of overexploitation of natural resources. An important aspect of this problem is the generation of excessive waste. This problem can be mitigated in circular economy (Potkány *et al.,* 2024; Zdonek *et al.*, 2024). The circular economy can mitigate this problem. The attractiveness of the transition to CE is underpinned by the need to achieve sustainable development goals and improve resource efficiency and employment. To make progress towards CE, policies should focus on environmental awareness, clear indicators of social, environmental, and sustainable development, and the decoupling of growth-related variables from environmental pressures. The move towards CE as a pre-entrepreneurial act involves their strategic policies, business models,

structures and processes, thus contributing to society and the economy. The circular economy is multifaceted. Dragan *et al.* (2024) indicate that a circular economy is a production and consumption model that involves sharing, reusing, repairing, renewing and recycling existing materials and products for as long as possible. It aims to improve resource efficiency, focusing on urban and industrial waste and renewable resources to achieve a better balance in the economy, environment and society. This new development model is linked to the 3Rs principle (reduce, reuse, recycle), and extended to the 5Rs model (reduce, reuse, renew, repair and recycle). This can determine environmental and economic benefits by reducing business-related waste, as well as social benefits (Ravikumar *et al.*, 2024).

According to research by Gutberlet *et al.* (2023), the closed-loop economy provides a model for improving resource efficiency through ecosystem regeneration, resource conservation, and waste elimination, as well as improving business models. Companies engaged in micro-level activities, such as recycling, contribute to the broader concept of a closed loop. In addition, Findik *et al.* (2023) indicate that it requires restructuring in several areas, such as economic growth, employment, environmental quality, and the introduction of new forms of production. The basis of CE is the prioritization of renewable raw materials and the recycling of by-products and waste in the production of goods and services. By implementing CE, it will be possible to move towards a low-emission economy. According to Silvério *et al.* (2023), the adoption of CE as a future economic model requires enormous environmental, economic, social, and legal efforts. Braz and Marotti de Mello (2022) indicate that CE promises to promote sustainable development and reduce environmental pressures and impacts through the creation of new sustainable businesses and jobs and the reduction of commodity price volatility, natural resource scarcity, and costs. Thus, we hypothetised that:

H2: The transition to a circular economy in the eastern regions of the EU increases enterprises' competitiveness, creates sustainable jobs, and reduces the pressure on the environment and resources, thus responding to the challenges of resource depletion and pollution.

Scholars seeentrepreneurship as a driver of regional growth and adaptation to challenges, while CE in the second group responds to the need to reduce the environmental impact of economic activity and improve resource efficiency.

RESEARCH METHODOLOGY

We presented the empirical data used in the study in spatial terms of the EU countries (including the EU Eastern Bloc: Czech Republic, Estonia, Slovenia, Lithuania, Latvia, Hungary, Slovakia, Poland, Bulgaria, Romania, Croatia) for the years 2013 and 2020, which allowed to capture the dynamic aspects of the studied phenomena as well as to control the phenomenon of deviations related to the cyclical changes occurring in the economy.

In the first stage of the ongoing research, we selected diagnostic variables to describe the phenomenon under study. We conducted statistical verification of the variables based on the value of the coefficient of variation ($|V_i| \leq 0.10$; critical value). We evaluated correlations based on the inverted matrix method (the diagonal value does not exceed 10). This allowed us to eliminate so-called quasi-constant variables. We wrote the resulting observation matrix – a set of objects and diagnostic variables – as (1):

$$X_{ij} = \begin{bmatrix} x_{11} & x_{12} & \dots & x_{1m} \\ x_{21} & x_{22} & \dots & x_{2m} \\ \dots & \dots & \dots & \dots \\ x_{n1} & x_{n2} & \dots & x_{nm} \end{bmatrix} \quad (1)$$

in which; X_{ij} – denotes the values of the j-th variable for the i-th object, i – object number (i = 1, 2, ..., n), j – variable number (j = 1, 2, ..., m).

Table 1 shows the selected diagnostic variables. These variables formed the basis for developing two synthetic measures of entrepreneurship and CE. The selected variables allowed us to assess the impact of the circular economy on entrepreneurship, considering both environmental and economic aspects. Variables such as recycling rates, the use of circular materials, and resource efficiency show

how the circular economy reduces negative environmental impacts and improves the efficiency of businesses. In turn, variables on employment, private investment, and value-added in the CE sector show how it supports the development of new industries and jobs. These variables make it possible to monitor the progress of business transformation, assess the effectiveness of policies, and compare EU countries in terms of their adaptation to the circular economy.

Table 1. Selected diagnostic variables for the construction of a synthetic measure of entrepreneurship and Circular economy

variables	Unit of measure	S/D
Entrepreneurship		
Unemployment by sex and age – annual data	Percentage of population in the labour force	D
Deaths of enterprises in t – number 5. Business demography main variables	number per capita	D
Births of enterprises in t – number 7. Business demography main variables	number per capita	S
The population of active enterprises in t – number 8. Business demography main variables	number per capita	S
Employment and activity by sex and age – annual data	Percentage of total population	S
Circular economy (CE)		
Recycling rate of waste of electrical and electronic equipment (WEEE) separately collected	Percentage	S
Recycling rate of municipal waste	Percentage	S
Circular material use rate	Percentage	S
Trade in recyclable raw materials	Tonne per capita	S
Generation of municipal waste per capita	Kilograms per capita	D
Resource productivity	Euro per kilogram, chain-linked volumes (2015)	S
Material footprint	Tonnes per capita	S
Material import dependency	Percentage	S
Greenhouse gas emissions from production activities	Kilograms per capita	D
Consumption footprint	Per inhabitant	D
Private investment and gross added value related to circular economy sectors	Percentage of gross domestic product (GDP)	S
Persons employed in circular economy sectors	Full-time equivalent (FTE) per cpaita	S

Note: S stimulant; D destimulant.
Source: own study.

In the next step, we used zero-based unitization procedures, according to the formula (2), (3):

$$X_j \in S;\ Z_{ij} = \frac{x_{ij} - \min_i x_{ij}}{\max_i x_{ij} - \min_i x_{ij}} \quad (2)$$

$$X_j \in D;\ Z_{ij} = \frac{\max_i x_{ij} - x_{ij}}{\max_i x_{ij} - \min_i x_{ij}} \quad (3)$$

in which: S-stimulant, D-destimulant, max_{xij} – the maximum value of the j-th variable (i=1, 2...n; j=1, 2...m), min_{xij} – the minimum value of the j-th variable, x_{ij} – denotes the value of the j-th variable for it object (Kukuła & Bogocz, 2014).

This resulted in a matrix of unitarized values ($Z_{ij} \in [0;1]$) of the j-th variable for the i-th object (4):

$$Z_{ij} = \begin{bmatrix} z_{11} & z_{12} & \dots & z_{1m} \\ z_{21} & z_{22} & \dots & z_{2m} \\ \dots & \dots & \dots & \dots \\ z_{n1} & z_{n2} & \dots & z_{nm} \end{bmatrix} \quad (4)$$

In the next step, by using the criteria importance through the intercriteria correlation (CRITIC) method, we determined weights for diagnostic variables based on standard deviations and

correlations. The method gives more weight to criteria with high standard deviation, high coefficient of variation, with low correlation with other variables (Hassan *et al.,* 2023; Rostamzadeh *et al*., 2018), according to the formulas (5), (6):

$$w_j = \frac{C_j}{\sum_{k=1}^{K} C_k}, j = 1,2,\ldots,K \tag{5}$$

$$C_j = S_{j(Z)} \sum_{k=1}\left(1 - r_{jk}\right), j = 1,2,\ldots K \tag{6}$$

in which: C_j denotes a measure of the information capacity of the jth $S_{j(Z)}$ is the standard deviation calculated from the normalized values of the jth variable, r_{jk} correlation coefficient between the j-th and k-th variables. A larger value of *Cj* indicates that one can obtain more information from the given criterion. The normalized values of the diagnostic variables are multiplied by the weighting coefficient w_j ($Z^*_{ij} = Z_{ij} * w_j$) (Wang *et al.,* 2023).

We determined the value of the synthetic measure (separately for entrepreneurship and CE) based on the formula (7):

$$q_i = \frac{d_i^-}{d_i^- + d_i^+} \tag{7}$$

in which: $q_i \in [0; 1]$; d_i^- – means the distance of the object from the anti-pattern (from 0), d_i^+ – denotes the distance of the object from the pattern (from 1).

The CRITIC-TOPSIS method allows for an objective evaluation of alternatives, considering correlations and weights of criteria, automatically calculated from the data. It combines multi-criteria analysis with an intuitive approach to classification, making it effective for spatial and economic analyses.

At the final stage of the research, we grouped countries in terms of entrepreneurship and CE. We also preseted maps of spatial variation, bag charts, and descriptive statistics (performed in Statistica software). In addition, we calculated Spearman's rank correlation coefficient.

The EU countries surveyed, based on a synthetic measure including mean ($\overline{x}$) and standard deviation (S_d), were divided into four groups. The size of the synthetic measure in the first group indicated the better unit. In subsequent groups, it indicates weaker units. We performed grouping according to the formula (8):

$$\begin{aligned} &\text{group 1: } \overline{x} + S_d \leq q_i \\ &\text{group 2: } \overline{x} \leq q_i < \overline{x} + S_d \\ &\text{group 3: } \overline{x} - S_d \leq q_i < \overline{x} \\ &\text{group 4: } q_i < \overline{x} - S_d \end{aligned} \tag{8}$$

To assess the differentiation (inequality of distribution) of the study population, we calculated the Gini coefficient (9):

$$G(y) = \frac{\sum_{i=1}^{n}(2\mathrm{i} - \mathrm{n} - 1)y_i}{\mathrm{n}^2 \overline{y}} \tag{9}$$

in which, yi is the value of the i-th observation, and $\overline{y}$ is the average value of all observations yi; G(y) ∈ [0.1] (Prus *et al*., 2021).

RESULTS AND DISCUSSION

The use of a synthetic measure of entrepreneurship and CE in EU countries (with an indication of the countries of the Eastern Bloc) in 2013 and 2020 is an effective way to compare disparities between countries. The research confirmed that in 2020, there was a positive change in both areas studied in all EU countries compared to 2010. In 2020, the value of the synthetic measure of entrepreneurship ranged from 0.36 to 0.79 (0.31-0.70 in 2013), and for the synthetic measure of CE in 2020. - 0.39 to 0.58 (in 2013 0.37 to 0.58). In the area of entrepreneurship, Malta, the Czech Republic, and the Netherlands were in a better situation, while Italy, Spain, and Greece were in a weaker situation (in 2020). On the other hand, in CE, the Netherlands, Slovenia, Italy recorded a better situation and Denmark, Portugal, and Greece a weaker one (in 2020). In Poland, the level of q entrepreneurship ranged from 0.50 to 0.62, q CE - 0.46-0.48, resulting in a change in the country's position in the overall

ranking. This shows a growing gap between EU countries and Poland. This shows a widening gap between the countries. This is an unfavourable phenomenon in the context of the policy of equalizing differences in regional development in the European Union. In the relationship of 2020 to 2013, the countries of Austria, Finland, Italy, Luxembourg, Sweden – in the aspect of entrepreneurship – and Austria, Belgium, the Czech Republic, Hungary, Latvia, Luxembourg, Malta, Portugal, and Sweden recorded a decrease in the value of the synthetic measure (Table 2).

Table 2. The EU country groups by synthetic measure of entrepreneurship in 2013 and 2020

Country	group	2013 q	position	group	2020 q	position	change q	group	2013 q	position	group	2020 q	position	change q
	measure of entrepreneurship							measure of CE (Circular economy)						
Malta	b	0.58	11	a	0.79	1	0.36	b	0.49	9	d	0.42	25	-0.14
Czechia	a	0.69	2	a	0.78	2	0.13	b	0.48	11	c	0.46	16	-0.04
Netherlands	a	0.68	3	a	0.75	3	0.1	a	0.58	1	a	0.58	1	0
Hungary	c	0.52	16	a	0.71	4	0.37	b	0.48	12	c	0.46	19	-0.04
Slovakia	c	0.51	17	a	0.71	5	0.39	b	0.47	16	b	0.5	9	0.06
Estonia	a	0.65	4	b	0.7	6	0.08	d	0.39	24	c	0.46	17	0.18
Slovenia	b	0.61	8	b	0.67	7	0.1	b	0.48	13	a	0.55	2	0.15
Portugal	c	0.49	19	b	0.66	8	0.35	c	0.45	20	d	0.39	27	-0.13
Sweden	a	0.7	1	b	0.66	9	-0.06	b	0.49	10	b	0.47	15	-0.04
Poland	c	0.5	18	b	0.62	10	0.24	c	0.46	19	b	0.48	13	0.04
Cyprus	c	0.48	20	b	0.61	11	0.27	d	0.37	27	d	0.42	23	0.14
France	b	0.57	12	b	0.61	12	0.07	b	0.5	6	b	0.51	6	0.02
Lithuania	b	0.61	7	b	0.61	13	0	b	0.47	15	b	0.49	11	0.04
Latvia	b	0.54	15	b	0.6	14	0.11	a	0.52	5	b	0.5	8	-0.04
Ireland	c	0.48	21	c	0.59	15	0.23	d	0.39	25	c	0.43	21	0.1
Belgium	b	0.55	14	c	0.58	16	0.05	a	0.55	2	a	0.52	4	-0.05
Denmark	b	0.56	13	c	0.58	17	0.04	d	0.41	23	d	0.42	24	0.02
Austria	b	0.61	6	c	0.57	18	-0.07	a	0.52	4	b	0.49	10	-0.06
Finland	b	0.59	9	c	0.57	19	-0.03	c	0.46	17	c	0.46	18	0
Germany	b	0.58	10	c	0.57	20	-0.02	c	0.46	18	b	0.5	7	0.09
Luxembourg	b	0.63	5	c	0.56	21	-0.11	b	0.5	7	b	0.47	14	-0.06
Bulgaria	c	0.45	23	c	0.54	22	0.2	c	0.43	21	c	0.44	20	0.02
Romania	c	0.44	24	d	0.48	23	0.09	c	0.43	22	c	0.43	22	0
Croatia	d	0.36	25	d	0.47	24	0.31	b	0.49	8	a	0.52	5	0.06
Italy	c	0.46	22	d	0.43	25	-0.07	a	0.53	3	a	0.53	3	0
Spain	d	0.31	27	d	0.37	26	0.19	b	0.48	14	b	0.49	12	0.02
Greece	d	0.31	26	d	0.36	27	0.16	d	0.38	26	d	0.39	26	0.03

Note. Sorted by 2020 (q entrepreneurship).
Source: own study based on Eurostat data.

The circular economy seeks to keep materials, raw materials, and product value in the economic cycle for as long as possible and to minimize the amount of waste generated. The realization of these goals in Poland is at a relatively low level. Corsini and Fontana *et al.* (2024) indicate that closed-loop value management requires responsible use of resources in the production of goods and services, as well as proactive and conscious consumption behaviour aimed at preserving closed-loop value. D'Adamo *et al.* (2024) point to a stronger synergy between the technical and sustainability dimensions than between the economic and sustainability components in terms of CE.

We divided EU countries (including the Eastern bloc) into four groups in terms of q entrepreneurship and q CE based on the mean and standard deviation. Figure 1 shows the classification

due to the synthetic measure. The dark colour indicates the group of countries characterized by a better level of the synthetic measure, and the lighter colour – a weaker level.

