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Exploring Digital Transformation Intensity and Its Relationship with Sustainability: Greek Managers' Perspectives

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Abstract: The digital transformation process gained significant research interest in recent years especially related to achievements in sustainability goals. Even though there exists growing research regarding various aspects of digital transformation and sustainability procedures, a more detailed analysis is needed in different national environments. The proposed study empirically analyzes the Greek managers' perspective on the relationship between digital transformation intensity and sustainability practices implemented. Almost 156 Greek senior managers from various organizational sectors were interviewed, while a synthetic index already developed from previous studies was used. Results indicate that Greek companies do not fully exploit digital technologies to further develop their environmental practices. A digital transformation strategy contributes effectively to environmental strategies in the case of reducing emissions of waste and avoiding environmental accidents, while in the rest of the cases, emerging technologies play a less important role and not as a part of a holistic digital strategy.

Keywords: environmental practices; digital management intensity; digital transformation; business strategy; environmental performance; sustainable management; Greek managers

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1. Introduction

Digital transformation has been a growing research trend over the last 10 years, gaining significant interest among academics and business professionals, while changing the whole business environment in terms of production, consumption, and value chains [1]. The concept has been theoretically and empirically associated with several business aspects including new ways of resource allocation [2], value creation and business evolution [3,4], competitive advantage [5], cultivation of digital culture [6,7], efficiency [8,9], increased competitiveness [10], productivity [11], innovation [12,13], economic benefits [14,15], creating agile methodologies of management [16,17], quick decision making [18], cost reduction [19], integration of new technologies [20,21], and development of new digital business models [22–25].

A careful reader could easily understand that all of the above-mentioned business aspects are related to internal factors that are affected by and at the same time affect digital transformation. Moreover, there exist several external factors associated with the implementation of digital strategies, including digital technologies (for example, 5G technologies, Virtual Reality, Artificial Intelligence, Augmented Reality, and Blockchain) that spawned a series of new industries [26,27], the implementation of big data analysis as an operational aspect of doing business [28,29], customers' need for personalized services/products [30], and changes that occurred to workforce's expected skills [31–33].

At the same time, another external factor arises as a necessity for businesses, namely "sustainability" as the core of circular economy that aims to overpass the linear economic model [34], which failed to address issues such as natural resources preservation, efficient waste management, and increased socioeconomic performance alongside environmental

responsibility [35]. New sustainable strategies emerged [36] to tackle issues about how recovering or recycling resources can be part of the products and services development process [37]. Existing research mainly focuses on the manufacturer's perspective on sustainability [38–40] or provides evidence about sustainability's interrelation with environmental, social, and corporate governance (ESG) factors as far as the services sector is concerned [41].

For both concepts, digital transformation and sustainability issues, their interconnection is not an easy task to be accomplished. Some scholars claim that such a difficulty arises from the lack of a widely accepted methodology to measure digital transformation [42], while others propose a reason due to the theoretical nature of both issues [43]. Even so, there is strong evidence that digital transformation can support sustainable management [44,45] or even promote it by developing a new business logic [46]. Researchers point out that digital transformation not only reshapes the nature of entrepreneurship [47,48] but, moreover, can change how businesses approach sustainability issues as well [49,50], leading to the development of new business models and a whole new business ecosystem [51–54]. Moreover, researchers explain how the implementation of emerging technologies, alongside cyclical economy practices can lead to sustainable benefits [55–57].

As far as the Greek business environment is concerned, there exists a few research works incorporating sustainability elements in digital transformation processes [58,59], as well as research that examines how the concept of sustainability is perceived in the Greek business environment and examines if it can provide a competitive advantage [60]. Moreover, other studies associate emerging technologies with several aspects of the Greek business environment, such as sustainable marketing [61], employees' acceptance of new technologies [62], or sustainability strategies during the COVID-19 pandemic [63].

Such a condition provides evidence that there is a lot of space for research exploration when it comes to the synergies between digital transformation and sustainable development in the Greek business environment. While sustainable practices gain more and more importance as part of a worldwide-accepted commitment to efficient environmental management [64,65], at the same time, the business ecosystem shifts towards digital transformation [66]. But, these two tendencies are not independent of each other, since digital technologies are regarded as potential enablers for the cyclical economy's business models [66] and as a means to minimize resource consumption, reduce greenhouse emissions, and apply efficient waste management [67].

The proposed research aims to address the gap in the relationship between digital transformation and environmental performance by using data from the Greek business environment. Enlightening such a research question can provide useful insights into how a digital transformation strategy can be accompanied by sustainable entrepreneurship. Our results indicate that in companies with a strong environmental orientation, there also exists a strong tendency for extensive use of digital technologies. In most cases, the tendency is embedded in organizational processes as part of a digital transformation strategy, especially when it comes to companies with a strong orientation to reduce emissions of waste and avoid environmental accidents. In contrast, when companies are oriented to reduce energy consumption, there still exists a digital orientation but mainly for using emerging technologies as part of an environmental strategy rather than developing a holistic digital strategy. Finally, companies with the main environmental purpose of reducing the consumption of hazardous or toxic materials are less likely to develop a digital transformation vision in the Greek business environment.

