JOURNAL OF TOURISM AND SERVICES
Issue 29, volume 15, ISSN 1804-5650 (Online)
www.jots.cz

Impact Analysis of the Digital Entrepreneurial Ecosystem to Improve the Tourism Industry and Social Sustainability

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Received: 22 April 2024. **Revision received**: 22 August 2024. **Accepted**: 9 September 2024

Abstract
Digitalisation is a key enabler of sustainable tourism in an industry that has recently been transformed by new sustainable innovations and digital solutions. In this study, we analysed the effects of the digital entrepreneurial ecosystem (DEE) on the tourism industry and social sustainability of 27 EU countries. The study underlines the key independent indicators representing the impact of the DEE's elements. Also, a quantitative and comparative approach was considered using the panel data method and clustering analysis for data from 2014 to 2021. Our findings show significant positive impacts of DEE elements that have significantly contributed to tourism and social sustainability growth. Furthermore, hierarchical clustering analysis (HCA) revealed that eight countries (cluster A), including Germany, the UK, France, Spain, and Italy, had the highest average digitalisation levels, affecting their tourism growth and social sustainability. Ultimately, we indicate that different digital user levels and marketplaces, such as networks designed to produce cloud infrastructure, digital platforms, and digital tourist-based devices and applications, have the capability to enhance tourism and social sustainability.

Key Words: Digital Entrepreneurial Ecosystem, Social Sustainability, Tourism, Panel Data Analysis, European Countries

JEL Classification: M21, O31, O520

Reference: Khatami, F., Ferraris, A., Palmucci, D. N., & Dabić, M. (2024). Impact Analysis of the Digital Entrepreneurial Ecosystem to Improve the Tourism Industry and Social Sustainability. *Journal of Tourism and Services*, *15*(29), 176–205. https://doi.org/10.29036/jots.v15i29.831

1. Introduction

In recent years, new insight into the connections between digitalisation, tourism and sustainability has been defined as 'smart tourism', which looks at tourism through the lens of sustainable tourism indicators (Ivars-Baidal et al., 2019). In smart tourism, digitalisation has enabled the creation of new entrepreneurial activities (Von Briel et al., 2018; Hoang et al., 2023; Zhou et al., 2022), ecosystems (Tandon et al., 2020), services (Lyytinen et al., 2016; Shpak et al., 2022), platforms (Tiwana et al., 2010), infrastructures (Aldrich, 2014), artefacts (Ekbia, 2009) and internet-based innovations (Kuester et al., 2018; Elia et al., 2020).

As mentioned by Sussan and Acs (2017) and Elia et al. (2020), the two concepts of digital and entrepreneurial ecosystems can be integrated to create a new concept—the digital entrepreneurial ecosystem (DEE)—to better study the role of digital technologies in the context of entrepreneurial activities and understand the interactions of agents and users within this ecosystem. The DEE deals with digital entrepreneurship, such as digital social entrepreneurship, business models, processes, platforms and ecosystems (Kraus et al., 2019; Sahut et al., 2021). In this sense, the DEE as a multi-actor, multistakeholder and multi-scalar phenomenon (Ferraris et al., 2018a) includes several interacting stakeholders; these stakeholders engage in networking, learning and executing business-oriented processes (Elia et al., 2020), in addition to developing roots in the business ecosystem. The main necessity of the current study arises from the European-country-level findings of Gomez et al. (2018), who revealed that digitalisation in the field of e-tourism varies depending on economic development. In this vein, another motivation for the current study is based on the results of Filipiak et al. (2020), Saseanu et al. (2020) or Streimikis et al. (2024), who both indicated the relationship between the level of development of digitisation (e-commerce) and development of the tourism industry. Moreover, Esses et al. (2021) demonstrated a strong relationship between sustainability and digitalisation transformation. Filipiak et al. (2020) mentioned that no current studies have explored the links between social sustainability, digitisation and the tourism economy. According to Dredge et al. (2018), research should focus on identifying the potential approaches and initiatives of European tourism policy to enhance digitalisation in tourism.

In fact, to define a specific service and destination, the tourism industry, which is a multi-billion-dollar industry with generating 10% of global GDP (Lane 2018), requires novel platforms to enhance the sustainable experience at a location (Cetin & Pala, 2022; Milwood & Maxwell, 2020; Mohammed Alnasser, Mohammed Alkhozaim, 2024). This prospect can be seen in the use of digitalisation and innovation processes to define sustainable tourism because digitalisation can define the social-based factors of sustainability, which can be assumed to be the motor of evolution for the tourism industry by extending high-tech infrastructures in the destinations (Filipiak et al., 2020).

The current paper examines how the DEE can influence the socioeconomic indicators of tourism and sustainability. The DEE is a creative platform for digital customers (users and agents) to create social values and communications (Sussan & Acs, 2017). The present study is novel in underlining the key independent indicators representing the elements of the DEE that have an impact. Also, the present paper shows the role of DEE elements in the field of sustainable tourism, as an element of wider sustainable development (Nguyen et al., 2019), by using correlation tests. Such tests between each key component of the DEE on the tourism industry at the national level have not been well studied among scholars because analysis of the DEE's impact on the progress of both socioeconomic sustainability and tourism development is a new research field. Digitalisation is a focus because the current paper addresses the impact of the aspects of certain DEE indicators and success of making tourism attractive, which is a possible proxy for ecosystem success (Cassia et al., 2021).

The variables chosen for tourism and sustainability are the indicators, which approximate measurement of digitalisation through the quality of life and proactiveness of a country. This paper also considers the pillar of social sustainability, promoting human development identities (e.g., Melissen et al., 2016; Celebi et al., 2022). Therefore, in the current paper, we limit ourselves to the two proxies that can indicate the quality of life and level of attractiveness: international arrival tourism and the Human Development Index (HDI), respectively. By analysing these indicators, we can determine the impact of the DEE on the quality of life in a proactive country. Hence, as the main motivation behind the current research, the variables were skimmed from macro-level databases using expert judgement to explore how DEE elements and the indicators. Thus, our research complements the research avenues on social sustainability and tourism growth using digital skills and technical processes applicable in social media transition (Tilson et al., 2010; Švarc et al., 2021).

At the country level, the fast spread of digital information technologies (e.g., computers and mobile devices) and related infrastructure (e.g., telecommunications) has promoted digital economic development (Mok tourismarzadeh et al., 2020, Skare et al., 2023). Given its novelty, the DEE and its

elements have not yet to be consolidated in the literature despite, some recent attempts to clarify the concept (Torres & Godinho, 2021). Hence, the current paper defines DEE elements and their digitalisation effects through the tourism growth and sustainability of EU countries because all DEE elements are necessary to produce digitally enabled situations (Torres & Godinho, 2021). On this basis, we propose three questions:

RQ1: Do DEE elements have significant positive associations with tourism growth at the country level?

RQ2: Do DEE elements have significant positive associations with social sustainability at the country level?

RQ3: Do social sustainability and tourism arrivals have a similar alignment in European countries?

Each country's development level and their corresponding sustainable indicators may play a role here. Hence, our paper focuses on analysing the key indicators related to a panel of 27 European countries for the period 2014–2021. According to Jafari-Sadeghi et al. (2021), the static panel data synthesis was used to test the hypotheses, here by considering some fixed and random effects.