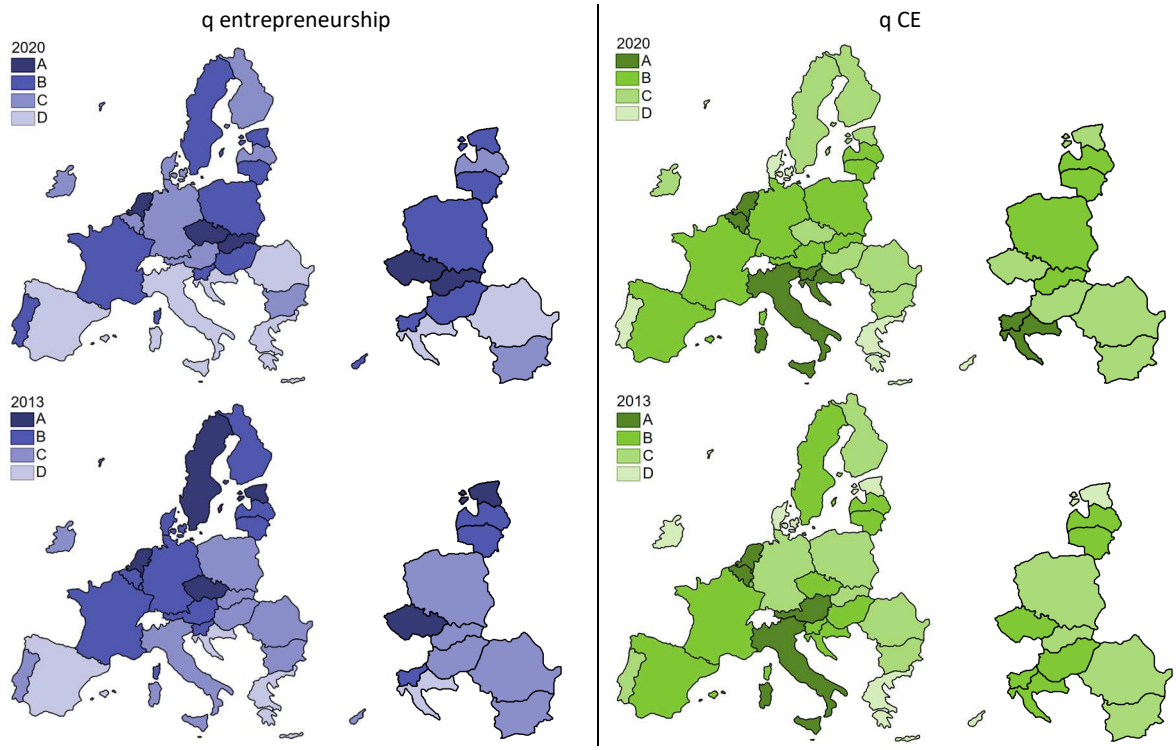

Figure 1. EU country groups by the synthetic measure of q entrepreneurship and q CE
Source: own elaboration based on Eurostat data.

The development of entrepreneurship in the European Union is increasingly influencing the degree of competitiveness of member economies, mainly by influencing economic growth or bridging the gap in economic and social development. Possible measures to bridge the disparity in the level of entrepreneurship include reducing barriers to business start-ups, reducing the cost of operating businesses, simplifying the tax and social security system, and increasing the availability of financial capital. Let us also note the leading role of the European Union in promoting and implementing policies to combat climate change and environmental sustainability, which therefore opens up opportunities for technological development and entrepreneurship (Ruiz *et al*., 2023).

Figure 2 provides information on the relationship (dependence) between the synthetic measure of entrepreneurship and the CE measure, and shows outlier observations. For the EU – Eastern Bloc countries, the correlation of the synthetic measure of entrepreneurship and CE in 2020 has a low level (in relation to 2013, it increases). This may indicate an increase in the importance of CE in the process of changing the economy.

We may see the transition to CE by public and private organizations as an entrepreneurial act involving their strategies, business models, structures, and processes. It also underscores the impact of CE principles on organizations that are transitioning to more sustainable development (Dragan *et al*., 2024). Table 3 presents the correlation values (positive, negative) of the synthetic measure of q entrepreneurship and q CE and their diagnostic variables. In the largest section, entrepreneurship was correlated with the rate of use of circular materials, trade-in recyclable raw materials, resource productivity, material footprint, dependence on material imports, greenhouse gas emissions from production activities, and consumption footprint.

The measure of inequality of the distribution of values 0.181-0.175 (2013-2020) for the synthetic measure of entrepreneurship, 0.133-0.120 for the CE measure in the case of EU countries. For the EU – Eastern Bloc countries respectively: 0.282-0.268 and 0.220-0.220. The higher the value of the indicator, the greater the degree of concentration of the synthetic measure and the greater its variation.

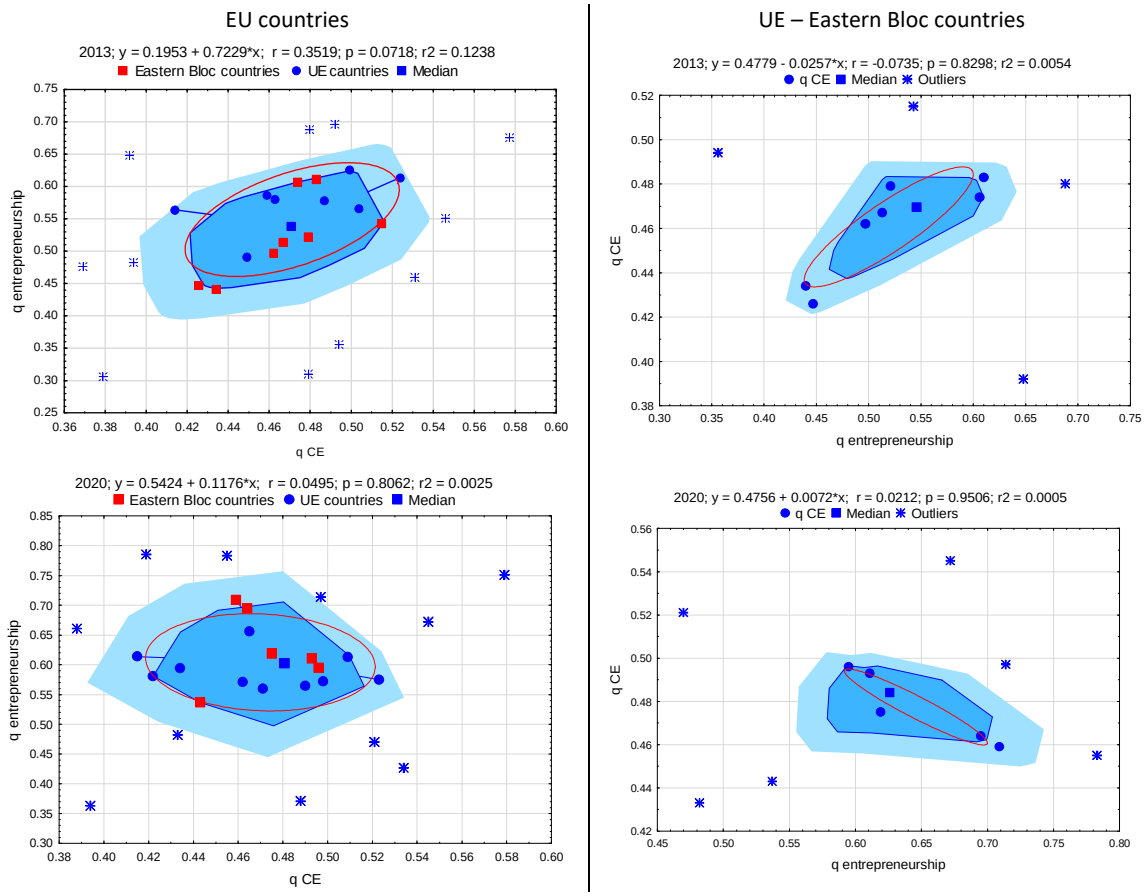

Figure 2. Differentiation of EU (also Eastern Bloc countries) countries in terms of q entrepreneurship and q CE
Source: own elaboration based on Eurostat data.

In the process of systemic transformation, the former Eastern Bloc countries, in addition to the barriers to entrepreneurial development inherent in Western European countries, had to overcome obstacles specific to their political and economic situation, administrative and legal solutions, taxation, financial barriers, competition, or the macroeconomic situation. Del Olmo-García *et al.* (2023) indicate that population loss (especially of young people) has fundamental consequences for the economic, social, and environmental sustainability of rural areas, as well as entrepreneurial activity. This phenomenon affects both developing and developed countries, among which Spain is a paradigmatic example, including Poland. As a network approach and an integrative approach (holistic models) in terms of changes in the field of entrepreneurship, especially in the conditions of a circular economy, international entrepreneurial orientation is also becoming an important element. The indicated process enables companies to identify and take advantage of internationalization opportunities, reflects the company's overall proactiveness and aggressiveness in its pursuit of international markets (Wach *et al.*, 2025), as well as exploring global opportunities through specific local businesses (Wach, 2013).

The results of the analysis of the synthetic measure of entrepreneurship and CE in EU countries are of considerable theoretical and practical interest. Theoretically, they confirm the development of the CE concept as a key element of sustainable development and point to the increasing role of innovation and entrepreneurship in achieving environmental goals. Practically, the results provide a basis for the formulation of economic policies that support the transition to a circular economy, especially in countries with lower development levels. They also help to identify areas for support, such as increasing resource efficiency or promoting more sustainable production practices. In particular, it is necessary to increase support for technological innovation and pre-enterprise development in sustainable production, especially in countries with a lower level of CE. It is also important to promote environmental education and awareness among entrepreneurs and consumers. At the same time,

efforts should be made to improve recycling and resource recovery infrastructure and to implement fiscal and regulatory incentive policies to support the transition to a circular economy.

Table 3. The correlation (Spearman's rank) of the synthetic measure of q entrepreneurship and q CE and their structure variables of EU countries in 2013 and 2020

Diagnostic variables	EU countries				UE – Eastern Bloc countries			
	2013		2020		2013		2020	
	q entrepreneurship	q CE	q entrepreneurship	q CE	q entrepreneurship	q CE	q entrepreneurship	q CE
Unemployment by sex and age – annual data	-0.8	-0.3	-0.5	0.01	-0.6	0.25	-0.5	0.38
Deaths of enterprises in t – number	0.09	-0.1	0.39	-0.1	0.61	0.16	0.55	-0.02
Births of enterprises in t – number	0.29	0.04	0.82	-0.1	0.75	0.21	0.72	0.12
Population of active enterprises in t – number	0.24	0.07	0.61	-0.1	0.8	-0.02	0.85	0.2
Employment and activity by sex and age – annual data	0.87	0.23	0.71	-0.06	0.91	0.05	0.73	-0.04
Recycling rate of waste of electrical and electronic equipment (WEEE) separately collected	-0.2	0.1	-0.3	0.12	-0.3	0.5	0.13	0.54
Recycling rate of municipal waste	0.43	0.43	-0.1	0.7	0.42	0.18	0.43	0.55
Circular material use rate	0.5	0.59	0.23	0.59	0.54	-0	0.66	0.15
Trade in recyclable raw materials	0.09	0.16	-0.1	0.18	0.05	0.41	-0.6	0.59
Generation of municipal waste per capita	0.14	0.06	-0.03	-0.1	0.04	0.39	0.36	0.47
Resource productivity	0.16	0.54	-0.1	0.37	0.2	0.71	0.46	0.74
Material footprint	0.41	-0.4	0.03	-0.4	0.25	-0.7	-0.3	-0.5
Material import dependency	0.3	0.6	-0.02	0.46	0.53	0.5	0.28	0.86
Greenhouse gases emissions from production activities	0.35	-0.3	0.04	-0.1	0.54	-0.6	0.48	-0.3
Consumption footprint	0.43	0.22	0.11	-0.03	0.74	0.32	0.34	0.29
Private investment and gross added value related to circular economy sectors	0.25	0.37	0.07	0.28	-0.1	-0.1	-0.5	0.19
Persons employed in circular economy sectors	0.13	0.14	0.3	0.13	0.99	0.12	0.99	0.01

Note. Marked correlation coefficients are significant with $p < 0.05000$.
Source: own study based on Eurostat data.

CONCLUSIONS

The use of a synthetic measure to assess entrepreneurship and the circular economy in EU countries in 2013 and 2020 allows for an effective comparison of differences between countries. The research shows that all EU countries have improved in both areas in 2020 compared to 2013, although there are significant regional differences. For entrepreneurship, Malta, the Czech Republic, and the Netherlands are the best performers, while Italy, Spain, and Greece were the worst. For CE, the Netherlands, Slovenia, and Italy were the best performers, while Denmark, Portugal, and Greece were the worst. Poland was in the middle in 2020, with a pre-entrepreneurship level of between 0.50 and 0.62 and a CE level of between 0.46 and 0.48, indicating a gradual widening of the gap between Poland and the rest of the EU, which is unfavourable in the context of policies to equalize regional development. Between 2013 and 2020, some countries, such as Austria, Finland, Italy, and Sweden, showed a decrease in the values of the synthetic measures, indicating changes in the dynamics of entrepreneurship and the circular economy in the EU.

The relationship between entrepreneurship and CE was clearly neither positive nor negative. During the period under review, we noted a trend in both the growth and decline of this relationship (between the circular economy and entrepreneurship). There are some countries (*e.g.*, Malta,

Czech Republic, Estonia) in which a relatively high level of entrepreneurship coincided with a lower level in the aspect of CE. On the other hand, for Spain, Greece, and Romania, we observed low levels of both processes under study. There is also a group of countries (Cyprus, France, Poland) in which, both in terms of entrepreneurship and CE, we observed average values of the studied phenomena. With a circular economy, companies can not only improve their efficiency but also gain a competitive advantage in the marketplace, build a stronger brand image and comply with growing environmental and regulatory requirements. The circular economy promotes the efficient use of resources through reuse, recycling and minimizing waste.

Entrepreneurs in Central and Eastern Europe should capitalize on the growing demand for sustainability technologies and eco-innovations by adapting business models to changing EU regulations. Investing in digitalization, skills development, and international cooperation will be crucial to increasing competitiveness. Entrepreneurs should also monitor available EU funds to support green solutions. Financial and technical support should be targeted at regions lagging in implementing modern economic solutions, and a common legal system for the green economy is needed.

Entrepreneurship development supports innovation and job creation and increases the competitiveness of the economy. Supporting businesses in the technology, sustainability, and digital sectors helps to develop new industries and improve efficiency. Supporting start-ups and SMEs through funding, advice, and administrative simplification stimulates economic growth and labour market stability. However, there are clear differences in the development of entrepreneurship and the circular economy in EU countries, including the Eastern Bloc countries, which affect economic transformation processes. Noteworthy, these differences can influence economic transformation processes, including increased competitiveness of economies, efficient use of resources, and reduced environmental impact.

The survey was limited to the range of publicly available diagnostic changes available in public statistics (some possible dates are unavailable and incomplete for all years surveyed). It is also hampered by the lack of an unambiguous definition regarding the interpretation of the circular economy or the multidimensionality of entrepreneurship, making it difficult to conduct research and draw conclusions or to indicate diagnostic variables (*e.g.*, indicating sustainable entrepreneurship).

The clustering results may be the beginning of further in-depth research to determine which variables have had a decisive impact on the CE transition process and changes in the area of entrepreneurship. Further empirical research is needed on the implementation of CE, the relationship with variables of demographics, financial situation, environmental changes, and also their impact on changes in the area of entrepreneurship. It also seems reasonable to verify whether, and to what extent, the impact of entrepreneurship on development is lagged by time.

The study makes international comparisons between entrepreneurship and CE. The value of the article is the set of variables and the results of the analysis presenting the indicated relationship in the EU countries, with an indication of the Eastern Bloc countries in 2013 and 2020. It is an important stimulus in the discussion on strengthening the effectiveness of CE implementation in the conditions of a country and its impact on entrepreneurship changes. Most often, scholars analyse the areas of entrepreneurship and CE separately.

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Use of Artificial Intelligence

The authors did not use artificial intelligence in the process of preparing the article.