This article contributes to a further understanding of the relationship between sustainable management and a digital transformation strategy in the Greek business environment. Differences in environmental orientation are not only associated with the existence or not of a digital transformation strategy but, moreover, with the strength of this relationship and its direction. Results can be used by companies' executives to reevaluate and further improve the development of both environmental and digital strategies. Moreover, the results provide useful insights for policymakers about the weaknesses of Greek companies in

fully exploiting emerging technologies and developing strong digital strategies to minimize their environmental footprint.

2. Materials and Methods

The research framework developed by Ribeiro-Navarrete et al. (2023) [68] was used to collect data from 156 Greek companies in different business sectors. According to the Greek Hellenic Statistical Authority [69], Greece operates more than 1.4 million companies and they are employing more than 4.5 million employees. Their total contribution to the Greek economy is almost EUR 341 billion. Companies employing more than 100 employees are almost 3000 and their contribution to Greek GDP rises to EUR 148 billion [69]. Our research emphasizes these companies since size and financial resources are both related to the implementation of sustainability principles and the application of digital transformation strategies.

The companies participating at the research were randomly selected from the database of the Greek Business Registry Portal (operating under the authorization of the Central Association of Chambers of Commerce in Greece) and were all based in the district of Athens (Greek Capital City). Data collection started in October 2023 and ended in February 2024. At first, an email was sent to senior managers and since they replied that they were willing to participate, then the research team arranged a personal interview. Interviewers used a structured questionnaire about their company's environmental strategy and the implementation of the digital transformation strategy. All research items included in the questionnaire were measured on a 7-point Likert scale (from completely disagree, to completely agree).

Research items included in the questionnaire developed 9 dimensions, including more traditional strategic orientations and also new, strategically innovative ones [70,71].

Research items were selected from the literature, as presented below, while dimensions were formulated by Ribeiro-Navarrete et al. (2023) [70]. Research items are presented in Table A1 (Appendix A), followed by environmental items. The proposed dimensions and the supporting literature behind each research item [72,73] are:

- Environmental performance [70], including (a) reducing the emission of waste, (b) reducing the consumption of hazardous and toxic materials, (c) reducing the frequency of environmental accidents and (d) reducing energy consumption.
- Digital skills and application of technology [74,75].
- Digital management intensity [73,76].
- Digital business process [73,76,77].
- Digital innovation performance [78–80].
- Digital management and departmental agility [81].
- Digital vision [81].
- Digital orientation [77].

Due to the large number of research items (variables), a factor analysis was used as a statistical technique for data reduction and to identify underlying relationships between variables. Factor analysis helps in reducing the number of variables by identifying a smaller set of underlying factors, which makes the data more manageable and interpretable. Each variable was given a factor loading score, indicating how much it contributes to each factor, while variables with high loadings on the same factor were grouped. Moreover, it helped to uncover the latent structures or patterns in data that were not immediately obvious. After this analysis, six factors were developed, namely:

1. Digital orientation,
2. Business strategy,
3. Innovativeness,
4. Customer Centricity,
5. Environmental orientation and
6. Organizational Structure.

A detailed analysis is followed in the next section together with demographic measures. The majority of companies have been operating in the Greek business environment for at least 20 years (63.5% of the answers, while at the same time they have more than 51 employees (69.3% of the answers). Most companies from the sample have a turnover of less than EUR 2 million (21.8% of the answers) or more than EUR 50 million (39.1% of the answers). Respondents come from various sectors including accommodation, retail, communications, financial services, business, engineering, military/security, health services, public sector, technology, transport and others. Most respondents (59.3% of the answers) believe that their organization is digitally mature, while almost the same proportion (59.6% of the answers) stated that there exists a digital transformation strategy in the act.

3. Results

The significance of this study is to reveal factors that promote environmental orientation in organizations through upgrading digitalization. Companies in the digitalization era are expected to develop and optimize their performance and operations by incorporating environmental factors that extend their growth. By being engaged in sustainable development, companies establish environmental and social responsibility, have environmental concerns and set social goals and policies while providing superior products and services [68]. Digital orientation adopted by organizations may differ across sectors. Managers in sectors with lower digitalization maturity may overlook necessary organizational transformations and delay digital implementation [68].

The scales of the construct were based on an existing instrument by [68] for assessing environmental issues and digitalization. This study aims to reveal factors contributing to sustainable development through corporate activities.