Our results suggest an independent and significant impact of DEE elements in promoting tourism growth and social sustainability at the country level. A macro-level or country-level study can represent individual, personal and professional activities through an economic study of multiple variables based on the availability and reliability of global databases. Effective relationships are anticipated to be found between DEE elements (e.g., digital entrepreneurship and digital user citizenship) and the aforementioned independent variables (tourism and sustainability).

Our paper provides at least two main contributions. First, we empirically test the relationships between DEE elements and tourism growth and sustainability at the country level. Hence, our findings reinforce the literature in suggesting the crucial role of digital technology in the tourism industry (e.g., Almeida-Santana et al., 2020; Gretzel, 2011). Moreover, our research also extends studies indicating the role of digital technology in sustainability (e.g., George et al., 2020; Skare et al., 2024) to address some major challenges in the field of management.

2. Literature review and Hypothesis development

2.1. DEE elements and the tourism industry

Digitalisation and DEE's elements are digital infrastructure governance, digital user citizenship, digital entrepreneurship, and the digital marketplace (e.g., Song, 2019). Digital infrastructure governance involves coordinating and governing to establish shared technological standards for entrepreneurial activities. Digital user citizenship refers to the legal and social contract between individuals in a digital space. Digital entrepreneurship refers to those activities that optimally utilise and reconfigure a digital infrastructure in new systems, platforms, and networks. The digital marketplace can be defined as value creation in the form of a new product in entrepreneurial activities (Sussan & Acs, 2017).

The levels of adoption and digitalisation used by tourism entrepreneurs remain low (Alford & Jones, 2020). Some innovative technologies can be found in the globalised countries of the EU, here based on regional and national stakeholders in tourism (Antón-Maraña et al., 2023; Eakin et al., 2012). For instance, one review described the promotion of rural tourism and entrepreneurship ecosystem framework through the use of innovation and digitisation avenues (Madanaguli et al., 2021). However, digital transformation is not limited to particularly innovative businesses, digital start-ups and high-tech giants; rather, it is a process that embraces companies of all scales in diverse industries (Ferraris et al., 2019; Bresciani et al., 2021b).

2.2. DEE elements and sustainability

Tiago et al. (2021) noted that the relationship between digital sophistication and sustainability communication is weak for tourism firms. In contrast to this, some scholars have pointed out the positive relationship between DEE and sustainability (e.g., Song, 2019; Yenidogan et al., 2021). Elia et al. (2020) also found the impact of two DEE elements (i.e., digital marketplace and digital entrepreneurship) on sustainability. However, the present research attempts to analyse the impact of four DEE elements on sustainability at the country level. Hence, the yearly HDI values for each country are assumed to be an integrated indicator of environmental and socioeconomic sustainability indices, here based on the United Nations Development Programme (UNDP, 2019). The HDI contributes as a tool for assessing a society's progress toward social sustainability by highlighting the well-being and capabilities of its people. In this research, we anticipate that the dependent variable the HDI (as a social indicator of sustainability) is influenced by the digital-based elements of the independent variable (the DEE).

We focused on the social aspect of sustainability because of its relation to the tourism organisation (Helgadóttir et al., 2019). Hence, the current paper has emphasised the social dimension of sustainability (instead of the environmental dimension).

3. Hypothesis development

Prior DEE studies have already discussed the role of digitalisation in several industries (Purbasari et al., 2021). Recently, Tandon et al. (2020) emphasised that entrepreneurial ecosystems are systems based on digitised innovation strategies. However, the four main DEE elements (e.g., digital entrepreneurship, digital infrastructure, the digital marketplace and digital user citizenship) may have different impacts in the tourism context and on a country's sustainability.

Although digitalisation trends could change the traditional ways in the firm's business (Fakhar Manesh et al., 2021; Caputo et al., 2021), several studies have indicated that it can support tourism growth (e.g., Adukaite et al., 2016).

On the other hand, sustainability can achieve competitive success (Mass et al., 2014) and establish a new role in social activities (Ferraris et al., 2018b; Bresciani et al., 2021a). Because digitalisation concerns all aspects of human social life, it can be defined as the transformation of entrepreneurial models that become a source for innovation in different industries; here, entrepreneurs are the affected agents of these digital transformations (António & Rita, 2021; George et al., 2020). As general term, industries like to understand how digitalization enhances the sustainability (Schneider, 2019). Particularly, digital entrepreneurship has a potential impact on the sustainability of such systems. In this way, higher levels of digital entrepreneurship can lead to higher social sustainability and higher growth in the tourism industry. Thus, we obtain the following main hypotheses:

Hp.1a: Digital entrepreneurship has a positive association with the growth of the tourism industry at the country level.

Hp.1b: Digital entrepreneurship has a positive association with high social sustainability at the country level.

Many scholars have focused on digital infrastructure as it relates to the tourism industry (Vasilenko & Tokareva, 2019). The digital infrastructure element of the DEE can be defined as a set of shared technological standards for entrepreneurial activities. The development of digital infrastructure integrates the technical, structural, and organisational components of systemic transformation into a country's economy (Vasilenko & Tokareva, 2019). Through the growth of digitalisation, the development of digital infrastructure in the tourism industry has become a trend when aiming to increase the speed of services, improve the quality of tourism services, and, as a result, maintain high tourist traffic (Pasquinelli et al., 2023). Hence, digital platforms can influence tourists, leading them to search for information about tourism products (Vasilenko & Tokareva, 2019). Digital infrastructure includes technical and organisational components, processes and networks. It also benefits sustainability, which then ensures

that the digital-transformation taking place in different industries increases the potential use of specific digital technologies (Hustad & Olsen, 2020). In this way, higher levels of digital infrastructure can lead to higher social sustainability and higher growth in the tourism industry. Thus, we obtain the following main hypotheses:

Hp.2a: Digital infrastructure has a significant positive association with the growth of the tourism industry at the country level.

Hp.2b: Digital infrastructure has a positive association with high social sustainability at the country level.

The digital marketplace element of the DEE can be defined as value creation in the form of a new product or service, which preserves the environment (Filep et al., 2023). The digitisation of activities in the tourism industry is connected to the use of digital marketing technologies to facilitate revenue growth in the host country (Vasilenko & Tokareva, 2019). A digital marketplace is designed to produce reliable big data to deliver sustainability compliance (Bergier et al., 2021). These platforms allow businesses to become actors in global growth and development via the promotion of social inclusion and sustainability (Van der Schyff et al., 2019; Horng et al., 2023). Besides, Labanauskaitė et al., (2020), have described the potential of digital marketing through the characterization of tourism innovation in the tourism industry. In this way, higher levels of the digital marketplace can lead to higher social sustainability and higher growth in the tourism industry. Hence, we obtain the following main hypotheses:

Hp.3a: The digital marketplace has a significant positive association with the growth of the tourism industry at the country level.

Hp.3b: The digital marketplace has a positive association with high social sustainability at the country level.

The digital user citizenship element of the DEE can be defined as a legal and social contract within a digital space. In the past few years, the evolution of new technologies has led to the changing behaviour and habits of users (Horng et al., 2023). Hence, choosing the correct digital platform is important for helping users follow the way in their industries (Senyo et al., 2019). Digital user citizenship in the tourism industry pursues users in their social network profiles on networks. Therefore, digital user citizenship is the best technique that can be implemented in the tourism industry because it can have links between its development and business models based on the tourism industry promoted by digital platforms (Reyes-Menendez et al., 2018).