Conflict of Interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Linking digital transformation, organizational strategic intuition, entrepreneurial orientation, and sustainable operation performance in the Vietnamese food industry

It Nguyen Van

ABSTRACT

Objective: This study aims to assess the role of the relationship between organizational strategic intuition, which serves as a mediator, and entrepreneurial orientation, which serves as a moderator. This will help us better understand how digital transformation leads to sustainable operation performance. Moreover, business seniority, business size, and degree of level of digitalization all contribute to variance analysis.

Research Design & Methods: The development of an empirical investigation utilized a quantitative methodological technique. I gathered data for the survey of 368 managers or owners who worked for various food processing businesses in Vietnam. I evaluated the acquired data using partial least squares structural equation modelling (PLS-SEM) and multigroup analysis.

Findings: The results showed that digital transformation positively affected sustainable operation performance, organizational strategic intuition mediated the interaction between digital transformation and sustainable operation performance, and entrepreneurial orientation modified the association between digital transformation and sustainable operation performance of enterprises.

Implications & Recommendations: Strategic intuition is an organizational competency appropriate for the organization with the resources, assets, and capabilities that are suitable for the organization in terms of the theory of sustainable competitive advantage, thanks to the study's contribution of new knowledge about expanding concepts of digital transformation, organizational strategic intuition, and entrepreneurial orientation. Based on the research's conclusions, I want to improve Vietnamese food enterprises' standard operating procedures (SOPs) in the context of globalization, free trade, the state of science and technology, etc., under pressure in the current competitive environment. The necessary steps to this aim are giving governance implications and aiding the business in creating a connection between digital transformation, organizational strategic intuition, entrepreneurial orientation, and sustainable operation performance in the future.

Contribution & Value Added: This study examines the relationship between digital transformation, organizational strategic intuition, and sustainable operation performance as well as the moderator function of entrepreneurial orientation and the degree of digitization in the food business in Vietnam, a developing market. Research shows that Vietnamese food companies need to improve sustainable operations to keep up with globalization, scientific and technological advances, and market trends. I made some conclusions to assist institution administrators in realizing the importance of strengthening the connections between digital transformation, organizational strategic intuition, entrepreneurial orientation, and sustainable operation performance in the upcoming stage.

Article type:	research article
Keywords:	digital transformation; organizational strategic intuition; sustainable operation performance; entrepreneurial orientation; and food industry
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INTRODUCTION

Digital transformation (DT) mainly embraces the fourth industrial revolution, which is currently in full swing. The core of DT is to analyze every part of the business by using digital characteristics such as copying, linking, simulation, and feedback. One can raise the total operational level of the company by exploiting clearly defined quantities and data, analysis, and optimization of consumption targets, as well as management tailored to every last detail. Businesses that must adapt to the new cycle of industrial transformation trends and science and technology revolution trends reap the benefits of increasing their understanding of digital technology and improving their ability to perceive quickly, act quickly, and make well-informed decisions. This enhances risk management and contributes to sustainable development in the digital era. According to the success stories of numerous traditional industries, it is typical for organizations to boost each link's performance by 30-50% after completion can increase its effectiveness by 8-10 times (Teng *et al.,* 2022).

We may also refer to employee strategic intuition as the organizational strategic intuition (OSI) to conduct its strategic decisions, even though it is an individual's perception. According to resource advantage theory, we must give attention to a firm's internal resources when identifying possible assets, capabilities, and capacities, to increase sustainable operation performance (SOP) (Barney, 1991). Strategic intuition is an individual perception, but from an organizational view, employee strategic intuition (OSI) helps in making strategic decisions. Knowledge capital influences economic performance, providing sustainable funding and adding value to businesses (Jordão *et al.,* 2022). In organizational environments, there have only been a few prior studies on strategic intuition and outcome empirical investigations. Therefore, by emphasizing OSI and researching OSI's mechanism in input-process-output or moving beyond conceptual thinking to practical methodology, this work has attempted to elaborate the gap theory. Strategic intuition is encouraged by cognitive, dynamic management and absorptive information, according to earlier research (Jutidharabongse *et al.,* 2020). These additional findings provide credence to the idea that an organization's knowledge management capabilities influence the development of strategic intuition. Because earlier research on knowledge management, capabilities, and the introduction of dynamic capabilities based on tri only provided insufficient data, the current study attempts to develop the results on such an empirical basis. Digital Transformation refers to a group of strategies that help digital entrepreneurs accelerate their business growth through technology. These approaches simplify the use of distributed systems, enhance mobility, and leverage virtualization to improve operations. By embracing DT, companies can sharpen their competitive advantage (Loonam *et al*., 2018), During the COVID-19 pandemic, DT proved especially critical, enabling businesses to deliver essential information to clients efficiently (Schoeman *et al*., 2021). By increasing operational effectiveness, the benefits of DT have enriched performance (Guo & Xu, 2021). However, no research has been done on the connection between DT and OSI. Therefore, this study evaluated this theoretical issue. According to findings from earlier studies, strategic intuition from a competence viewpoint, or strategic intuition competency, magnifies enterprise performance and the organization's dynamic strategy as well as innovation performance. To evaluate a comparable relationship in an organizational setting, this study, which has a similar goal, took a different approach. Furthermore, the notion of SOP has been employed to flexibly change the performance variable. To develop into an SOP, long-term rivalry in the corporate world including research interests in innovation, technology, and the environment, an organization must grow its effectiveness, capacity to serve customers' requirements, competitive advantage, and dominance over rivals (Songkajorn *et al*., 2022). According to in-depth research (Ferreira *et al.,* 2019; Covin & Slevin, 1989), businesses gain from entrepreneurial approaches when they face novel and unknown issues. Such a company response most likely has its roots in entrepreneurial orientation (EO) or its engagement and strategic orientation in favour of innovation, initiative, and risk-taking (Covin *et al.,* 2020; Covin & Lumpkin, 2011). However, the advantages of a business approach are different for food firms that are in the process of transitioning to digital value creation, *i.e.*, seizing the opportunities brought about by technological development. With no doubt (Kraus *et al.,* 2019a), a more conservative approach can produce the same or greater profits for one organization than another because clients,

especially elderly customers in particular, occasionally disagree with the creation, application, and deemed worth of digital services like online tools (Niemand *et al.,* 2021). According to a study by Nguyen *et al*. (2023) it is asserted that for companies operating in the food industry in Vietnam, those that effectively implement digital transformation (DT) experience a significant improvement in business performance. According to research, a strategic transformation strategy, digital technology, and digital competencies are required for the success of metrics transformation. Digital technology serves as the basis for DT, digital talents are its secret, and DT strategy serves as its primary objective. This investigation augments knowledge and comprehension of the DT of the food business, broadens the field of existing research on DT, and promotes effective transformation by investing money in digital, necessary resources. It also offers references, methodologies, and routes for company management techniques. Due to their lack of resources, the majority of Vietnam's food firms find it challenging to address these complicated problems. We think that the goal of DT is innovation and that, via it, firms in poor nations have discovered a fresh approach to growth (Teng *et al.,* 2022). Businesses in developed nations have the advantage of flexibility and the capacity to adopt new changes when compared to those in less developed nations. To start going digital is a pretty simple organizational change strategy for businesses. We contend that attaining competitive advantage requires consideration of both the level of digitalization (LD) and the amount to which businesses must strategically acquire income and grasp market opportunities. Businesses may either function without a clear vision or build a DT vision and provide customized packages or new online services as part of their company plan. Moreover, they can employ various DT strategies, which we can distinguish by various degrees of business intensity. As companies roll out online goods, services, and features that have been effective, one strategy for LD in business would be to adopt a wait-and-see attitude (Niemand *et al*., 2021). In contrast, a business-oriented approach to LD (Kraus *et al.,* 2019a) would expose novel online services to competition (Lumpkin & Dess, 1996) while acknowledging that such services might not deliver extra benefits for revenue, profit, or customer pleasure. This study focuses on linking DT, OSI, EO, and SOP in the Vietnamese food industry. I also tested the moderating effect of DT level and the control variable for firm size and company seniority influencing SOP. Thus, I examined the following four research inquiries:

RQ1: How does digital transformation impact an organization's ability to operate sustainably?

RQ2: How does organizational strategic intuition mediate the relationship between digital transformation and the viability of business operations?

RQ3: How does the entrepreneurial mindset influence the relationship between digital transformation and an enterprise's capacity for sustainable operation?

RQ4: Is the level of current digitalization necessary for an entrepreneurial strategy to succeed in the food industry?

Based on these inquiries, I developed study aims to comprehend the connections and effects among variables operating a structural model. I focused on companies in the food industry because they produce significant amounts of money for Vietnam. Thus, this work offers theoretical and applied contributions. I expanded the theoretical idea of DT, OSI, and EO, which has never been done previously in the context of an organizational setting. The scholarly concept will grow as a result of new results. Moreover, it offers a framework for empirical proof of concept that makes it easier to reform DT and build OSI and EO to improve SOP. This essay's remaining sections are organized as follows. The next section will present the literature background and formulation of the hypothesis. Next, I will describe the research method. Then, I will present the results. In the following section, I will expose the analysis and conclusion. Finally, I will discuss restrictions and future research.

LITERATURE REVIEW AND HYPOTHESES DEVELOPMENT

Resource-based View (RBV) Theory

One of the earliest academics to support the idea of corporate resources was the American economist Penrose. He exemplifies resources as tangible items that a company buys, rents, or produces for its use as well as a workforce that is employed under specific circumstances. The author also underlines

how each company has its distinct qualities due to the variety of service performance or production capabilities developed by businesses utilizing their resources (Penrose & Penrose, 2009). We may track the initial presentation of the resource-based theory back to Wernerfelt (1984), within the context of a resource-based company. According to Barney (1991), some businesses may stand out from the competition in some way and maintain their edge. Resource-based theory places a strong emphasis on strategic decisions and holds that finding, developing, and allocating resources in a way that maximizes profits is a strategic challenge for corporate management. In line with Peteraf (1993), for a firm to attain a sustainable competitive advantage, it is necessary for the resources under its control to fulfil four criteria: they must possess value, rarity, uniqueness, and irreplaceability. Taking this resource-based perspective and refining this idea, Teece *et al.* (1997) denoted dynamic competencies as the ability to integrate, build, and reconfigure a firm's internal and external capabilities to cope with a quickly changing environment. The dynamic capacity theory grew from this in a gradual yet quick manner. Depending on their DT level, businesses have varying requirements when it comes to elements such as organizational structure, organizational culture, growth strategy, digital resources, and other related competencies. Their coordination and adaption will help increase firm sales (Verhoef *et al.,* 2021). However, SMEs have trouble starting their DT journey because of a lack of resources and skills, according to several recent studies. The dynamic capabilities might help DT as a support mechanism (Fischer *et al.,* 2020). Furthermore, a company's DT is significantly impacted by awareness of learning integration, digital leadership, and critical resources, where awareness and learning capacity are also crucial elements that stimulate corporate revenue (Matarazzo *et al.,* 2021). Dynamic capabilities play a mediating role in the relationship between digital transformation (DT) and firm performance. They not only mediate the impact of DT on innovation performance at the individual level but also have an overall influence on the relationship between DT, entrepreneurial orientation (EO), and innovation performance. The association between performance and the three interaction effects of EO is also mediated (Teng *et al.,* 2022). I used resource-based theory to examine the pertinent literature and better comprehend our DT and SOP assumptions.

Digital Transformation

Even if academics and professionals are currently more interested than ever in DT, there are still differing opinions about what it actually implies (Osmundsen *et al.,* 2018). Academics regard it as a business model (Henriette *et al.,* 2016), a process (Hausberg *et al.,* 2018), or a strategy (Kane *et al.,* 2015). The majority of economists place a strong emphasis on adopting new digital technology to significantly enlarge business (Fitzgerald *et al.,* 2014). The phrase DT refers to major changes based on a combination of information technology, computation, communication, and networking rather than a single technology, which is a crucial distinction to make (Bharadwaj *et al.,* 2013). A combination of sophisticated technologies is incorporating physical and digital systems (EC, 2018). It is crucial that not all DT technologies be digital. Delivery trucks, forklifts, and conveyors are examples of nondigital technologies that can be integrated into DT (Mathauer & Hofmann, 2019) provided that they are fitted with new technological components that allow, for example, for tracking based on position and speed. The function of exploiting people's digital capacities in DT was added by Morakanyan *et al.* (2017). Operational efficiency, a better customer experience, an upgraded business model, strategic differentiation, a competitive advantage, refined stakeholder relationships, cost savings, and other values are among those cited as DT's main outputs (Morakanyane *et al.,* 2017). Moreover, DT is a continual process that fluctuates as an organization executes its level of digital maturity, which is assessed by how well it has adapted to the current condition of the digital business ecosystem (Kane *et al.,* 2017).

Organizational Strategic Intuition (OSI)

According to RBV, internal resources are necessary for creating a persistent competitive advantage (Barney, 1991). Because of this, the study's methodology views OSI as an organization's capacity to understand strategies or decide how to react in risky scenarios. Since it is a fresh concept, applying the concept of strategic intuition is crucial to advancing comprehension. Intuition or a sense of insight is the ability to perceive or understand something instinctively without having to research or analyze it

(Songkajorn *et al.,* 2022). Everyone can benefit from intuition by changing their perspective, acting wisely, finding their passion, recognizing possibilities, and achieving goals even with little resources. The higher self can connect with a person through intuition in a variety of ways, enclosing sensations and pictures (Songkajorn *et al.,* 2022). Without consulting any evidence, people might begin the decision-making process by making use of their intuition (Kuusela *et al.,* 2020). Making efficient strategic decisions necessitates the simultaneous use of intuition and rationality, two very different thought processes (Calabretta *et al.,* 2017). Experts can generate solutions by applying both analysis and intuition, alternating between the two techniques (Okoli & Watt, 2018). Conforming to Klein *et al.'s* (1986) recognition-based decision-making model, due to the balance, intuition is more likely than analysis. First impressions that are formed intuitively and naturally tend to be broken by reminders. Although intuition operates implicitly, analysis is not always at odds with it. In conformity with Songkajorn *et al.* (2022), intuition is an analysis linked to habit and the capacity for swift perception-based reactions. Furthermore, the speed and simplicity of the application of intuition and analysis are two mental processes that stand out clearly from one another.

Entrepreneurial Orientation

Rigtering *et al.* (2017) claim that the idea of EO often refers to managerial techniques and initiatives that result in new commercial ventures in developing or mature markets, with either current or outdated goods or services. Prior to that, Miller (1983) and Covin and Slevin (1989) proposed the most general idea of EO, which refers to a company's strategic orientation vision toward innovation, initiative, and risk-taking. As stated by Lumpkin and Dess (1996), innovation refers to the processes of novelty and creativity as well as the creation of new ideas through experimentation. Being proactive means looking for fresh opportunities that might or might not relate to the current stream of activities. It also refers to introducing new products and brands before competitors and strategically phasing out old activities that are nearing their peak or declining in importance (Venkatraman, 1989). The uncertainty that results from top managers or businesses acting in an entrepreneurial spirit is referred to as risk-taking. Incorporating research done in numerous cultural situations (Semrau *et al.,* 2016) and diverse industries (Rigtering *et al.,* 2014), one of the most influential subfields of entrepreneurship studies is now called EO (Covin & Lumpkin, 2011). For the most part, these studies have shown a positive relationship to business performance. As explained by Hambrick and Mason (1984), we may find the theoretical foundations of EO at the top, which suggests that organizations eventually take on the characteristics of their top management. The strategic centre of a business actually has the most influence on crucial decisions like where to enter new markets, where to invest in technology, and how much service to offer (Eggers *et al.,* 2017). Nonetheless, individuals operating at discrete organizational levels can plan, organize, and conduct business operations on behalf of the company (Wales *et al.,* 2011). Consequently, scholars frequently view EO as the result of senior management's propensity for entrepreneurship and the actions of organizations that exhibit entrepreneurial behaviour by placing a premium on initiative, innovation, and risk-taking at the corporate and management levels (Covin & Wales, 2012). In agreement with Wales *et al.* (2020), the organizational structure of EO fosters innovation and risk-taking behaviour. It also demonstrates a forward-looking mindset. The outcomes of EO are not always positive and may occasionally lead to failure or, in more catastrophic situations, insolvency (Wiklund & Shepherd, 2011). Basic EO studies (Lumpkin & Dess, 1996) have built on stochastic theory (Burns & Stalker, 1961) to comprehend the circumstances in which EO leads to firm performance. According to the stochastic theory, attaining a high degree of business performance requires that the important variables be in agreement with one another (Donaldson, 1995).