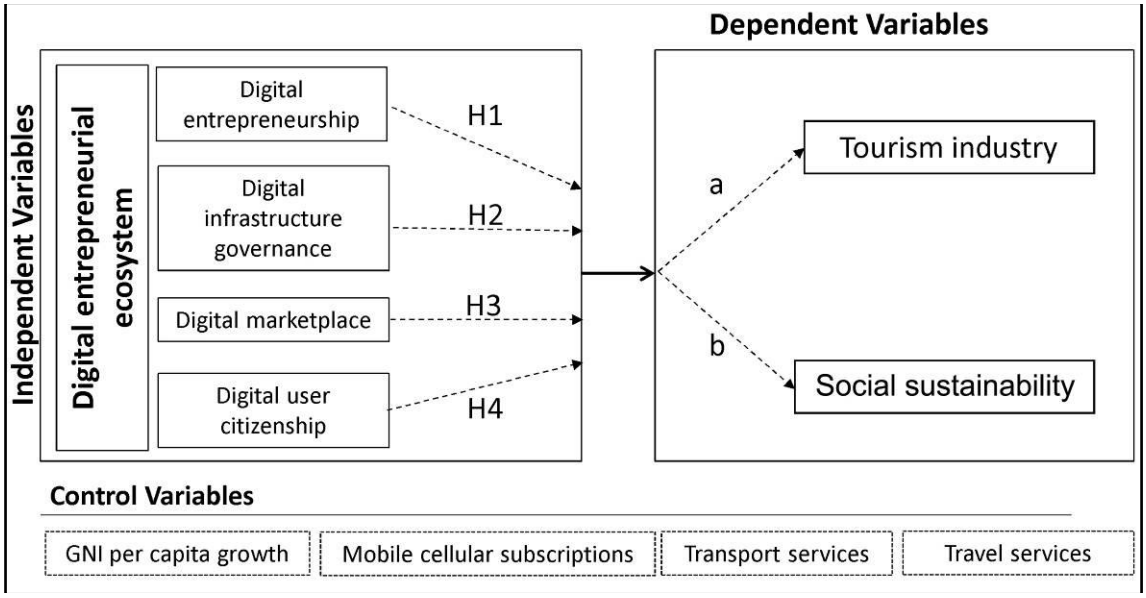
DEE elements can change one's social interactions towards the use of technology, leading to sustainability (Filep et al., 2023). By improving a country's social sustainability, digital user citizenship can have a positive impact on both industries and users. In addition, higher levels of employment in services, a labour force with advanced education, and trademark applications in digital user citizenship can promote a country's sustainability. We posit that higher levels of digital user citizenship can lead to higher social sustainability and higher growth in the tourism industry. Hence, we obtain the following main hypotheses:

Hp.4a: Digital user citizenship has a significant positive association with the growth of the tourism industry at the country level.

Hp.4b: Digital user citizenship has a positive association with high social sustainability at the country level.

A simple model showing the development of the hypotheses is given in Graph 1.

Graph 1. **Development of the hypotheses**



Source: own research

4. Methodology

4.1. Study area

In terms of data and methods, a quantitative approach was chosen, here using the data from 27 European countries in the Organisation for Economic Cooperation and Development's (OECD, 2024) database (https://www.oecd-ilibrary.org/statistics). Data collection of 40 variables was carried out to gain the time series for the 27 selected European countries in the period of 2014–2021.

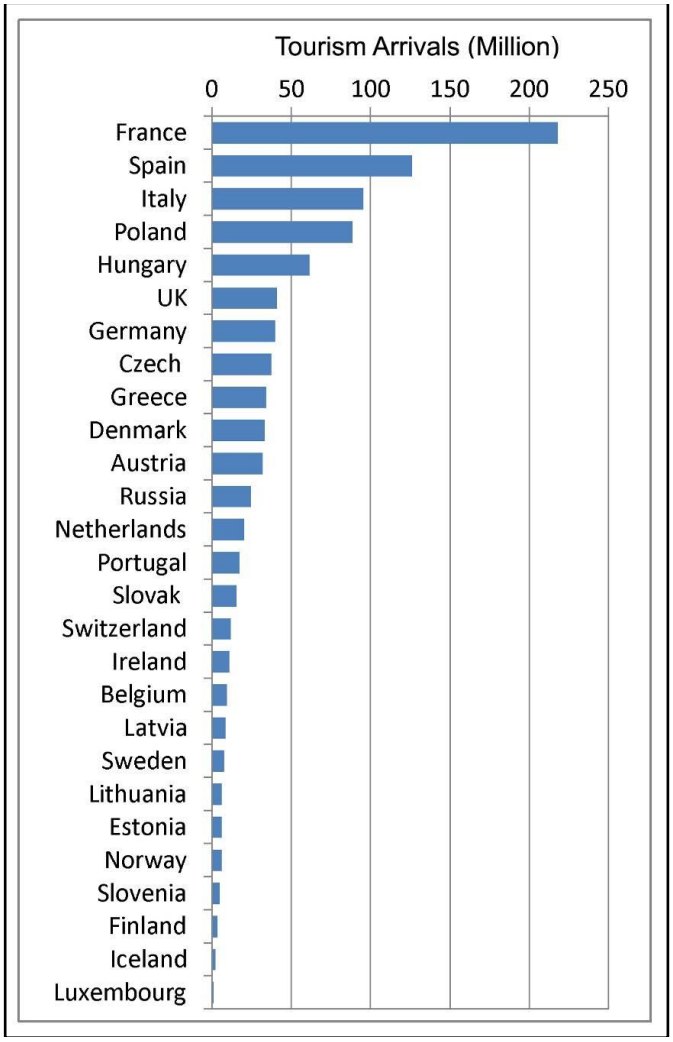
The main reason for selecting these countries was to choose the maximum number of EU countries (European Union countries in addition to the UK) to present a comprehensive analysis without data availability or missing data in the source link of OECD. Moreover, selecting these countries depends on their multifaceted economies affected by the different labor force and population status (Bosma and Kelley 2018).

Owing to Brexit (withdrawal of the UK from the EU), we are obliged to gain the UK data in addition to the EU data in the given databases. We selected the following 27 European countries out of 44 worldwide cases: Austria, Belgium, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, the Netherlands, Norway, Poland, Portugal, Russia, Slovak Republic, Slovenia, Spain, Sweden, Switzerland, and the United Kingdom.

The total contribution of tourism industry to GDP in the world is recorded at 9,630 billion USD in 2019 based on the global statistics of tourism (Statista 2022). On this basis, the share of tourism industry to GDP in European countries is estimated at 2.141 billion USD in 2019, as 22% of the world's contribution to tourism industry. Meanwhile, the international tourism arrivals data (World Bank 2022) indicates 968.9 and 2403.1 million tourists in the European region and the world in 2019 (before the effect of Covid-19 in 2020 statistics). The contribution of the selected 27 European countries to the European region and the world is estimated equal 99% and 40% of total tourism arrivals. The most tourists have been recorded for France, Spain, Italy, and Poland with 217.9 million tourists (22.5% of the European region), 126.2 (13.0%), 95.4 (9.8%), and 88.5 (9.1%), respectively (Graph 2). The selected 27 countries are contributed 22% of the tourism industry GDP in the world; however, their tourism arrivals

are about 40% of the world, revealing the progress of tourism sector in the selected European countries. Overall, from a tourism industry viewpoint, the selected countries have an important position in the world tourism data.

Graph 2. **Total tourism arrivals for 27 selected European countries in 2020**



Source: derived from World Bank 2024

4.2. Data collection and variables

In this study, we selected two dependent variables of the tourism industry (tourism arrivals) and social sustainability (HDI), 34 independent indicators representing DEE elements (as mentioned in Table 2), and four control variables (which are found in the GNI index and are per capita growth, mobile cellular subscriptions, transport services, and travel services) at the country level (World Bank, 2024).

We selected 34 independent indicators from Digital Business Indicators, as a joint dataset between the Global Indicators Group, the Digital Development Global Practice, the Trade and Investment Global Practice, and the World Bank research teams (World Bank, 2022), to represent the DEE elements because a robust index among the global datasets that could expose the overall digitalisation level in a country or even for each element was lacking.

In the current study, we consider two proxy variables to indicate the statuses of two dependent variables of tourism industry and sustainability. tourism industry and sustainability are general

phenomena and the best procedure to quantify and describe their values is using the proxy variables. For instance, the yearly HDI, which is a reanalysed indicator of sustainability, was obtained as a proxy measure for the dependent variable of sustainability (UNDP, 2019). The HDI is the geometric mean of the normalised measures of the three dimensions of human development, including the life expectancy index, knowledge, education index, and GNI index.

All the aforementioned data were collected based on the World Bank development indicators (https://databank.worldbank.org/source/world-development-indicators) and OECD statistics (https://www.oecd-ilibrary.org/statistics) and were based on one-year intervals between 2014 and 2021 before being organised for each country. Empirical analyses for the aforementioned multidimensional variables were constructed based on the main elements of the DEE [34 variables], tourism arrivals [35 variables], and social sustainability [36 variables]. The given variables were selected based on their relevance to the main subjects from 140 indicators (e.g., UNCTAD, 2019; UNDP, 2019), and were skimmed by expert judgment, including seven academic professors in management, entrepreneurship, economy, and business model experience, through a web-based interview. Regression analysis was used to detect the relationships between DEE elements and the dependent variables to answer the first and second research questions and analyse the hypotheses (Hp. 1 to Hp. 4). Panel data analysis using Stata software (ver. 14) was used to analyse the correlations and associations. Based on meaningful correlations between DEE elements and the two dependent variables (e.g., tourism and social sustainability), we investigated the overall digitalisation impact on the improvements in each country's tourism industry and social sustainability. We used general indicators (tourism growth (arrivals) and social sustainability (HDI) to approximate a measurement of digitalisation through the quality of life and proactiveness of a country. Tourism arrivals as proxy for international tourism-growth are measured in this research following Ekeocha et al., (2021). If a country has a good quality of life and good leisure facilities, this would be perceived as a safe country that attracts tourist arrivals.

On the other hand, social indicators of sustainability (HDI) can affect life expectancy, being knowledgeable and having a decent standard and quality of living (Gaucher et al. 2022; Grum & Kobal Grum 2020). HDI also provides a ready-made measure of social sustainability, as recognised by Bravo (2014) and Morris et al. (2019).

Digitalisation directs this process to promote the tourism industry and social sustainability while increasing the quality of life. In fact, digitalisation influences processes to provide smooth progress and well-being.

Meanwhile, we assumed a constant correlation of Pearson's correlation test between these two variables to interpret a possible alignment and answer our third research question. Ultimately, to present comparisons between the selected countries, hierarchical clustering analysis (HCA) was established to cluster the digitalisation levels of the countries in how they relate to their tourism and sustainability. The application of the HCA was intended to achieve an integrated plot for all countries, variables and time series which could then indicate the level of each country's digitalisation, tourism and sustainability. The HCA outputs then helped classify the countries via a dendrogram. (Tables 1 and 2).

Table 1. **Description of obtained 40 indicators**

Indicator name	Unit	Code	Source
Digital: Electronic transactions	Index from 0 to 1	[01]	OECD-STRI
Digital: Other barriers affecting trade	Index from 0 to 1	[02]	

Digital: Infrastructure and connectivity	Index from 0 to 1	[03]	
Digital: Indicator STRI	Index from 0 to 1	[04]	
Ease of doing business	Index from 1 to 100	[05]	DBP
Starting a business	Index from 1 to 100	[06]	
Dealing with construction permits	Index from 1 to 100	[07]	
Getting electricity	Index from 1 to 100	[08]	
Registering property	Index from 1 to 100	[09]	
Getting credit	Index from 1 to 100	[10]	
Protecting minority investors	Index from 1 to 100	[11]	
Trading across borders	Index from 1 to 100	[12]	
Enforcing contracts	Index from 1 to 100	[13]	
Resolving insolvency	Index from 1 to 100	[14]	
Cost of business start-up procedures	% of GNI per capita	[15]	WBDBP
Procedures to register property	Number	[16]	
Start-up procedures to register a business	Number	[17]	
Time required to start a business	Days	[18]	
Automated teller machines (ATMs)	Per 100,000 adults	[19]	IMF
Computer, communications	% of service exports	[20]	
Trade in services	% of GDP	[21]	
Secure Internet servers	Per 1 million people	[22]	NETCRAFT

Adjusted net national income	Annual %	[23]	CWN
Adjusted net national income per capita	Annual % growth	[24]	
Employment in services	% of total employment	[25]	ILOSTAT
Self-employed, total	% of total employment	[26]	
Labour force with advanced education	% of total number	[27]	
Labour force	Total number	[28]	
ICT goods exports	% of total goods exports	[29]	UNCTAD
Trademark applications	Total number	[30]	WIPO
Research and development expenditure	% of GDP	[31]	UNESCO
Trade	% of GDP	[32]	WBSE
GDP growth	Annual % growth	[33]	
GDP per capita growth	Annual % growth	[34]	
International tourism	Number of arrivals	[35]	WTO
Human Development Index	Index from 0 to 1	[36]	UNDP
GNI per capita growth	Annual % growth	[37]	WBNAD
Mobile cellular subscriptions	Per 100 people	[38]	ITU
Transport services	% of commercial service exports	[39]	IMF
Travel services	% of commercial service exports	[40]	

Source: own research

Table 2. **Distribution of the 34 independent indicators within the four elements of the entrepreneurial ecosystem (DEE)**

DEE element	Indicator title [code]	Direction*
Digital entrepreneurship	Cost of business start-up procedures [15]	-
	Procedures to register property [16]	-
	Start-up procedures to register a business [17]	-
	Time required to start a business [18]	-
	Ease of doing business [05]	+
	Starting a business [06]	+
	Dealing with construction permits [07]	+
	Getting electricity [08]	+
	Registering property [09]	+
	Getting credit [10]	+
	Protecting minority investors [11]	+
	Trading across borders [12]	+
	Enforcing contracts [13]	+
	Resolving insolvency [14]	+
Digital infrastructure governance	Electronic transactions [01]	+
	Barriers affecting trade in digitally enabled services [02]	-
	Infrastructure and connectivity [03]	+
	Indicator STRI [04]	+

	Automated teller machines [19]	+
	Computer, communications and other services [20]	+
	ICT goods exports [29]	+
	Research and development expenditure [31]	+
	Secure Internet servers [22]	+
Digital marketplace	Adjusted net national income [23]	+
	Adjusted net national income per capita [24]	+
	Labour force, total [28]	+
	Trade [32]	+
	Trade in services [21]	+
	GDP growth [33]	+
	GDP per capita growth [34]	+
Digital user citizenship	Employment in services [25]	+
	Labour force with advanced education [27]	+
	Self-employed, total [26]	+
	Trademark applications, total [30]	+

Source: own research

* Coordinated direction of indicators for the respective element; +: positive direction and -: negative direction. Direction between the variables depends on their coordination signs, which a positive sign implies that increases in the value of one variable tend to be accompanied by increases in the other variable and a negative sign implies that increases in one are accompanied by decreases in the other (tourismtps://www.washington.edu/assessment/scanning-scoring/scoring/reports/correlations).