Sustainable Operation Performance

Conforming to Waterman and Peters' (1982) book, where SOP originally appeared, a company that upholds a strong culture and alignment between leadership, strategy, structure, and staff abilities is considered to have SOP. This notion has grown and ameliorated over time. To beat its rivals in terms of financial performance over the long term, De Waal (2007) described SOP as an organization that manages long-term and builds an integrated management structure, continuous improvement, and

core competencies, regarding its personnel as its most precious assets. SOP was previously construed by Amah and Oyetunde (2019) as an organization that integrates economic terms, social and environmental achievements, and actions to achieve an observable consequence. They also suggested that SOP activities consider how to preserve the economic and social environment. Theorists contend that De Waal (2007) is widely mentioned in investigations even though we may divide SOP into sundry components. The study explores the concept of SOP in relation to organizational activities and aims to present fresh and captivating perspectives while also respecting traditional notions. It considers elements such as innovation, technology, and the environment, recognizing their significance in maintaining a competitive edge for organizations amidst rapidly changing conditions and unpredictable global economic circumstances (Liu *et al.,* 2021). By exploiting new or enhanced production techniques and introducing new or revised items to the market, innovation increases revenues while lowering costs (Rahimnia & Molavi, 2021). The company efficiently supports its operations with technology. Organizations also employ IT to make it easier for people to share information and build expertise (Nieves & Osorio, 2019). Furthermore, businesses should listen to community requests, practice corporate social responsibility, or protect the environment to boost community engagement. Moreover, maintaining performance requires both the usage of awareness-raising materials and the updating of necessary skills in light of current trends (Al Koliby *et al.,* 2022).

Hypotheses Development

Because adopting DT will boost a firm's SOP, this study hypothesizes that a food company with DT will perform better financially and non-financially than a company without DT. The widespread adoption of digital technology can boost productivity, significantly lower maintenance and inventory costs, and better the effectiveness of production tools. By incorporating numerous digital technologies into its everyday operations, an organization that opts for the DT approach also displays a desire to increase commercial value. Moreover, the pursuit of DT by a company will be incorporated into the corporate culture, enhancing its competitiveness (Gatignon & Xuereb, 1997). Furthermore, the development of digital technology can successfully address the issue of asymmetric information and lower the costs associated with data collection, product creation, and contract performance, while simultaneously elevating the effective use of resources by businesses (Lin & Kunnathur, 2019). To reduce resource consumption and production costs, efficiently address the production capital shortfall, and optimize the allocation of production means, businesses might share technology, equipment, and services (Lyytinen *et al.,* 2016). Businesses can access new relationships and information thanks to DT, which fosters innovation and the globalization of markets (Parida *et al.,* 2012). The DT strategy as a whole encourages innovation, cost reduction, and a company's sustained competitive advantage. As a result, a company with DT will have a higher SOP than a company without DT. It demonstrates how DT aids in the creation of a company's business model (Hess *et al.,* 2020). Furthermore, DT creates fascinating chances for creativity and has the potential to become the main source of innovation (Secundo *et al.,* 2020). To foster innovation and entrepreneurship, digital infrastructure enables computing, communication, and teamwork capabilities (Nambisan, 2017). To create value and get an advantage over the competition, almost all firms employ DT. This enables them to reconfigure their networks, strengthen communication channels with suppliers and customers, and boost their flexibility and capacity (Vial, 2019). The organization will accomplish SOP thanks to digital technologies. Consequently, I hypothesized:

H1: The actual combination of barriers and stimuli has been oriented on restructuring of Russian export.

Digital transformation upgrades and combines information technology, computing, communication, and connection within an organization to take advantage of digital opportunities, create innovation, and have an impact on business (Vial, 2019). Digital transformation makes it easier for implicit knowledge to become explicit knowledge and vice versa (Fernandes, 2018). Members of the organization have this knowledge stored in their collective memories, which is consistent with the emergence of the first stage of strategic intuition. Moreover, in the OSI development process' final stage, the DT's decision and determination to drive activities (Von Clausewitz, 1968) effectively support the organiza-

tion's desired strategy. DT affects the changing goods, organizational structure, and processes because it is connected to a shift in the organization's business model (Hess *et al.,* 2020). It is performed by employing digital technology, such as platforms, infrastructure, and artifacts (Nambisan, 2017). In line with RBV, DT is an organizational resource that supports OSI capabilities to acquire a long-lasting competitive advantage (Barney, 1991). Because of this, I hypothesized:

H2: Digital transformation has a positive effect on organizational strategic intuition.

Digital transformation innovation originates from the personal intuition of the company's leaders to each member of the company, whether the top leader or the lowest employee. The strategic intuition technique allows innovation to emerge through the imaginative fusion of historical aspects in a novel way that adds value (Duggan, 2013). When making judgments based on intuition, it is important to consider organizational issues, such as the regulatory environment, time constraints, decision-making culture, and market conditions, as well as external influences like disruptions and changes in the market (Kuusela *et al*., 2020). In the context of a deeply and widely integrated economy like Vietnam, there is pressure when it comes to intuitive decision-making because it has the most important role in responsiveness and SOP (Bullini Orlandi & Pierce, 2020). In accordance with RBV, achieving a sustained competitive advantage for a firm requires the crucial leadership skill of OSI (Barney, 1991). In light of this research, I hypothesized:

H3: Organizational strategic intuition has a positive impact on sustainable operation performance.

H4: Organizational strategic intuition acts as an active mediator between digital transformation and sustainable operation performance.

The emphasis on EO at the organizational level reflects an environment where organizations display stronger levels of creativity, initiative, and risk-taking than their corporate counterparts (Wales *et al.,* 2020). Businesses will actively seek out market possibilities and act faster than their competitors to take advantage of them with more creative solutions (Webb *et al.,* 2010) if they place a strong emphasis on innovation and initiative. Therefore, businesses with a high level of EO will be better able to discover new market niches, attract new customers, and provide cutting-edge products and services to their current clients (Covin & Lumpkin, 2011). Furthermore, emphasizing market orientation, innovation, and proactive corporate behaviour enables businesses to react quicker to shifting customer and technological demands (Nguyen *et al.,* 2023). Moreover, EO stands for a forward-looking orientation, and when a corporation embraces that approach as its strategic apex, businesses are more receptive to novel ideas and technological advancements. Prior research on EO in units suggested that EO had a network effect (George *et al.,* 2001). Diversity networks enable top managers to more effectively identify and evaluate multiple business prospects. Therefore, top executives in the food sector who have an EO bias are more likely to recognize novel (digital) opportunities and better assess the risk associated with those digital chances. On the other hand, risk can have a larger range of financial effects and is never totally avoidable (Wiklund & Shepherd, 2011). However, profits are anticipated to be positive overall. This suggests the following hypothesis:

H5: Entrepreneurial orientation has a positive effect on sustainable operation performance.

Different organizations may offer different digitization approaches. Some enterprises may implement DT according to a rigorous process aimed at responding to customer requests quickly and efficiently (Warner & Wäger, 2019). However, this process may not be very novel given the online services these businesses offer. In those cases, management evaluates effectiveness.

Nevertheless, a distinct revenue strategy is necessary to secure a lasting competitive advantage (Porter, 1996). Instead, businesses must develop distinctive assets that are challenging to replicate (Barney, 1991) and continuously position their goods and services in front of rivals (Lumpkin & Dess, 1996). The food industry is moving towards more online tools and services overall, while it is yet unclear what specific formats or popular designs will be in use. However, the setting fosters a corporate atmosphere where these businesses can focus on individuals willing to test out novel approaches and emerging technology (Boudreau *et al.,* 2011). Therefore, a more business-oriented

approach to digitization can align a company's strategic approach to the needs of the environment and produce unique resources (Kraus *et al.,* 2019a; Kraus *et al.,* 2019b), helping it to stay ahead of the competition when it comes to introducing new digital services (proactivity), and it can allow for reasonable costs to be incurred while testing new digital solutions, which is expected to result in more innovative and unique digital services. Moreover, companies managing sustainable practices will end up with sustainable outcomes, which will result in sustainability for the industry as a whole (Islam *et al.,* 2020). This induces the following recommended hypothesis:

H6: The moderating role of entrepreneurial orientation in the relationship between digital transformation and sustainable operation performance.

Entrepreneurial orientation not only helps food firms more successfully realize their digital vision but also allows businesses that have made the transition to digitization to provide goods and services for an infinite amount of time in space. With the use of digitization, businesses may communicate with their clients swiftly and effectively (Jayachandran *et al.,* 2004). Moreover, the employment of information technology applications is frequently necessary to take advantage of business opportunities for quick and highly secure payments in the money transfer process (Gerritsen *et al.,* 2015). Businesses with a high rate of digitalization will therefore be better able to acquire the necessary skills and change their business models to benefit from economic opportunities. If businesses regularly implement and test new technologies, they will eventually become accustomed to digital solutions and technology. As a result, businesses with a relatively high level of digitalization (LD) will be in a better position than rivals with less expertise to seize commercial opportunities that call for digital solutions and make optimum use of their EO. In a world where information technology is changing quickly, businesses with a high degree of EO and digitization may explore business prospects more successfully. This provoked the next hypothesis:

H7: A high level of digitalization has a positive effect on entrepreneurial orientation and sustainable operation performance.

Control variables can have a confounding influence on the relationships between the variables by reducing the sources of undesirable variance in the study's model. Firstly, company size can also affect a company's SOP. Often, large enterprises have more advantageous resources to accommodate DT implementations. Furthermore, smaller enterprises face limitations in terms of their capacity, which acts as a barrier to entry into their respective industries. This highlights that larger companies possess a higher level of competitiveness, making it comparatively easier for them to adopt and implement SOPs. In light of these justifications, scholars advise to regulate firm size (Terjesen *et al.,* 2011). Secondly, older businesses may experience problems with consistency and unreported operating expenses that could make it challenging to identify DT and influence SOP. The number of years after a company was founded was kept to a minimum in this analysis, as suggested by Park and Ro (2011). In summary, I expect that in the context of the global economic integration of an emerging economy like Vietnam, businesses operating in the food sector will need to make quick changes and coordinate with DT, OSI, and EO to achieve SOP. I propose a research model as shown in Figure 1.

RESEARCH METHODOLOGY

The study employed the following quantitative research techniques. Initially, I conducted focus group discussions with two groups. To identify and calibrate the research model and the measured observed variables of the DT, OSI components, EO, and SOP at food enterprises, group 1 includes 7 scientists with PhD degrees, group 2 consisted of nine people who held a Master's degree and are currently the directors of representatives of food enterprises in 9 provinces. The results of the focus group discussions indicated that, generally, the participants approved of the proposed approach. Moreover, the majority of the members' suggestions centred on changing the observed variable's language to make it more understandable and appropriate to Vietnamese food enterprises. Following consultation with subject-matter experts, I created a survey questionnaire that comprised 21 observable variables (Appendix), significant demographic survey variables, and a 5-point Likert scale (1 denoting a significant disagreement and 5 a strong agreement). I conducted the research from

January 2024 to July 2024. A total of 429 businesses volunteered to take part in the survey, although I sent only 1 survey per business to owners and managers of food businesses in Vietnam. I conducted the survey throughout the entirety of Vietnam, encompassing the southern, middle, and northern areas. Finally, I employed a dataset of 368 questionnaires to evaluate data with a pass rate of 85.8%. I used PLS-SEM to assess the acquired data and test the hypotheses.

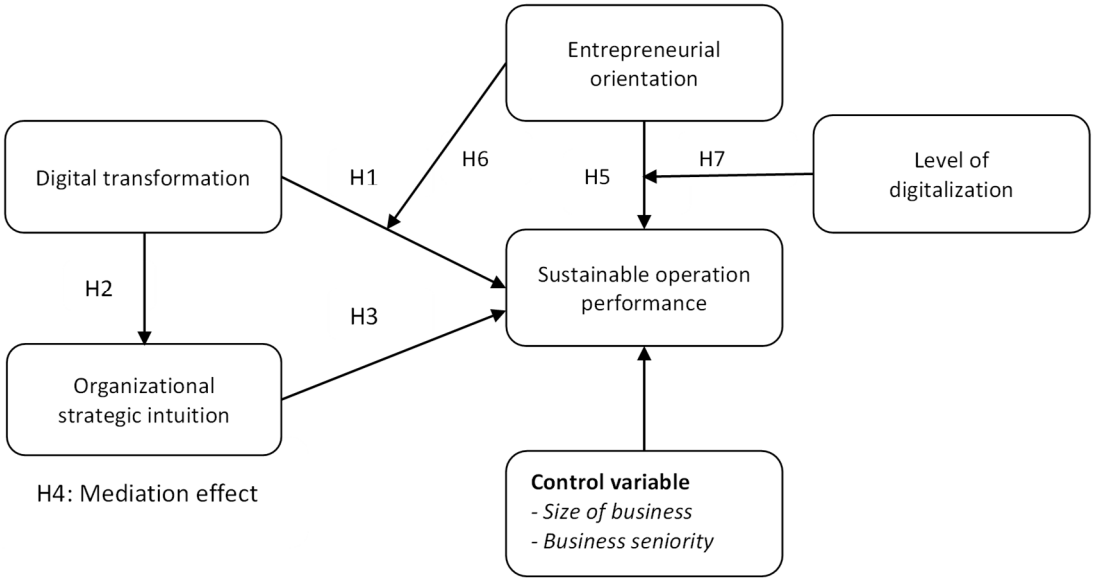

Figure 1. Proposed research model
Source: own elaboration.

RESULTS AND DISCUSSION

Table 1 displays the survey sample's characteristics, ensuring the sample size representativeness.

Table 1. Respondents profile

Construct	Categories	# of cases	%
Size of business (people)	Small (<50)	73	19.84
	Medium (50-99)	166	45.11
	Large (≥100)	129	35.05
Business seniority	Less than 5 years	61	16.58
	From 5 to 10 years	203	55.16
	More than 10 years	104	28.26
Working position	Managers	239	64.95
	Owners	129	35.05
Levels of digital transformation	Level 1: Scattered use of data	57	15.49
	Level 2: Business-centered data-based operations	185	50.27
	Level 3: Data competitiveness formation	126	34.24

Note: N = 368.
Source: own study.

Measurement model. I conducted confirmatory factor analysis (CFA) to evaluate the psychometric properties (convergence and discriminant), average variance extracted (AVE), and composite reliability (CR) of all items (Hair *et al.,* 2018). Due to the low CR score, I removed one item from the recovery satisfaction scale. Reevaluation of the results revealed that the research met all minimal criteria, leading to CR and Cronbach's alpha values for every construction that were both higher than 0.70. Furthermore, as mentioned by Hair *et al.* (2018), all variable AVE values were higher than 0.5. Therefore, the convergent value was acceptable (Table 2). Due to the fact that all HTMT ratios were less than 0.90, Table 3 demonstrates that discriminant values were likewise acceptable (Henseler *et al.,* 2015).