5. Results

5.1. Descriptive data analysis

In the first step, the raw data obtained from the global databases were converted into standardised data. Then, the data were combined to obtain the final mean values for the DEE elements, tourism, and social sustainability. Based on the mean values within the eighttime periods, we produced an initial descriptive analysis of each country's DEE standardised mean values, tourism and social sustainability. The results revealed that France, Spain, and Italy had the strongest tourism industry values (> 0.64) because of their highest number of tourist arrivals, while Norway and Switzerland had perfect social sustainability (1.00) based on their HDI scores. When comparing the digital, tourism, and social sustainability values among the EU countries, Germany and the UK could be considered stable and well-adjusted in terms of each of these factors (Tables 3).

Table 3: **Standardized mean values for all indicators in selected countries within 2014-2021**

Country Name	Digital entrepreneurship	Digital infrastructure governance	Digital marketplace	Digital user citizenship	Sustainability	Tourism
Austria	0.91	0.22	0.08	0.25	0.96	0.00
Belgium	0.86	0.23	0.00	0.00	0.97	0.00
Czech Republic	0.88	0.20	0.08	0.09	0.94	0.00
Denmark	0.95	0.25	0.10	0.04	0.98	0.00
Estonia	0.91	0.16	0.00	0.00	0.93	0.00
Finland	0.91	0.17	0.08	0.02	0.98	0.00
France	0.82	0.12	0.29	0.00	0.94	0.00
Germany	0.91	0.26	0.00	0.00	0.99	0.00
Greece	0.74	0.15	0.14	0.00	0.92	0.00
Hungary	0.85	0.32	0.29	0.00	0.89	0.00
Iceland	0.91	0.19	0.00	0.00	0.99	0.00
Ireland	0.91	0.38	0.07	0.00	0.99	0.00
Italy	0.79	0.29	0.00	0.25	0.93	0.00
Latvia	0.91	0.29	0.00	0.00	0.90	0.00
Lithuania	0.88	0.26	0.00	0.12	0.92	0.00
Luxembourg	0.81	0.25	0.14	0.21	0.96	0.00
Netherlands	0.87	0.23	0.00	0.00	0.99	0.00
Norway	0.94	0.23	0.04	0.24	1.00	0.00
Poland	0.84	0.34	0.00	0.00	0.91	1.00

Portugal	0.88	0.20	0.00	0.00	0.90	0.00
Russia	0.80	0.33	0.00	0.00	0.86	0.52
Slovak Republic	0.80	0.17	0.14	0.09	0.90	0.00
Slovenia	0.87	0.24	0.00	0.00	0.95	0.00
Spain	0.84	0.20	0.07	0.12	0.94	0.00
Sweden	0.93	0.37	0.14	0.07	0.99	0.00
Switzerland	0.88	0.16	0.00	0.00	1.00	0.00
United Kingdom	0.94	0.19	0.08	0.25	0.97	0.00

Source: own research

5.2. Application of panel data analysis

The regression coefficients between all DEE elements and tourism were produced using Stata for the data period of 2014–2021, as represented in Table 4, which shows the results from panel data analysis regarding the effects of DEE on the tourism industry. The static test indicated that Hp. 3a and Hp. 4a could be supported, with p values of < 0.1. Hence, digital marketplace and digital user citizenship have a significant positive association with tourism growth in the 27 countries studied. Moreover, one control variable, the GNI per capita growth, supported the relationships, here with a p-value of < 0.1. In the next step, the regression coefficients were produced, as represented in Table 5, which reveals the effects of the DEE on each country's social sustainability. Here, Hp. 1b, Hp. 2b, Hp. 3b, and Hp. 4b were found supported, with p values of < 0.1. Hence, the relationship between DEE elements and social sustainability had significant positive coefficients among the EU countries. Hence, DEE elements were found to have a more significant impact on the countries' social sustainability, with the control variable of GNI per capita growth, supporting this relationship, here with p-values of < 0.1.

Table 4. **Results of panel data analysis revealing DEE effects on the tourism industry**

Tourism industry		
	Fixed	Random
Digital entrepreneurship: DE	0.172□	-0.359□
	(0.476)	(0.342)
Digital infrastructure governance: DIG	0.229□	-0.033□
	(0.232)	(0.195)
Digital marketplace: DM	-0.447*	-0.466*
	(0.097)	(0.095)
Digital user citizenship: DUC	0.406*	0.459*
	(0.130)	(0.120)
GNI per capita growth	0.048**	0.041**

	(0.019)	(0.020)
Mobile cellular subscriptions	-0.370□	-0.371□
	(0.263)	(0.256)
Transport services	0.146□	0.160□
	(0.119)	(0.118)
Travel services	-0.035□	-0.515□
	(0.103)	(0.104)
R2	0.2018	0.2842
F-test	0.0000	0.0000
P value	0.4782	
Hausman test	(Random)	
Observations	216	216
Groups	27	27

Coefficients (std. error) * p < 0.01, ** p < 0.05, *** p < 0.1, □ p > 0.1
Source: own research

Table 5. **Results of panel data analysis revealing DEE effects on social sustainability**

Social Sustainability		
	Fixed	Random
Digital entrepreneurship: DE	0.050*	0.059*
	(0.019)	(0.019)
Digital infrastructure governance: DIG	0.023**	0.023**
	(0.009)	(0.010)
Digital marketplace: DM	0.035**	0.031***
	(0.017)	(0.017)
Digital user citizenship: DUC	-0.026***	-0.022□
	(0.014)	(0.014)
GNI per capita growth	-0.001*	-0.001*
	(0.0004)	(0.0004)

Mobile cellular subscriptions	0.001□	0.001□
	(0.005)	(0.005)
Transport services	-0.002□	-0.002□
	(0.002)	(0.002)
Travel services	0.0009□	0.0008□
	(0.001)	(0.001)
R2	0.0281	0.0645
F-test	0.0011	0.0008
P value	0.0059	
Hausman test	(Fixed)	
Observations	216	216
Groups	27	27

Coefficients (std. error) * p < 0.01, ** p < 0.05, *** p < 0.1, □ p > 0.1
Source: own research

A detailed panel data analysis was used to control our overall findings. The regression coefficients between each DEE element and tourism industry, on the one hand, and regression coefficients between each DEE element and social sustainability, on the other hand, were produced using Stata from 2014 to 2021, as presented in Tables 6 and 7.

Table 6. **Results of panel data analysis revealing the effect of each DEE element on the tourism industry**

Tourism industry				
GNI	0.034**	0.033**	0.052**	0.031*
	(0.020)	(0.170)	(0.020)	(0.0202)
MOB	-0.317***	-0.274□	-0.295□	-0.419□
	(0.269)	(0.268)	(0.265)	(0.273)
TRANS	0.115□	-0.110□	0.177□	0.073□
	(0.123)	(0.123)	(0.123)	(0.123)
TRAV	0.129□	0.101□	0.386*	-0.069□
	(0.080)	(0.086)	(0.065)	(0.107)
DE	-0.859*			

	(0.337)			
DIG		0.442*		
		(0.170)		
DM			-0.336*	
			(0.096)	
DUC				0.3437*
				(0.094)
R2	0.1417	0.0558	0.1444	0.1765
F-test	0.0000	0.0000	0.0000	0.0000
P value	0.0230	0.0533	0.2402	0.0005
Hausman test	Random	Random	Random	Fixed
Observations	216	216	216	216
Groups	27	27	27	27

Coefficients (std. error) * p < 0.01, ** p < 0.05, *** p < 0.1, □ p > 0.1
Source: own research

Table 7. **Results of panel data analysis revealing the effect of each DEE element on social sustainability**

Social Sustainability				
GNI	-0.001*	-0.001*	-0.001*	-0.001*
	(0.0004)	(0.0004)	(0.0004)	(0.0004)
MOB	-0.0008□	0.003□	0.001□	0.001□
	(0.005)	(0.005)	(0.005)	(0.005)
TRANS	-0.0007□	-0.0001□	-0.0001□	-0.0010□
	(0.002)	(0.002)	(0.002)	(0.0022)
TRAV	-0.0003□	0.0003□	0.0002□	0.0007□

	(0.001)	(0.001)	(0.001)	(0.001)
DE	0.035***			
	(0.019)			
DIG		0.017***		
		(0.009)		
DM			0.029***	
			(0.017)	
DUC				-0.0107□
				(0.014)
R2	0.3174	0.0001	0.0047	0.0013
F-test	0.0141	0.0127	0.0156	0.0419
P value	0.0005	0.1318	0.8952	0.8755
Hausman test	Fixed	Random	Random	Random
Observations	216	216	216	216
Groups	27	27	27	27

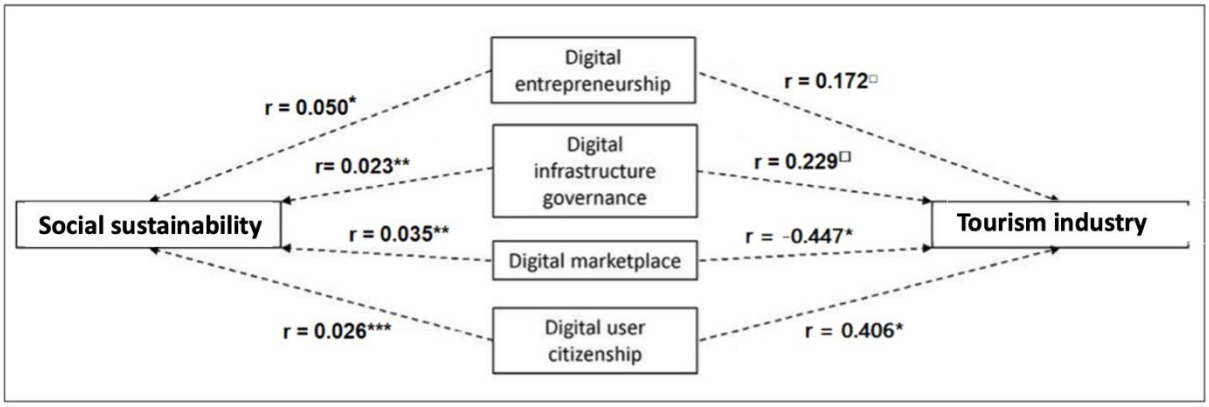
Coefficients (std. error) * p < 0.01, ** p < 0.05, *** p < 0.1, □ p > 0.1
Source: own research

Regarding the effects of DEE elements on the tourism industry, the impact of digital entrepreneurship (Hp. 1a) and digital infrastructure governance (Hp. 2a) were not supported while the impact of digital marketplace (Hp. 3a) and digital user citizenship (Hp. 4a) on tourism were supported.

Regarding the effects of the DEE elements on social sustainability, the impacts of digital entrepreneurship (Hp. 1b), digital infrastructure governance (Hp. 2b), and the digital marketplace (Hp. 3b) on social sustainability were also confirmed. These findings indicate that the overall impact of the DEE on social sustainability is more significant than that on the tourism industry (Graph 3).

The effect of digital user citizenship on social sustainability was not adequately supported, but the impact of it on tourism was confirmed. However, the association between digital user citizenship and sustainable ecosystems has been interpreted by user-generated content, user-friendly interface, and interoperability across different hardware and software (Song, 2019). Improvements in each user's or visitor's digital skills can be considered as having an influential role in increasing the flow of tourism in the selected EU countries. Also, digital skills gained through a social or technical process, such as online web services (especially cloud computing) (Elia et al., 2020) have been noted by Tilson et al. (2010) as the main step of digitalisation.