Table 2. Results of the measurement model

Constructs	Indicator	Outer loading	Cronbach's alpha	rho_A	Composite reliability (CR)	Average variance extracted (AVE)
Digital transformation	DT1	0.69	0.89	0.89	0.89	0.65
	DT2	0.83				
	DT3	0.91				
	DT4	0.75				
	DT5	0.79				
Organizational strategic intuition	OSI1	0.65	0.85	0.87	0.84	0.66
	OSI2	0.77				
	OSI3	0.93				
	OSI4	0.81				
	OSI5	0.68				
Entrepreneurial orientation	EO1	0.63	0.88	0.89	0.89	0.62
	EO2	0.81				
	EO3	0.83				
	EO4	0.86				
	EO5	0.79				
Sustainable operation performance	SOP1	0.81	0.87	0.87	0.87	0.79
	SOP2	0.81				
	SOP3	0.68				
	SOP4	0.85				
	SOP5	0.78				

Note: N = 368.
Source: own study.

Table 3. Discriminant validity of measure model Heterotrait-Monotrait ratio (HTMT) of correlations

Constructs	DT	OSI	EO	SOP
DT	–	–	–	–
OSI	0.55	–	–	–
EO	0.79	0.67	–	–
SOP	0.73	0.81	0.53	–

Source: own study.

Model structure. In compliance with Hair *et al.* (2018), I evaluated the structural model's beta, *t*-values, effect sizes (f^2), predictive relevance (Q^2), and coefficient of determination (R^2). I found that support for the impact of perceived DT on SOP (H1) β = 0.78 and *p* = 0.000. OS (H2) was positively affected by perceived DT (β = 0.37 and *p* = 0.000). Moreover, I validated OS's impact on SOP (H3) with β = 0.66 and *p* = 0.000. I applied Preacher and Hayes' (2008) technique with subsamples of 10 000 bootstrapping procedures to calculate *t*-values and confidence intervals for the mediating hypothesis. I found that OS positively and significantly mediated the relationship between DT and SOP (β = 0.43, *t* = 6.75, and *p* < 0.05). Consequently, I accepted H4. Moreover, the effect of EO on SOP (β = 0.58 and *p* = 0.000) supported H5 and the finding that EO moderates the relationship between DT and SOP (β = 0.55, *t* = 8.73, and *p* < 0.05) supported H6. Though I rejected H7 was rejected, I found no support for the combined effect of EO and LD (β = -0.69, *t* = 3.57, and *p* > 0.05).

The next step involved 10 000 samples for additional bootstrap testing. According to Efron and Tibshirani (1993), specific metrics (deviation, variance, confidence intervals, prediction error, etc.). Comparing the crucial rate's absolute value to 1.96 (which indicates the value of a regularly distributed transaction at 0.9750 or 2.5% on one side and 5% on both sides), we may see that it was significantly higher. Given that the absolute value of the critical ratio (CR) in the aforementioned relationships was less than 1.96, the outcomes demonstrated statistical significance with a 95% confidence interval. The model had remarkable predictive reliability. Therefore, it was acceptable to infer that the study's esti-

mates were accurate and that all 6 hypotheses, H1 to H6, were true. Moreover, I applied the ANOVA test with five qualitative variables. The variance results showed that Sig > 0.05, signifying that there was no difference in the variance between the groups. It is evident from this that there was no distinction in terms of demographic parameters such as gender, education level, place of employment, business type, and number of years in operation. Figure 2 presents SEM results.

Table 4. Results of structural model analysis (Hypothesis testing)

Hypotheses	Relationships	β	t-values	p- values	f^2	R^2	Q^2	Decision
H1	DT -> SOP	0.78	11.63	0.000	0.71	0.52	0.31	Supported
H2	DT -> OSI	0.37	5.56	0.000	0.32	0.56	0.53	Supported
H3	OSI -> SOP	0.66	12.56	0.000	0.69	0.47	0.34	Supported
H4	DT -> OSI -> SOP	0.43	6.75	0.000	0.37	0.63	0.49	Supported
H5	EO -> SOP	0.59	9.58	0.000	0.49	0.61	0.52	Supported
H6	Interaction effect EO ->DT -> SOP	0.55	8.73	0.000	0.47	0.59	0.50	Supported

Source: own study.

The next step involved 10 000 samples for additional bootstrap testing. According to Efron and Tibshirani (1993), specific metrics (deviation, variance, confidence intervals, prediction error, etc.). Comparing the crucial rate's absolute value to 1.96 (which indicates the value of a regularly distributed transaction at 0.9750 or 2.5% on one side and 5% on both sides), we may see that it was significantly higher. Given that the absolute value of the critical ratio (CR) in the aforementioned relationships was less than 1.96, the outcomes demonstrated statistical significance with a 95% confidence interval. The model had remarkable predictive reliability. Therefore, it was acceptable to infer that the study's estimates were accurate and that all 6 hypotheses, H1 to H6, were true. Moreover, I applied the ANOVA test with five qualitative variables. The variance results showed that Sig > 0.05, signifying that there was no difference in the variance between the groups. It is evident from this that there was no distinction in terms of demographic parameters such as gender, education level, place of employment, business type, and number of years in operation. Figure 2 presents SEM results.

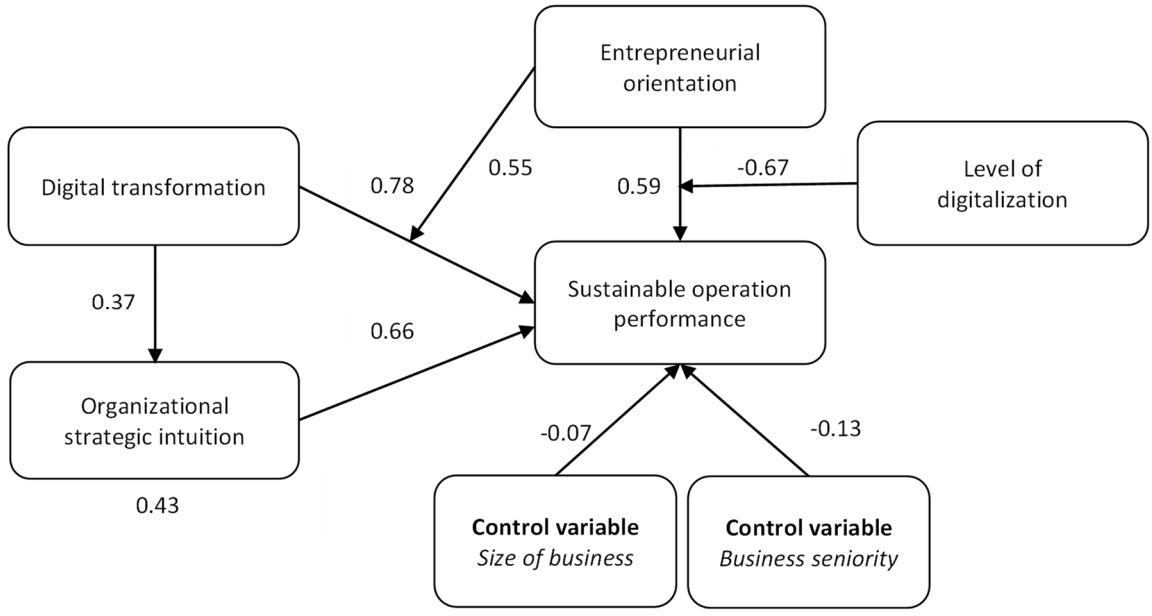

Figure 2. The results of the SEM
Source: own elaboration.

RESULTS AND DISCUSSION

The main discovery of this study was the association between DT, OSI, EO, and SOP. Compared to previously published articles on the topic of food, my findings are innovative because no experimental research has been done to confirm this relationship mechanism. Despite the fact that studies on the particular impacts of DT, OSI, and waist to SOP are frequently used, this study substantially adds to the body of knowledge by building on the previous discoveries and formulating a novel strategy to aid the food industry in a developing country like Vietnam. Firstly, the study's primary goal was to ascertain how revenue influences food enterprises' standard operating procedures favourably. Our findings are consistent with those of Teng *et al.* (2022) and Matarazzo *et al.* (2021), which discovered that firms might boost efficiency and customer value by adopting effective digital marketing. The trend states that the company becomes sustainable. Our study adds to the corpus of research by illuminating both the procedure for growing DT in the workplace and the essential elements for successful DT. Furthermore, Madzík *et al.* (2023) assert that, in the current international economy, organizations must be more vigilant and implement DT when necessary. Long-term users will profit more from DT implementation than they will from conventional strategies, despite the risks and costs. Secondly, the empirical evidence demonstrating how DT greatly enhances OSI and facilitates OSI development and decision-making addresses the second research aim: What role does the OSI play in businesses' DT and SOP relationships? Digital marketing promotes promotional techniques, brand positioning, and the growth of e-businesses, based on a study on the effects of DT (Melović *et al.,* 2020). Shen *et al.* (2022) suggest a digital platform built on knowledge management for strategic asset management solutions. The existing body of research could thus explain this in one of two ways: either DT helps choose a consistent strategy or DT convinces OSI to come up with a strategy. To further understand this, more research is needed. Numerous studies have demonstrated the value of the DT approach. For instance, a study on the benefits of DT on Indian manufacturing found that strategic alignment had a beneficial impact on sales and operating performance. This underlines the need to have a thorough grasp of the organizational process to develop and implement an effective DT strategy before transformation (Singh *et al.,* 2021). Even if the results of recent studies on the connection between DT and OSI are unclear, they provide a foundation for future research in this field. Furthermore, the study's findings support the idea that LD has no moderating influence on the relationship between EO and SOP. In contrast to Niemand *et al.* (2021) findings, it is asserted that technology is evolving quickly and that companies in the financial sector are dealing with a transition from traditional to digital service formats, which presents chances for companies to gain a competitive edge.

Finally, prior studies did not explore the impact of DT on the food industry SOP, which presents a hurdle in advancing digitization in the food business. We filled this gap by conducting a survey among businesses on the topic approach, and we discovered fresh findings that also addressed our third research question. Businesses that presented a high degree of EO reported higher performance levels, but, more significantly, EO moderated the relationship between DT and SOP. This result is also consistent with Niemand *et al.* (2021) who claim that EO directly regulates the relationship between SVD and FP as well as the digitization degree in the financial industry. If an organization successfully implements its DT vision, it will meet the financial performance maximization criteria, such as the ratio return on assets (ROA), return on invested capital (ROI), revenue, asset turnover, market share, profit margin, revenue growth rate, and economic indicators. Technology-based strategies have the potential to boost a company's success independently, as opposed to aligning its strategic vision with its aims and inherent commercial skills. These findings add fresh, long-lasting insights into the function of EO and DT in the food industry and emphasize the need for businesses to have a comprehensive understanding of digitalization during periods of rapid technological change, which is characterized by creativity, staying one step ahead of the competition, and taking risks.

Theoretical Implications

The study's findings have assorted scientific applications. Firstly, it contributes to the existing literature by constructing a research model and empirically testing the proposed theoretical model. The study examined the dynamic interplay between DT, OSI, and EO in relation to SOP. It also investigated the mediating role of OSI between DT and SOPs, as well as the moderating role of EO between DT and SOP within companies operating in the food sector in Vietnam. Secondly, I explained the theory in this study using the RBV theory, which also produces some surprising results regarding the above associations. Moreover, this investigation supports RBV theory (Barney, 1991). Thirdly, this study contributes new knowledge about expanding concepts of DT, OSI, and EO forcing to explain that strategic intuition is considered not only as an individual competency but also as an organizational competency that is suitable for the organization suitable with resources, assets, and capacities in light of the sustainable competitive advantage theory. Finally, the study also examined the differences in demographic variables such as firm size, year-end business, and adjusted revenue levels of Vietnamese food companies.

Managerial Implications

The study's findings will help ameliorate standard operating procedures for Vietnamese food companies as they face pressure from globalization, free trade, and scientific and technological advancements. Given the current competitive environment, the following solutions will assist the business in concentrating on reinforcing the relationship between DT, OSI, EO, and SOP in the future. In addition, for DT, companies need to pay attention to adjusting their sustainability strategic focus to ensure the company's SOP. Prioritizing accreditation management competencies for the DT process is key to increasing financing through the promotion of sustainability strategies. Therefore, managers need positive behavior and good management capacity leading to a sustainable strategy to achieve better financial and nonfinancial returns for the company. Consequently, managers must develop a strategic business strategy for DT businesses centered on the sustainability principle. In other words, managers should prioritize tasks in accordance with their objectives and focus on DT business strategy, which serves as the cornerstone of sustainable strategy, as their first concern. The management's capability to grab digital possibilities and significantly influence company outcomes is another indicator of how well-organized the digitalization operations are. This result is also similar to that of Teng *et al.* (2022) when affirming that SMEs want to maximize operational efficiency and must actively apply DT in their businesses. Moreover, companies employing DT will have an impact on customer culture and behaviour (Silva *et al.,* 2023). A sustainable sustainability strategy and the goal of SOP must also be balanced in corporate companies. Instead of only being the solution to economic success, adopting a sustainability plan emphasizes a holistic sustainability approach.

Another outcome of this work is that causal analysis has empirically proven that DT promoted OSI advancement and led to SOP. Therefore, organizations that want to become SOPs need to have better support or investment activities to promote DT. Systems from DT for mobility, analytics, and virtualization are used as tools or channels to elucidate or elaborate the strategy's viability and raise the organization's potential. Moreover, OSI is necessary to help the organization advance toward becoming an SOP. Scholars need to give strategic intuition more weight throughout the hiring and training processes because it is a good indicator of an employee's OSI. Another strategy for increasing OSI potential is to help employees develop their strategic intuition. This outcome is in line with the research by Rogers (2016) and Songkajorn *et al.* (2022). Finally, the study's findings support those of Pratono *et al.* (2019) that gaining sustainable competitive advantage through market orientation and green EO would increase SOP. Moreover, EO contributes positively to the regulation of the interaction between DT and SOP. Companies that prioritize innovation and initiative will be more proactive in identifying market possibilities and will exploit them more quickly than their rivals with creative solutions. This result is congruent with Niemand *et al.'s* (2021) study, which showed that if a business successfully conducted its DT vision, it would be able to maximize its financial performance. In conclusion, DT, OSI, and EO in enterprises directly contribute to the increase of organizational SOP. This suggests that the

above linkage can operate as an amplifier for managers to refine their ability to diversify in accordance with business goals in the setting of global integration.

CONCLUSIONS

Although I achieved the study's objectives, there were still a number of shortcomings, such as the sheer number of samples that needed to be gathered, which might provide interesting areas for future research. I ensured the sample representativeness, albeit not very well. I conducted the study among food enterprises in emerging markets, namely, Vietnam. Furthermore, the mediating role of entrepreneurial orientation in the relationship between digital transformation and sustainable operation performance; thus, more research is required. Following a thorough examination of the preceding function, it was vital to clarify the roles of OSI and EO. Moreover, for the company to achieve SOP in addition to DT, OSI, and EO, there are many other factors such as social responsibility, organizational culture, and sustainable resources. Thus, the next study path should include additional variables, larger sample sizes, and an expansion of the number of research subjects, as well as other industries and economies.

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Appendix: Constructs' items

Digital transformation (DT)
- Digital Technology Usage
- Encouragement
- Barrier Elimination
- Important factors for successful DT
- Next steps to expand DT

Organizational strategic intuition (OSI)
- Learning from History
- Business Strategy Creation

Resolution
Entrepreneurial orientation (EO)
We encourage people in our company to take risks with new ideas.
We engage in risky investments to stimulate future growth.
We work to find new businesses or markets to target.
We consider ourselves as an innovative company.
Our business is often the first to market with new products and services.
Sustainable operation performance (SOP)
Return On Assets (ROA)
Return On Equity (ROE)
Innovation Generation
Technology
Internal Environment
External Environment

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Use of Artificial Intelligence

The author confirms that no AI/GAI tools were used in the creation of this text. All work was done manually without the assistance of any artificial intelligence or generative AI.