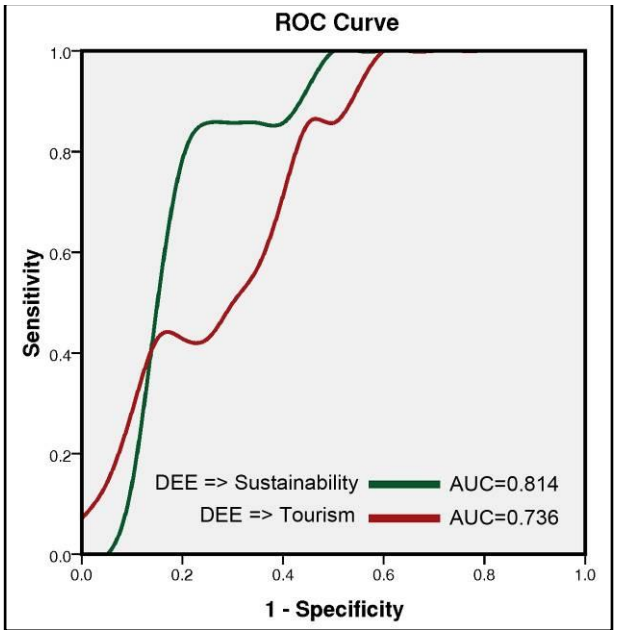
Graph 3. **Research results**



Source: own research

5.3. Model validity

Graph 4. **ROC curve of the DEE model for sustainability and tourism data**



Source: own research

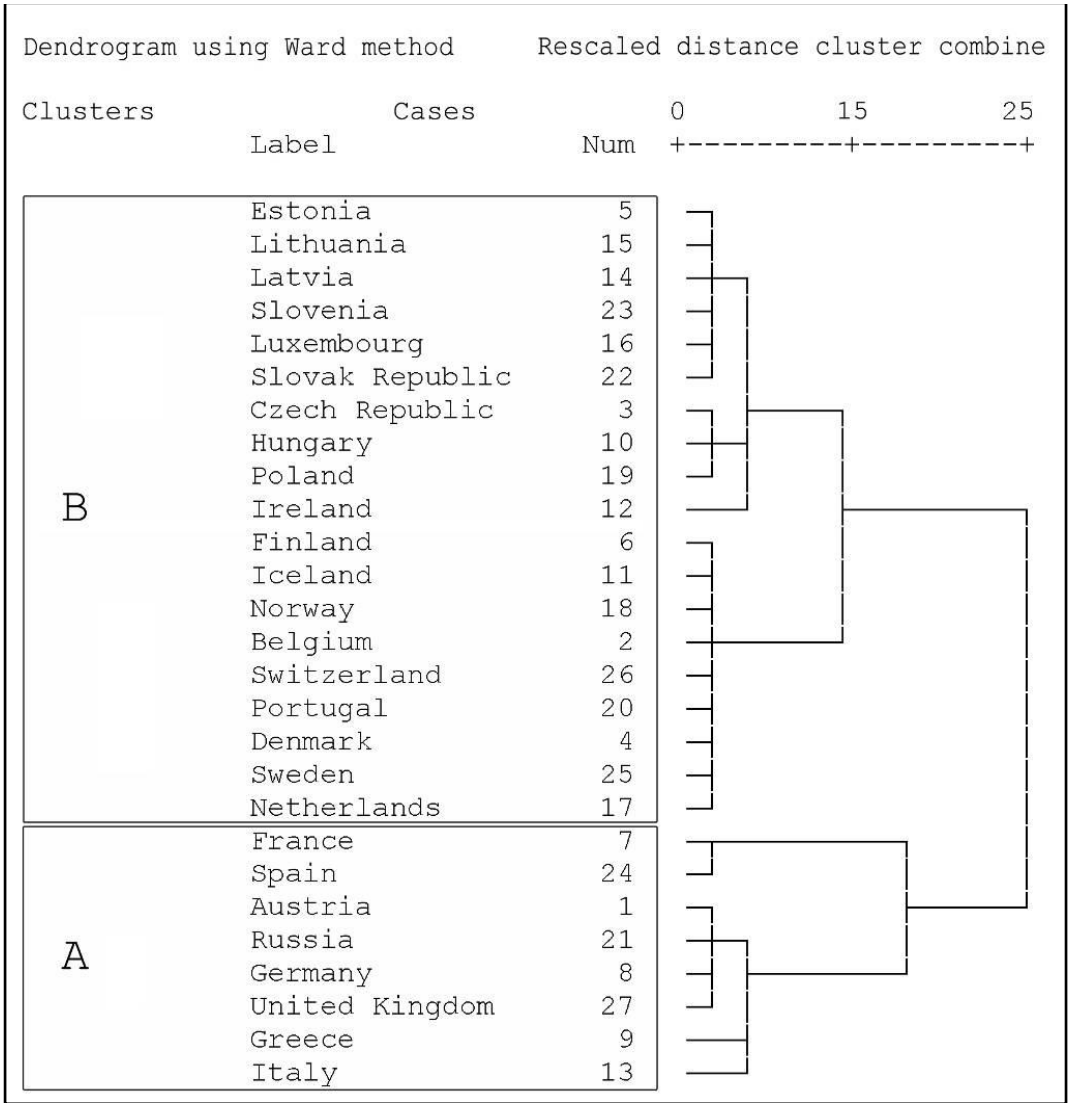
In this section, the model validity is evaluated based on the receiver operating characteristic (ROC) curve, and its informative area under the curve (AUC), to validate the effects of DEE model data regarding the sustainability and tourism variables (based on average data for the period of 2014-2021. AUC values are computed from 0.5 to 1; however, the values above 0.7 are depended on the acceptable performance and excellent sensitivity of the model. In our study, a ROC curve was plotted for the DEE model validity in Graph 4. The AUC values are calculated over 0.7 for both sustainability and tourism data, revealing the excellent performance and sensitivity to further clustering analysis.

5.4. HCA application

To obtain a proximity matrix based on the squared Euclidean distance, the HCA procedure was established, and the final clustering using Ward's method is illustrated graphically as a dendrogram (Graph

5). Here, the 27 countries were classified into two main clusters—cluster A and cluster B corresponding to robust and weak service levels, respectively, in terms of their integrated digital ecosystem, tourism industry, and social sustainability. Eight tourism countries (France, Spain, Austria, Russia, Germany, Greece, Italy, and the UK) were grouped into cluster A, having high DEE levels combined with high tourism flows and social sustainability. The remaining countries were grouped into the weak cluster (B).

Graph 5**. Dendrogram of the countries based on clustering analysis**



Source: own research

The countries in cluster A were found to have the highest average DEE values and lowest differences from 2014 to 2021, significantly affecting their tourism industry and social sustainability when compared with the other EU countries. For instance, Italy, France, and Spain, like Germany and the UK, have high stability regarding DEE progress affecting tourism arrivals and social sustainability. Italy, Spain, and France also had high tourist attractiveness and social sustainability, as well as a DEE. When compared with other EU countries, these countries' main advantage is their strong digital entrepreneurship.

6. Discussion

6.1.Discussion of the results

Many governments are implementing policies to foster digital adoption within the tourism industry. Thus, the tourism industry is being transformed through innovation aimed at finding solutions to the latest global challenges, such as the COVID-19 pandemic. All European countries should enhance their tourism industries by using digital-based technologies and indicators beyond those related to COVID-19. In this regard, the DEE can transform each industry's leadership and ecosystem innovation. It also improves the utilities for consumer communication, driving tourism marketing. Our main results are as follows:

I. Two hypotheses of Hp.3a and Hp.4a could be supported due to P values < 0.1. Hence, digital marketplace and digital user citizenship have a significant association with the tourism industry in the EU countries during the study period (2014-2021). In other words, at least two DEE elements expose a meaningful relation with tourism flow. This evidence demonstrates the relative effects of DEE elements on the tourism industry in EU countries. This would address the increased cost pressures and the faster competitive landscape in the rate of digitization within the tourism sector. By prioritizing these areas, the EU can empower a more robust and innovative tourism industry across the member states (Mura & Stehlíkova (2023). This is in line with previous research; for example, Filipiak et al. (2020) revealed that digitalisation has a more significant impact on the development of a country's tourism industry when compared with its effect on its sustainability. Despite the importance of sustainability, many parts of the tourism industry remain unsustainable (Desbiolles, 2010).

II. Hp. 1b, Hp. 2b, Hp. 3b and Hp. 4b were all confirmed, highlighting ng that DEE elements and social sustainability have a significant association at the national level. Our findings also indicate that entrepreneurial activities can positively effect on social sustainability, such as the tourism industry, at the national level by, for instance, reconfiguring digital infrastructures. These positive relationships also highlight the findings of George et al. (2020), Hustad and Olsen (2020), who confirmed links between DEE elements and sustainability in various ways. In detail, all social dimensions of sustainability, such as the healthcare variable, can be promoted by digitalisation and innovative modern technologies (Cassia et al. 2020).

III. To test and compare the results of all the hypotheses, we aimed to create different individual models by decomposing the DEE into its elements and then analysing the individual impact of each element on the dependent variables (tourism industry and social sustainability). For instance, digital entrepreneurship by creating opportunities for marginalized groups, like people with disabilities, digital infrastructure by promoting transparency in government and organizations, digital marketplace by providing access to new markets to sell their goods and digital user citizenship by teaching critical thinking about online information and raise awareness about social issue could support more social sustainability and tourism industry. The results show more robust functions. This method has also been highlighted in previous scholars' research (e.g., Cavallo et al., 2019).

IV. To answer the third research question, we assumed a constant correlation between sustainability and tourism indicators within the eight temporal windows (Table 7); the results reveal that these two dependent variables do not have a similar alignment in the European countries, however in 2020 and 2021, the relationship between these two variables has become more significant.

Also, Pearson tests between these variables indicate a weak negative association between the two variables, which means the relationship is not very strong. Hence, our findings regarding the independent effects of DEE elements on the tourism industry, on the one hand, and social sustainability, on the other hand, could be considered accurate.

V. In our study, we used the ROC curve for the DEE model validity with AUC values over 0.7 for both sustainability and tourism data, which revealed excellent performance and sensitivity to further analysis.

Table 8. **Correlation tests between sustainability and tourism**

Variable	Test	Social sustainability							
		2014	2015	2016	2017	2018	2019	2020	2021
Tourism	Pearson correlation	-0.069	-0.082	-0.066	-0.068	-0.090	-0.1007	-0.400	-0.388
	Sig. (2-tailed)	0.731	0.686	0.744	0.737	0.662	0.625	0.039	0.046
	N	27	27	27	27	27	27	27	27

Source: own research

VI. Based on hierarchical clustering, we found that eight of the countries (Germany, the UK, France, Spain, Austria, Russia, Greece, and Italy) (cluster A) generally had the highest average values for each DEE element, which significantly affected their tourism industry and social sustainability. Digital entrepreneurship in these countries supports digital-based participation in world tourism

6.2. Theoretical implications

The current research has contributed to a better understanding of Entrepreneurship and tourism management. Prior studies have focused on the DEE (e.g., Song, 2019; Elia et al., 2020), However, the different impacts of DEE elements on the tourism industry and social sustainability have not been simultaneously analysed and needs further clarification. As a novel approach, our research investigates the role of each element of DEE elements, demonstrating their roles in growing tourist arrivals and social sustainability at the country level.

The current research findings respond to three calls from the literature on tourism. The first is a research call analysing the influence of digital social media on the tourism industry (e.g., Nunkoo et al., 2020) and the tourism destination's image (Fu and Timothy 2021; Streimikiene and Kyriakopoulos, 2024). The results show that digital entrepreneurship and digital user citizenship, as substantial elements of the DEE, can improve tourist arrivals in the EU by using the outcomes of digitalisation (Kamali Saraji et al., 2021; S˘treimikiene˙ et al., 2021). The second call focused on the specific elements of the DEE in how they may be connected with tourism growth (Horng et al., 2024), such as how the proliferation of digital platforms can help tourists search for images of their destinations. The third call focused on how can technology be leveraged to enhance support for accessible tourism? (Cassia et al., 2020).

Based on the literature review, sustainability can achieve competitive success in the digital industries (Horng et al., 2023; Kurowska-Pysz et al., 2024) and establish a new role in social activities. Our results can complement the literature on digital-induced social sustainability (e.g., George et al., 2020). The literature has mainly highlig tourismed the role of the specific element of digital entrepreneurship on sustainability at the firm micro level. Hence, we contribute by using macro-level databases to improve insig tourisms into how all DEE elements can significantly influence countries' social sustainability, thus affecting how the tourism industry should deal with major challenges in the field of management. Previously, scholars have noted that transitions and structural changes in digital ecosystems may disrupt environmental sustainability (e.g., Filep et al., 2023). Therefore, DEE elements require a political framework to ensure that DEE development considers social sustainability through entrepreneurial activities.

6.3. Practical implications

The practical implications of the current research depend on the direct and indirect effects of digitalisation on tourism and social sustainability, which can be assumed as destination-based protocols by policymakers. In recent years, 'smart tourism' has been defined as a type of tourism arising from tourists' high technology usage (Ivars-Baidal et al., 2019). For European policymakers, our research suggests supporting DEE development to facilitate an increase in the number of tourists using digital technologies and media. In this regard, national policymakers can appraise the smart tourism level and social sustainability by measuring the routine values of digitalisation and innovation levels. For instance, the annual monitoring of 34 variables for DEE elements can be considered to measure the certain effects of digitalisation on the tourism growth and sustainability improvement of each country. Also, the proposed method of our study may be considered an initial approach to examine the sustainable policy solutions applicable in the frameworks for tourism by the European Commission, which handles the creation of digitalisation in the sustainable planning of tourism (EC, 2021).

On the local scale, we recommend usage the of digital platforms in destination marketing organisations (DMO) for managing entrepreneurial activity and cooperation between other businesses.

Besides, two elements of DEE (digital entrepreneurship and digital user citizenship) should receive more attention from policymakers' interventions and from those project managers involved in the implementation of skills, tools, and techniques (in new tourism platforms to support entrepreneurial activities. In this regard, tourist and customer insig tourisms driven by user-based digital and smart services can create a new opportunity for entrepreneurs to enhance their knowledge of tourism-friendly products, demands, and competitive information. Importantly, this will allow tourism entrepreneurs and destination managers to take control of their future (Pasquinelli et al., 2023) by facilitating tourists' and customers' demands. For this purpose, web-based platforms allow individual users to interact directly with individual tourism hosts. For example, AirBnB and VizEat are simple cases for disintermediation and bookings in the tourism destination managing system (Milwood & Maxwell, 2020). As recommended by Horng et al., 2023, tourism managers should aim to improve customer and user experiential values and to optimize customer satisfaction using digital technology in alignment with the Fourth industrial revolution.

Moreover, our results support recent studies at the macro level that show the role of ecosystem actors (i.e., entrepreneurs) in promoting society (e.g., Jafari-Sadeghi, 2021). Indeed, some expected global changes, such as climate change, could lead to a geographical shift in international tourist arrivals (Spirkova et al., 2022). Hence, further research should consider the prospects of global tourism.

7. Conclusion and limitations

7.1.Conclusion

The overall results indicate that the role of the DEE within the area of social sustainability is more significant when compared with that within the tourism industry. Two elements of digital entrepreneurship and digital user citizenship have substantial DEE effects on tourism growth (RQ1). This result adds to the literature by expanding on the contributions of recent studies, which cover different elements of the DEE. All four DEE elements could have substantial effects on sustainability (RQ2). The main contribution of this finding is related to recent research on the relationships between DEE elements and sustainability (e.g., George et al., 2020; Hustad & Olsen, 2020). Moreover, the two dependent variables of sustainability and tourism were found to have no similar alignment in European countries (RQ3). Furthermore, overall clustering results between the countries showed that the countries with the highest values of DEE elements significantly had higher tourism industry, because digitalisation in these countries can support their smart level (e.g., Pasquinelli et al., 2023).

7.2.Limitations and future research

The first limitation is the lack of datasets representing a wider range of countries globally, rather than just EU countries. To address this, the same type of analysis should be used to compare the EU and non-EU countries, showing the DEE's impact on tourism and social sustainability. The second limitation is the characterisation of sustainability. In the current study, we considered only one standardised indicator for sustainability, the HDI, because of the accessibility and reliability of the data. In future research, more indicators could be extracted to obtain a comprehensive index representing the major role of sustainability in correlation and mediation models. Ultimately, the current study focused on a general category of both subjects of tourism and sustainability; hence, further research is needed to develop empirical systems to define detailed indicators of tourism and sustainability. For instance, further research could investigate other econometric or intangible determinants or different approaches to examining what factors influence new tourism venture growth.

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