Conflict of Interest

The author declares that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Identification and direction of changes in work-life balance dimensions in Visegrad Group countries

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ABSTRACT

Objective: The article aimed to identify the dimensions and trajectories of work-life balance (WLB) across the Visegrad Group (V4) countries (Poland, the Czech Republic, Slovakia, and Hungary) during the period 2008-2022. We posed two research questions: which factors are most responsible for WLB and how do the dimensions of WLB evolve over time among the V4 countries?

Research Design & Methods: We employed a quantitative and interpretative approach. Based on statistical data, we identified WLB dimensions in the multiple factor analysis (MFA). The estimated factor values formed the basis for analysing the trajectories of changes in three indices (WORK, TIME, FAMILY) for each of the V4 countries over the 2009-2022 period.

Findings: Among the three WLB dimensions, WORK was the most explanatory for WLB. The eigenvalue of the first dimension explained 32% of the total variance, the second dimension eigenvalue contributed 26% of the variance, and the third extracted dimension explained 15% of the total variance. We demonstrated the status of three WLB dimensions over a period of 14 years across the V4 countries. We found the greatest stabilization of WLB in the FAMILY dimension, while the WORK dimension distinctly differentiated the V4 countries. Although all V4 countries showed an increasing trend in the WORK index alongside a decrease in the TIME index, they clearly followed different paths in the development of WLB, including the pursuit of diversification (WORK), similarity (FAMILY), and the maintenance of stationarity (TIME).

Implications & Recommendations: The findings may be valuable for planning future strategies aimed at enhancing the employees' WLB. Further research should focus, among other aspects, on the observation of WLB dimensions and the assessment of the trajectories identified in the article, including the impact of the V4 countries' decisions on the development of work-life balance policies.

Contribution & Value Added: The number of studies on WLB has increased significantly over the past ten years, revealing the complexity of the phenomena and presenting diverse research perspectives. The proposed study approach based on multiple-factor analysis allowed us to capture the state of WLB in terms of its dimensions (WORK, TIME, FAMILY) and its dynamics over a longer time frame (14 years) in countries originating from the same political-economic system. The differences identified at this level have led to the conclusion that the state of WLB of employees from the V4 countries is only partly determined by systemic-historical conditions. WLB in the V4 countries reveals national-level differences and prompts further comparative research.

Article type:	research article
Keywords:	work-life balance (WLB); multiple factor analysis (MFA); WLB trajectories; Visegrad Group Countries (V4); international comparisons
JEL codes:	I31, J7, E24, D6

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INTRODUCTION

Despite a 40-year history of work-life balance (WLB) research, there is still a deficit in its operationalisation and effective systemic solutions. The political transformation (1990s) within the borders of the

European continent has revealed different rates of development of labour markets and implementation of WLB-supportive solutions in post-communist countries.

The article distinguishes three groups of variables describing work-life balance issues: TIME (C), WORK (P), and FAMILY (R). Using the example of the Visegrad Group, it is shown how the complexity of these groups develops and what differences exist between countries in this respect. A dynamic analysis on an annual basis (2008-2022) makes it possible to observe trends and changes in the dimensions over time. We aimed to identify the trajectory of WLB across V4 countries, with two subsidiary objectives: to identify the latent dimensions underlying WLB (1) and to assess the dynamics of WLB across countries (2).

At the foundation of the goals lies the necessity for a systematic approach to the analysis and evaluation of WLB systems. Numerous studies demonstrate the complexity of these systems, primarily stemming from the need to consider a multitude of variables that enable the understanding and assessment of their effectiveness (Fernandez-Crehuet *et al.*, 2016). The efficiency of the WLB system signifies both the robust and diversified labour market resources (Ehrenberg & Smith, 2012), flexibility in time and work organisation (Ágota-Aliz, 2021; Marumpe *et al.*, 2023; Ralston & Flanagan, 1985) as well as the welfare of households in which both parents have the opportunity for professional development (Farré *et al.*, 2023; Goldin, 2015; Kurowska, 2020; Magda *et al.*, 2024; Petrongolo & Ronchi, 2020). Consequent to this foundation, we formulated the following research questions: (1) Which factors most significantly contribute to WLB, and (2) how do the dimensions of WLB evolve over time among the V4 countries?

A crucial contribution to the research on the specificity of WLB is the applied dynamic approach, which entails comparing the changing dimensions of WLB over time. This represents a valuable supplement to previous studies that compared variables across a single year (Fernandez-Crehuet *et al.*, 2016; OECD, 2021). In turn, focusing on the evolution of dimensions allows for a deeper understanding of the WLB trajectories within a specific geographical context (V4 countries), offering a more targeted insight into policy interventions under similar conditions of transformation. In this manner, it will be easier to comprehend how certain external factors (economic crisis, COVID-19) have impacted the work-life balance systems and how policy decisions have regulated this system.

The conducted analysis encompassed two significant research stages. Initially, through MFA, we identified variables that most characterise the WLB systems in the V4 countries. Based on this, we determined trajectories of WLB dimensions, enabling a deeper understanding of WLB dynamics and its impacts on the labour market.

The article's next chapter reviews the literature and develops hypotheses. The third chapter provides a methodology description. Policy implications, research constraints, and future research possibilities are indicated by empirical findings and discussion of results in the fourth chapter and the last section.

LITERATURE REVIEW AND HYPOTHESES DEVELOPMENT

The origin of the work-life balance concept involves the conflict between work and family, first defined by Kahn *et al.* (1964). Subsequent research by Pleck (1977) introduced the theme of gender, analysing the work-family role system from the perspectives of men and women. Greenhaus and Beutell (1985) developed the issue of work-life conflict focusing their attention on the role of the family and women. It was not until the 1990s that a broader view of the issue emerged, encompassing both men and women, with or without children. As a result, the discourse on the work-family axis and family-friendly policies broadened towards everyone's work-life balance (Lewis *et al.*, 2007).

In the last decade, the number of studies on the topic of work-life balance has increased significantly, revealing the complexity of the phenomenon and presenting different research perspectives:

1. Individual – research interests focus on the struggles of individuals in the area of reconciling professional and personal roles (Anxo *et al.*, 2012; Brough & Timms, 2009; Darcy *et al.*, 2012; Fedakova, 2017; Newman, 2016; Roberts, 2007; Timms *et al.*, 2012). More recently, much research has also focused on the blurring of the boundaries between work and personal life as a consequence of the COVID-19 pandemic and technological transformation (Bencsik & Juhasz, 2023; Kusairi *et al.*, 2022).
2. Organisational – research in the area of management, relating to flexibility of place and time at work, the use of specific solutions to enhance efficiency and job satisfaction and quality of non-

work life (Ágota-Aliz, 2021; Alassaf *et al.*, 2023; Haeger & Lingham, 2014; Karim *et al.*, 2023; Van Hugten *et al.*, 2021).

3. Systemic – research is used to recognise how legal, political and cultural orders govern work-life balance opportunities at both the individual and organisational levels (Albanesi *et al.*, 2023). The subject of gender equality in the workforce and the persistent disparities between men and women in terms of work-life balance opportunities remain pertinent in this field of study (Farré *et al.*, 2023; Harman & Bartůsková, 2023; Petrongolo & Ronchi, 2020).

Work-life balance deficiencies in each of these areas lead to unfavourable outcomes. From a systemic perspective, which is the focus of this article, this issue manifests in the diminishing labour market resources, and deepening inequalities, particularly between women and men (Petrongolo & Ronchi, 2020). There is also an increase in the costs associated with sustaining individuals outside the labour market and rising healthcare expenses. A long-term deficit can lead to households' material deprivation (Hansen & Stutzer, 2022; Vignoli *et al.*, 2020). A particular group affected in this context are parents. Research in the domain of WLB confirms the influence of parenthood on the ability to maintain a balance between work and caregiving responsibilities (Feldman *et al.*, 2004; Gloor *et al.*, 2018; Greenhaus & Allen, 2011; Shanmugam, 2017). Becoming a parent leads to a reevaluation of life goals and priorities, often resulting in work being subordinated to new duties (LaTronica-Herb & Karalis Noel, 2022; Polizzi *et al.*, 2022). Maintaining family and employment becomes a significantly greater challenge. Mothers typically reduce their professional activity, whereas fathers (due to the necessity of securing income) increase their work intensity (Magda *et al.*, 2024; McMunn *et al.*, 2015; Rahmqvist, 2006; Wood *et al.*, 2018). As a result, having a child profoundly influences the work dimension and tips the scales in favour of a possible rise or fall in employment indicators (Hansen & Stutzer, 2022). Inadequate job security for working parents may also have demographic consequences. The fear of job loss or the fact of being unemployed influences the decision to delay parenthood, thereby reducing birth rates (Landaud, 2021; Miettinen & Jalovaara, 2020; Studer *et al.*, 2018). Therefore, we formulated the following hypothesis to determine the work-life balance dimension associated with employment (WORK):

H1: The employment rate of individuals with children holds a greater contribution in defining the WORK_WLB dimension, compared to the employment rate of individuals without children.

The second important dimension regulating Work-Life Balance is TIME, understood both as time devoted to work and time outside the professional sphere. The average number of weekly working hours directly affects the capacity to reconcile professional and personal life. The Visegrad countries deviate from the European Union average, which stood at 37.3 hours in 2022. In Poland, it was 40.4 hours, in the Czech Republic – 39.8 hours, and in Hungary and Slovakia – 39.6 hours (Eurostat, 2023). The Better Life Index, which is the main metric comparing OECD countries in terms of work-life balance, primarily bases its WLB assessment on data concerning long working hours, correlating higher rankings with a smaller percentage of individuals working over 50 hours per week. Research in Western European countries also supports the positive impact of shorter working hours (including part-time work) on WLB (Dillenseger *et al.*, 2023a; Hobson *et al.*, 2011). Conversely, extended working hours not only reduce the time employees can devote to rest and personal matters but also increase the risk of sickness absence (Ropponen *et al.*, 2019). Excessive absence diminishes productivity, decreases work engagement, and can lead to employee turnover (Bainbridge & Broady, 2017; Chadi & Goerke, 2018; Cucchiella *et al.*, 2014). Therefore, variables depicting the scale of workplace absence affect the assessment of the work-life balance system. However, given their often secondary nature to long working hours, we hypothesised (H2):

H2: Employee absenteeism has a weaker effect on explaining and contributing to the TIME_WLB dimension than working overtime.

As previously highlighted, a deficient WLB system can lead to reduced professional engagement or exclusion from the labour market, and consequently, to families' material deprivation (Hansen & Stutzer, 2022; Vignoli *et al.*, 2020). Therefore, in the analysis of the WLB issue, it is also essential to include variables that illustrate key aspects of life outside the professional sphere (referred to as the FAMILY dimension). For families with children, these include the availability and standard of public

daycare. The low percentage of children covered by the public care system, along with the accompanying high percentage of parents caring for children at home, indicates an insufficient fulfilment of WLB needs (Albanesi *et al.*, 2022; Greenhaus & Beutell, 1985). In the event of a work-family conflict, it is typically women who resign from professional activity in favour of childcare. This stems from culturally assigned roles to women and men, as well as existing inequalities in the labour market. One manifestation of these disparities is the gender pay gap, that is, the difference between men's and women's earnings. It is simply more economically feasible for a woman to leave her job if her income is lower for the family (Harman & Bartůsková, 2023; Petrongolo & Ronchi, 2020). In European Union countries, there has been a gradual narrowing of the gender pay gap (Cukrowska-Torzewska & Matysiak, 2020; Leythienne & Pérez-Julián, 2021; Newell & Reilly, 2001), which may imply that its importance in determining the dimensions of WLB will no longer be as significant as an effectively functioning childcare system. As a result, we hypothesised (H3):

H3: Institutional support for parental care contributed to the FAMILY_WLB dimension more than the reduction of the gender pay gap.

The subject of the analysis is the Visegrad countries, which, due to macroeconomic, historical and institutional similarities, present a similar level of economic development and are characterised by a similar employment structure. They also joined the European Union and made the switch from a planned to a free market economy at the same time (Bieszk-Stolorz & Dmytrów, 2020).

The agreement between the Visegrad Triangle countries was concluded in 1991 at the Hungarian castle in the town of Visegrad. After the break-up of Czechoslovakia in 1993, the formation became the Visegrad Group V4 and has since consisted of four countries, *i.e.*, Poland, Hungary, the Czech Republic, and Slovakia. The founding of the partnership was based not only on converging foreign policy objectives but also on similar implementation tools (Fedakova, 2017).

From the perspective of the WLB system study, it is significant to highlight the comparable socio-economic conditions that characterized these countries at the time of integration with the EU. The differences between the situation of women and men in the labour market largely determined the basis of the system supporting WLB during the integration of the V4 countries into the European Union. Women in the former communist bloc countries spent, on average, more time at work than their Western counterparts. The top-down wage and price-setting system created a situation in which both men and women had to work to maintain a basic standard of living for the family. Women were granted a wide range of rights and privileges at work. There was also a very extensive and accessible childcare system (Newell & Reilly, 2001). At the same time, women performed a very large proportion of domestic duties, which entailed a double burden and limited career development to a similar extent to men. Moreover, the Western revolution in the implementation of gender equality in the labour market, which brought a slow but fundamental change in the distribution of unpaid non-work labour, did not take place in communist countries (Harman & Bartůsková, 2023).

The high participation of women in the labour market began to decline sharply after 1989 as a result of the free market transition. The scale of the collapse of women's labour market participation varied across the V4 countries. The most affected country was Poland, where between 1989 and 1994 approximately one and a half million jobs previously held by women disappeared (Newell & Reilly, 2001). Declining employment in the Visegrad Group was compensated by higher average working hours (Szymańska, 2017), which negatively affected the ability to reconcile professional and personal responsibilities among the employed.

The democratization of the V4 countries varied the central approach in establishing conditions that allow for reconciling professional and personal life. Over the span of two decades, changing governments across the V4 countries – left-wing, centrist, and right-wing – differed in their emphasis on particular elements of the system supporting the balance between work and non-work life. Despite these differences in the development of WLB systems, V4 countries are characterized by some of the longest working hours in Europe, a sizable gender pay gap, insufficient female participation in the labour market, and a childcare system less developed than that of Western Europe. Therefore, determining the dynamics of WLB trajectories, we hypothesized (H4):

H4: The dynamics of WLB dimensions across V4 countries express parallel developmental trajectories.

With Hypothesis 4, we intended to confirm the assumption that historical and social factors determine the development directions of WLB systems. Furthermore, previous comparative WLB studies lack a dynamic perspective as the scholars based the evaluations on a single year (Anxo *et al.*, 2012; Fernandez-Crehuet *et al.*, 2016; McGinnity & Whelan, 2009; Rollnik-Sadowska & Dabrowska, 2018). Designating the trajectories of WLB dimensions in the Visegrád Group countries over a 20-year period will enable the identification of WLB systems development's main phases. It will also be possible to ascertain how differently the WLB systems in the studied countries have developed.

In conclusion, our research's hypotheses aimed to enable the verification of the adopted classification of WLB dimensions: P, C, and R, as well as the identification of the most significant variables contributing to the creation of effective WLB systems. In turn, determining the trajectories of dimensions will support a better understanding of how the WLB systems are shaped in countries with similar socio-economic conditions.

RESEARCH METHODOLOGY

Scope of the Study and Selected Variables

We used databases from Eurostat (Eurostat, 2023). The data covered all V4 countries from 2008 to 2022, which ensured continuity and comparability of the analysed variables. We chose the year 2008 as the beginning of the period under consideration, as data in all the analysed variables were available for that time. The end of the study period was 2022, the last year for which a full set of statistical data was available.

To analyse work-life balance systems in the group of V4 countries, we selected a number of variables and attributed them to three dimensions: WORK, TIME, and FAMILY. The selection of variables allows for a comprehensive identification of the relationship between the factors describing the work-life balance issue and the identification of those variables that regulate the work-life balance system to the greatest extent. The comparative analyses conducted so far in this research area use variable selection to develop work-life balance assessment indices.

One indicator for comparing countries is the OECD's proposed Better Life Index, consisting of eleven areas[1] assessing the quality of life in member countries. The OECD defines the area of work-life balance based on the following variables: the percentage of the workforce that works very long hours (more than 50 hours per week) and time spent on 'leisure and personal care.' Fernandez-Crehuet *et al.* (2016) extend this relatively narrow range of variables by proposing the National Work-Life Balance Index. The index includes five dimensions (time, work, family, health, politics) that rank the countries studied according to WLB conditions. Comparative studies based on secondary variables provided by public databases also use the results of the cyclical European Social Survey (McGinnity & Whelan, 2009). The survey concerns a subjective evaluation of different areas related to work-life balance issues. Other proposed measures for assessing work-family relationships are Work-Family Strains and Gains (Marshall & Barnett, 1993), the Work-Family Balance Scale (Wooden, 2003; Zhang *et al.*, 2012), and the overall well-being of working families (Kapteyn *et al.*, 2010).

We propose a set of variables that consider longitudinal data characterising the three dimensions of work-life balance: TIME, WORK, and FAMILY. In this way, it is possible to identify differences between V4 countries and capture the dynamics of change over time.

The first dimension proposed was TIME, which included four variables (C1-C4):

1. The average number of working hours per week (symbol – C1 in the MFA analysis results) is a key element influencing the possibilities of reconciling work and family life. The V4 countries deviate

[1] Housing and related expenses (1), household income and financial health (2), earnings (3), job security and unemployment (5), quality of social support (6), education and skills (7), quality of the environment (8), civic engagement (9), health care (10), life satisfaction, personal security, work-life balance (11).

in this respect from the EU average, which was 37.3 hours in 2022. It was 40.4 hours in Poland, 39.8 hours in the Czech Republic, and 39.6 hours in Hungary and Slovakia (Eurostat, 2023).

2. Part-time employment (C2) – research in Western European countries shows that part-time employment promotes WLB (Dillenseger *et al.*, 2023; Hobson *et al.*, 2011), but in V4 countries it is infrequent and associated with reduced income, and labour market inequalities (Harman & Bartuskova, 2023).
3. Employed persons absent from work on a medium-quarterly basis (C3) – we may attribute work absences to sick leave, childcare needs, or annual leave, allowing for recognition of employees' need for non-work responsibilities.
4. The percentage of employed people working more than 50 hours per week (C4) – the variable used in the OECD indicator, shows the scale of the problem associated with excessive hours spent at work. It is lower than the OECD average in all the V4 countries. In 2022, it stood at 3% in Poland and Slovakia, 1.4% in Hungary, and 4.2% in the Czech Republic (OECD, 2023).

The next dimension, WORK, included five variables (P1-P5):

1. The employment rate for the whole population (P1) – the problem of WLB directly affects working people. High rates may be indicative of a system in place to support WLB opportunities but also of greater responsibility on the part of employers and governments, in particular, to promote and maintain gender equality (Petrongolo & Ronchi, 2020).
2. The employment rate of people with children (P2); the employment rate of people who have at least one child under 6 (P3); and the employment rate of people without children (P4) – having children reinforces work-life balance issues (Czerniak-Swędzioł & Kumor-Jezierska, 2021).
3. The unemployment rate (P5) – a variable indicating potential WLB constraints that prevent people from becoming economically active (Hansen & Stutzer, 2022). The variable serves to create indicators for assessing WLB (Fernandez-Crehuet *et al.*, 2016).

The last dimension, FAMILY, included the largest number (9) of variables (P1-P9):

1. Average annual income (R1) – higher incomes offer more resources for work-life balance goals like healthcare and leisure, while lower incomes may require more intensive work, reducing personal time and increasing stress. Individuals often face trade-offs between time and money when assessing work-life balance opportunities. Therefore, this variable is often considered when assessing work-life balance opportunities (Fernandez-Crehuet *et al.*, 2016; OECD, 2007).
2. Pay gap (R2); Adjusted pay gap (R3) – the difference between men and women earnings. It illustrates inequalities in the labour market and their impact on WLB (Harman & Bartůsková, 2023; Petrongolo & Ronchi, 2020).
3. The percentage of children under three in public care (R4); the percentage of children aged three attending school in public care (R5); the percentage of children under three cared for solely by their parents (R6); and the percentage of children aged three to school age cared for solely by their parents (R7) – insufficient effective childcare system affects limited WLB opportunities. The low percentage of children in the public childcare system and the high percentage of parents caring for their children at home are indicative of low satisfaction with WLB needs (Albanesi *et al.*, 2022; Greenhaus & Beutell, 1985).
4. Birth rate (R8) and fertility rate (R9) – WLB systems correlate with birth/fertility rates, but factors like social policy, childcare access, and financial support vary across V4 countries. Poland recorded the lowest birth rate (8.3) in 2022, while the Czech Republic had a higher fertility rate (1.33). The declining rate may be a signal to take measures to better protect young parents (Dlugosz & Raźniak, 2014; Matei *et al.*, 2014; Vignoli *et al.*, 2020).

A review of the differences between countries along the proposed dimensions will allow individual countries to better focus their public policy efforts on improving the WLB.

Multiple Factor Analysis Characterization and Trajectory Analysis

We identified the latent dimension of WLB based on multiple-factor analysis (MFA). It is a statistical technique that extends the principles of factor and correspondence analysis to the analysis of multiple data sets (block of variables) simultaneously (Escofier & Pagès, 1994). The method aims to identify and

interpret patterns and relationships within complex data structures, underlying patterns of variables, and insights into the data's multidimensional nature.

As a rule, scholars perform MFA in three steps (Abdi & Valentin, 2007). In the first stage, one performs the separate principal component analysis on each data table.

T data sets consist of

$$X_{[t]} = I \text{ x } J_{[t]} \tag{1}$$

rectangular matrices including quantitative or categorical data.

After that, one obtains the normalized data:

$$Z_{[i]} = 1\lambda_i \text{ x } X_i \tag{2}$$

in which: λ_i – the first singular value of data table.

Secondly, on concatenates the merged and normalized tables into I x T global data matrix Z:

$$Z = [X_1 X_2 \dots X_t] \tag{3}$$

Then, we must factorise the global data matrix using PCA and singular value decomposition:

$$Z = U\Delta V^T \tag{4}$$

in which U and V is the left and right eigenvectors and Δ is an eigenvalue.

In the last step, the individual data sets are projected onto the multidimensional component space:

$$F = M^{-1/2}U\Delta \tag{5}$$

in which: F – factor scores and M – importance weights of each observation (masses) as an inverse of the first eigenvalue.

Additionally in partial analysis, researchers can superimpose the groups of variables onto the sub-space created by PCA of global analysis.

We will present the trajectories of WORK, TIME, and FAMILY indices generated by principal component analysis (as weighted sumscores) across time points for analyzed countries using the lineplots.

RESULTS AND DISCUSSION

MFA results

In the first step, we used an MFA to reduce the data dimensionality and identify key factors describing the WLB issue. In this way, we identified the most differentiating aspects of the V4 countries in this area.

We analysed the explained variance by the next 10 principal components to assess the number of dimensions.

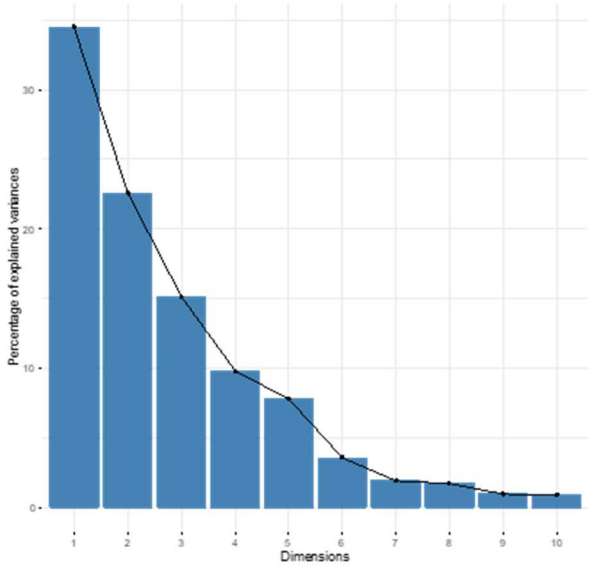

Figure 1. The proportion of variance of data explained by successive components (principal axes)
Source: own elaboration based on analysis results.

We identified three dimensions based on the extent of the explained variance, explaining a total of more than 72% of the variance in the variables structure. We then ranked these dimensions in descending order by the amount of variance explained, which means that the first dimension explained the most variance in the data, the second less, and so on.

Figure 2 shows the contribution of each quantitative variable to dimension 1:

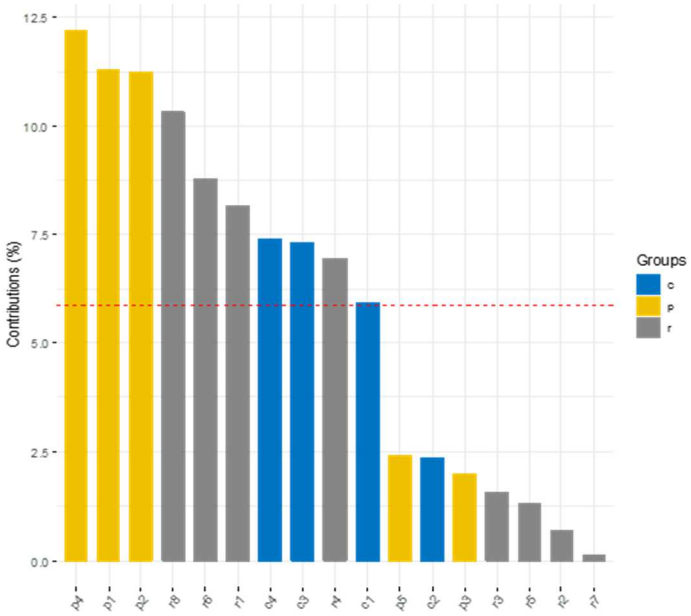

Figure 2. Contribution of quantitative variables to Dimension 1
Source: own elaboration based on analysis results.

The WORK (P4, P1, P2) and FAMILY (R8, R6, R1; Figure 2) indicators contribute the most to the explanation of the first dimension.

Figure 3 illustrates how each variable contributed to the explanation of the second dimension (TIME).

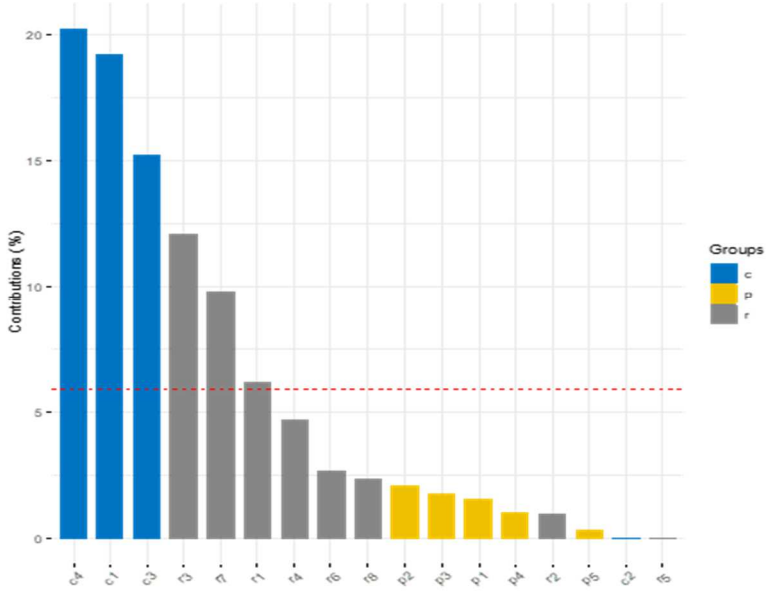

Figure 3. Contribution of quantitative variables to dimension 2
Source: own elaboration based on analysis results.

The greatest contribution to explaining dimension 2 comes from the TIME factor indicators (C4, C1, C3) followed by FAMILY (R3, R7, R1).

Figure 4 shows dimension 3:

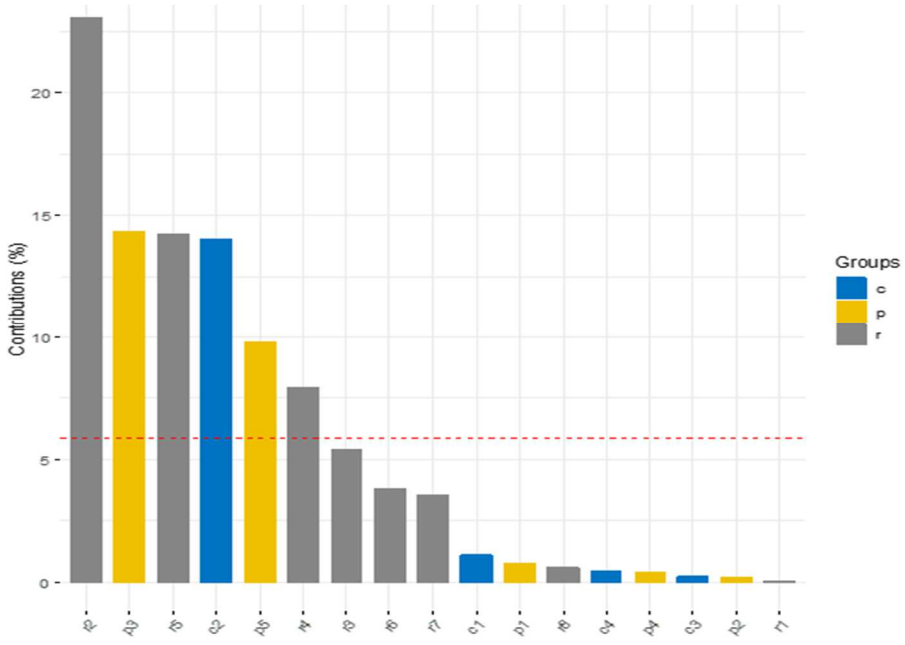

Figure 4. Contribution of quantitative variables to dimension 3
Source: own elaboration based on analysis results.

The indicators of the FAMILY factor (R2, R5) and WORK (P3) make the greatest contribution to explaining dimension 3.

In summary, dimension 1 most strongly related to the WORK, the second to the TIME factors and the third to the FAMILY factors. The MFA allowed three main dimensions to be distinguished, explaining more than 72% of the variance in the data, related to groups of variables: Time, Work and Family (Figure 1).

This finding confirmed the notion that the assessment of WLB systems should be conducted comprehensively, considering at least three dimensions of WLB. This conclusion is consistent with the trend of cross-countries comparative analyses, which demonstrate that satisfaction with WLB is a result of individual capabilities, needs, and the regulatory framework governing the labour market, working hours, and social policy (Ágota-Aliz, 2021; Boghirnea, 2023; Fernandez-Crehuet *et al.*, 2016; Hobson *et al.*, 2011; Kohara & Maity, 2021). Simultaneously, this result does not support the individualistic approach that posits achieving a balance between professional and private life is a matter solely of personal endeavour and minimally (or not at all) dependent on socio-demographic factors or other external circumstances (Newman, 2016).

Moreover, the extracted components that explain the largest part of the variance allowed us to indicate which primary variables (WLB indicators) contribute most to the variance of each principal axis and, thus, which WLB indicators are most strongly associated (correlated) with each dimension. The variables that explain the largest part of Dimension 1 include three variables from the WORK group: P4 Employment rate of people without children (the strongest input), P1 Employment rate, P2 Employment rate of people with children.

Thus, the outcome of this part of the analysis contradicted hypothesis 1, which assumed that the employment rate of individuals with children (P2) plays a more significant role in defining the WORK dimension than the employment rate of individuals without children (P4). The analysis results indicated that the greatest contribution to explaining this dimension is indeed the employment level of childless individuals. Nonetheless, this does not imply that the employment of parents will be irrelevant in explaining the WLB system. MFA still qualifies this variable as highly descriptive of the WORK dimension, while also noting that the individuals without children are similarly affected by the WLB issue. This conclusion validates the development of WLB systems based not only on improving family

policies but also on implementing solutions that favour childless individuals (Darcy *et al.*, 2012). Research indeed confirms that unemployment can cause the postponement of decisions to have children, which has a detrimental effect on addressing demographic challenges (Landaud, 2021; Miettinen & Jalovaara, 2020; Studer *et al.*, 2018).

With a smaller but still significant contribution to explaining variance, dimension 2 consists of three variables from the TIME group: C4 Percentage of employed persons working more than 50h per week, C1 Average number of working hours per week, C3 Employed persons absent from work on average quarterly. Further variables from the FAMILY group were less important for this dimension (Figure 3).

Thus, the most significant variables in describing the second dimension were those associated with the amount of time spent working. The impact was highest if these hours surpassed 50 in a week. This supports hypothesis 2: overtime shapes the WORK_TIME_WLB dimension more strongly than employee absenteeism. This result also validates the rationale for including in comparisons of WLB systems a variable associated with working hours (OECD, 2004; 2021), which is crucial in evaluating the effectiveness of WLB systems and their quality in regulating time allocated to work and rest (Pullinger, 2014; Strzemińska *et al.*, 2014). The research also emphasizes the importance of workplace absenteeism in addition to the factors that are most descriptive of the TIME dimension. Even if working hours are a more significant aspect, this one should still be considered for assessment purposes. Monitoring absences connected to health leaves is crucial, as these may point to overwork, physical, and emotional stress, and hence suggest disturbances in the work-leisure balance (Ninaus *et al.*, 2021; Robichau *et al.*, 2023).

With the smallest contribution to the characteristics of the data structure, dimension 3 consists of two variables from the FAMILY group: R2 Pay gap, R5 Percentage of children from 3 years to school age in public care and one variable from the WORK group: P3 Employment rate of people who have at least one child under 6 years of age (Figure 4).

The conclusions from this part of the analysis did not support hypothesis 3, which posited that public childcare holds greater significance in describing the WLB system than the gender pay gap. This is a crucial finding, indicating the need for further action towards equalizing the situation of women and men in the labour market. It is also consistent with the direction of research showing that a more in-depth and detailed examination of the differences in wages between women and men still reveals significant disparities in certain industries or at high managerial positions (Keller *et al.*, 2023; Leythienne & Pérez-Julián, 2021; Petrongolo & Ronchi, 2020; Redmond & McGuinness, 2017).

In summary, work-related variables explained dimension 1 the most and contributed the most variation in the set of eighteen WLB variables. This may indicate that differences in employment policies or other work-related factors are what most differentiate the countries studied in the data set selected for WLB.

Analysis of WLB profiles over time: Changes in work, time and family indices across years and countries. Calculation of P, C and R indices

We calculated the indices for the P, C, and R dimensions as weighted linear combinations of the standardised indicators of P1, P2, P4 for WORK, C1, C3, C4 for TIME and R2, R4, R5 for FAMILY. We estimated the weights using the partial least squares analysis. Table 1 shows the structure of the weights of the individual variables.

These allowed for the estimation of factor scores for the WORK, TIME, and FAMILY dimensions.

Notation of the equations of the three dimensions of WLB (WORK, TIME, FAMILY):

$$Work = 0.337 \cdot P1 + 0.340 \cdot P2 + 0.335 \cdot P4 \quad (6)$$

$$Time = 0.505 \cdot C1 + 0.057 \cdot C3 + 0.505 \cdot C4 \quad (7)$$

$$Family = 0.543 \cdot R2 + 0.479 \cdot R4 + 0.260 \cdot R5 \quad (8)$$

The estimated factor scores formed the basis for the analysis of the trajectories of changes in the index values for individual countries in the analysed years 2009-2022 (the actual time series was 2008-2022 but we shortened it by one year in the analyses due to data shortages). Note the low weight of the C3 variable (0.057) in the formation of the TIME index and the high weight of the R2 variable (0.543) in the FAMILY index. This provides more support for H2 and once more highlights

the necessity of including the pay gap factor in the evaluation of WLB systems (H3). The variables in the WORK index had the most equal importance (from 0.335 to 0.340), the variables in the TIME index showed the highest average importance (from 0.057 to 0.505), while the variables in the FAMILY index varied the most in importance (from 0.260 to 0.543).

Table 1. Factor weights of the three WLB dimensions PCA Weights

Latent	Indicator	Weight estimate
Work	P1	0.337
	P2	0.340
	P4	0.335
Time	C1	0.505
	C3	0.057
	C4	0.505
Family	R2	0.543
	R4	0.479
	R5	0.260

Source: own study based on analysis results.

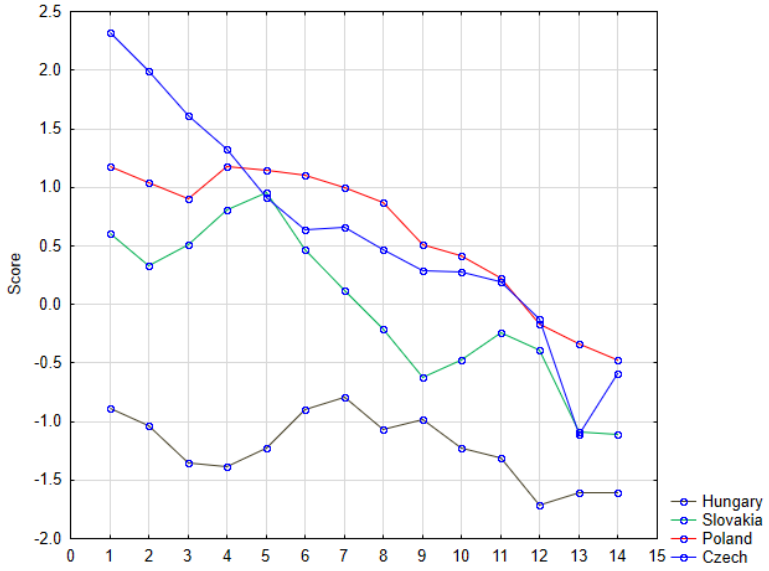

Figure 5. The TIME dimension index 2009-2022*

Note: *Periods from 2009 (1) to 2022(14)

Source: own elaboration based on analysis results.

In the case of the TIME index, we observed declining index values for all countries surveyed (especially the Czech Republic), alongside an increase in homogeneity in the final period (the profiles of the V4 countries are converging). Poland had the highest level (except for 2009-2012), and Hungary had the lowest level.

Regarding the WORK index, all countries (particularly Hungary) have increasing index values. The Czech Republic has the highest level and Poland the lowest level (except for the years 2009-2013).

Increasing work-related variables imply strong dynamics in the area of WLB. The increase in employment, also among those with children, suggests the existence of favourable conditions for combining work and non-work responsibilities. On the other hand, work activity increases the risk of work-life conflict. This poses major challenges for the state but also for employers, who are responsible for shaping favourable conditions for work-life balance.

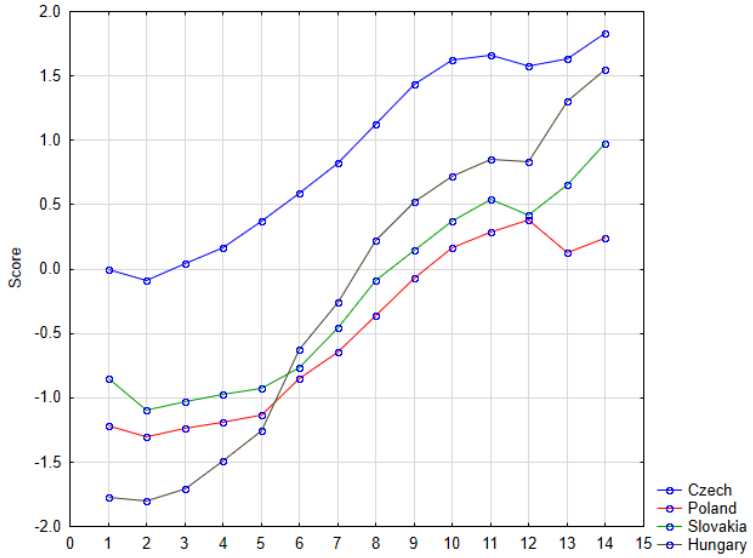

Figure 6. The WORK dimension index 2009-2022
Source: own elaboration based on analysis results.

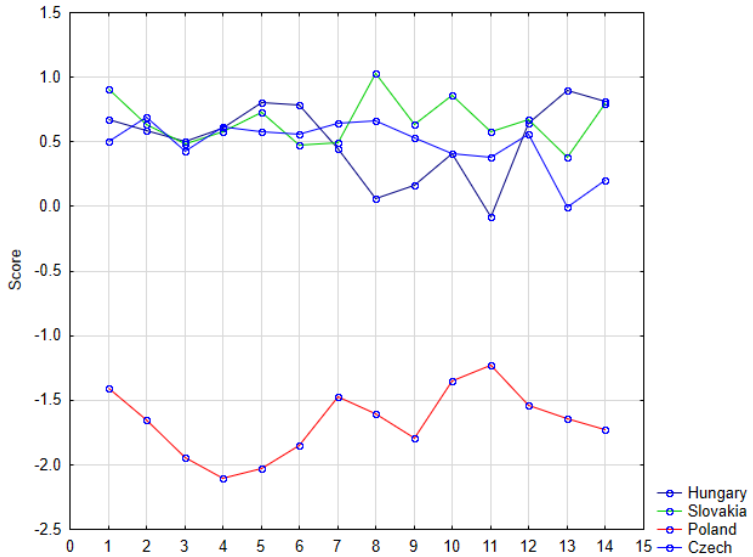

Figure 7. The FAMILY dimension index 2009-2022
Source: own elaboration based on analysis results.

With the exception of Poland, all countries' FAMILY index values were steady until the halfway point of the study period, at which point there was an increase in heterogeneity until the last year of analysis. The Czech Republic, Slovakia, and Hungary are characterized by the highest levels, while Poland significantly had the lowest level.

The trajectory of the V4 countries was similar across every Work-Life Balance dimension (WORK, TIME, FAMILY), with only three types of changes occurring. In the TIME dimension, the trajectories are marked by homogeneity in index increments; in the WORK dimension, differences were stable. Meanwhile, in the FAMILY dimension, the trajectories tended towards heterogeneity (in the final stage). The trajectory for the FAMILY dimension for Poland significantly diverged from the rest of the V4 countries, showing indices below the average by 1-2 standard deviations (Figure 7).

Thus, we confirmed hypothesis 4, which postulates that the WLB systems of the V4 nations will develop similarly in several dimensions. This finding aligns with previous studies that emphasize the

similarities in WLB systems characteristic of countries with similar socio-cultural backgrounds (Fernandez-Crehuet *et al.*, 2016; Thévenon, 2011). We compared culturally similar countries that entered the European Union under nearly identical economic and social conditions. They also chose similar paths in the development of their WLB systems. The foundation of these choices were political and legal decisions that introduced various systemic solutions supporting employment flexibility, working time, and family support. Comparing the consequences of these decisions, which illustrate the variables of work, time, and family in the V4 countries, sheds additional light on the significance of the governing political options in shaping work-life balance.

CONCLUSIONS

The research allowed us to identify the dimensions underlying WLB and assess their dynamics. On this basis, we identified the trajectories of WLB in a cross-section of V4 countries between 2008 and 2022.

The most notable distinctions between V4 countries in the data set for their WLB related to employment policy or other work-related factors. This result also constitutes an important recommendation for the development of WLB systems, which should be based on labour market indicators as benchmarks for their evaluation.

We identified similarities in the trajectories of each dimension of WLB. The decline in the TIME index indicates a general trend towards fewer working hours, which we may see as a positive signal in the context of WLB. Nonetheless, in comparison with other EU countries, the V4 countries still record some of the highest weekly working hours (verification of hypothesis 2).

Rising WORK index values across the V4 countries underscore a significant dynamism within the domain of WLB, particularly suggesting favourable conditions for work-life integration, especially for those with children. This is evident as the Czech Republic showcased the most dynamic labour market development, indicated by the largest increase in the WORK index, whereas Poland experienced the least dynamic changes, reflecting varying degrees of labour force participation among these countries. However, this increased participation, while beneficial, also introduces potential work-life conflicts, challenging both nations and employers to create optimal WLB conditions. Despite these differences in labour market dynamism, we observed contrasting stability in the FAMILY index across all V4 countries. This stability signifies a slow pace of change in critical areas such as the gender pay gap and childcare provision underscoring a consistent approach towards family support across these nations despite the varying economic activities (verification of hypothesis 3).

The comparison of the analysed WORK and TIME indices yielded valuable insights as well. The increase in work indicators, coupled with a decrease in time-related indicators, is potentially beneficial for assessing the WLB system. It implies that more individuals are actively participating in the labour market, which positively affects the households' financial condition. Conversely, shorter working hours mean more time for personal life, translating into a higher sense of well-being. All V4 countries showed a trend of increasing WORK index while experiencing a decrease in working hours, revealing a similarity towards improving WLB through reduced working hours and increased employment (verification of hypotheses 1 and 2).

Prior comparative studies in the field of WLB have emphasized that efforts towards better balancing professional and private life in countries with relatively low outcomes should focus on family and health issues (Fernandez-Crehuet *et al.*, 2016). Proposals include increasing average earnings for individuals, reducing the gender pay gap, or expanding the reach of formal education that is free or subsidized for young children. While our research confirms the significance of the gender pay gap and public childcare up to the third year of life (verification of hypothesis 3), it also specifies that employment rates and working hours significantly determine WLB systems (verification of hypotheses 1 and 2). This is supported by additional studies showing that employment uncertainty is a crucial factor affecting the ability to balance work and personal life (Hobson *et al.*, 2011) and that this ability (also understood as satisfaction with WLB) is negatively correlated with weekly working hours (Fedakova, 2017).

Policy Implications

The results will be useful for developing future WLB improvement initiatives and for additional trend research. Such a long-term strategy can reduce gender inequality and increase the labour market's accessibility and flexibility (OECD, 2001). The intensity and directions of policy are largely regulated by the political option that governs a given country. It has an impact on the regulation of the labour market, including, among others, the number of working hours, the right to annual leave, the availability of flexible forms of employment, and also on the family support system – the right to family leave and benefits, support in the area of childcare, or finally, the general system of tax benefits (McGinnity & Whelan, 2009).

Liminations and Further Research

The conducted research has limitations that may encourage further exploration. Firstly, we based the study on aggregated data, not direct outcomes from respondent surveys. Secondly, a limitation could be the comparative analysis between the V4 countries and highly developed (European) countries. Thirdly, the absence of exploratory (regression) models with additional parameters (predictors) could broaden the interpretation of the WLB dimensions' trajectories.

There are multiple options for integrating variables into WLB dimensions. Hence, future research should focus on observing WLB dimensions and evaluate the trajectories outlined in the article, including the impact of decisions by V4 countries on the formulation of WLB policies. Research interest in WLB should continue to be sparked by the consequences of unemployment, and the situation of individuals (both women and men) in the labour market, regardless of whether they have children, including younger generations as well as seniors and migrants.

Moreover, an analysis of the relationship between governmental decisions (legislative acts, government programs) and the development of the labour market in the aspect of supporting work-life balance would be of particular interest.

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