Data used in the research were gathered through questionnaires and analysis of the data was performed using the SPSS (25) for univariate and multivariate analysis to ensure that were suitable for subsequent factor assessment. Data were tested through a normality test revealing the normality of data. The suitability of the factor analysis was evaluated by assessing the Kaiser–Meyer–Olkin measure of sampling adequacy, which is considered very good at 0.841. According to Bartlett's test statistic the significance level was marked as $0.000 < 0.001$.

The exploratory factor analysis of the research proceeded by integrating the Varimax Rotation which created 6 factors. Every item was loading on its factor with a higher value of 0.4. The total variance explained by the six factors was 54.15%. Table A2 (Appendix B) presents the scales of measurement of the factor analysis. As far as composite reliability and Cronbach's alpha are concerned, these proved to be higher than the threshold of 0.7 [82], indicating a rather high reliability as we can see in Table 1.

Table 1. Reliability analysis.

Factor	Cronbach's Alpha	Items
Digital orientation	0.900	14
Business strategy	0.876	8
Innovativeness	0.853	10
Customer centricity	0.816	9
Environmental orientation	0.757	4
Organizational culture	0.783	2

We applied a multivariate technique on data, cluster analysis, in order to group objects based on their proximity characteristics [82]. We are interested in the environmental orientation of the companies and we applied a K-means algorithm based on the minimum distance to the initial cluster. We focus on the four questions about company's environmental perceptions. Two initial cluster centers were formed. The number of cases in each

cluster are as follows: In the 1st cluster, there are 53 companies and in the 2nd cluster there are 103 companies, creating a data sample of 156 valid cases (companies). The number of cases per cluster and per environmental activity are presented in Table 2.

Table 2. Clusters' number of cases.

Cluster Number of Case		Our Organization Reduces the Emission of Waste (Air, Water And/or Solids)	Our Organization Reduces the Consumption of Hazardous and Toxic Materials	Our Organization Reduces the Frequency of Environmental Accidents	Our Organization Reduces Energy Consumption
1st Cluster	Mean	3.2075	3.7358	4.2642	3.2830
	N	53	53	53	53
2nd Cluster	Mean	5.6311	5.8544	5.3786	5.4854
	N	103	103	103	103
Total	Mean	4.8077	5.1346	5.0000	4.7372
	N	156	156	156	156

In the first cluster of 53 companies, there exist small companies, younger in age with smaller turnover. In contrast, in the second group, there exist bigger (in size) companies, with a higher number of employees (mean 5.80 > 5.41) and higher turnover (mean 4.74 > 3.96). Moreover, there are older companies in the second cluster (mean 5.42 > 5.24).

Moreover, Table 3 provides the means that each cluster has per environmental activity, while most values are over the average (of the Likert 7 scale). Comparing these two clusters of companies in terms of "mean", we can characterize Cluster 1 as "Environmental Neutral", while Cluster 2 can be characterized as "Environmental Worried". Such characterizations are not an absolute but rather a comparative measure of the degree of environmental orientation between the two clusters.

Table 3. Cluster number of cases per age, size, and turnover.

		N	Mean	Std. Deviation
Company's age (in years)	Environmental Neutral	53	5.2453	1.70864
	Environmental Worried	103	5.4272	1.72412
Company's size (number of employees)	Environmental Neutral	53	5.4151	1.82329
	Environmental Worried	103	5.8058	1.78808
Turnover of sales revenues (in million EUR)	Environmental Neutral	53	3.9623	2.67440
	Environmental Worried	103	4.7476	2.37932

Such a tension in environmental orientation is also common in digital transformation orientation, where larger-sized firms are capital intensive and can exploit resources more easily. Smaller organizational structures can facilitate digital transformation, but financial constraints faced by SMEs can hinder the whole process [70]. Managers of smaller companies may recognize more easily the importance of digitization for the company's survival and growth, but they usually face financial obstacles and lack of resources to implement digitization [68].

The emphasis given to financial factors, seems to be important concerning companies with environmental orientation. Table 3 presents the distribution of mean values of the two clusters regarding the company's age, the number of employees and the company's turnover. Results indicate the existence of less significant differences when it comes to the company's AGE and moderate significant differences when it comes to the company's size, while most significant differences exist when it comes to turnover. Under every situation, companies of Cluster 2 have higher mean values, explaining their characterization as more environmentally worried.

Another interesting result comes when comparing results according to the company's sector. As seen in Table 4, the cluster number of cases per sector presents that companies belonging to sectors such as retail, communications, financial services and business are more environmentally worried and managers take actions towards environmental orientation. Companies in the public sector, accommodation and transport sector are more environmentally neutral rather than environmentally worried. Companies operating in other sectors are considered more environmentally worried and this trend indicates that in the Greek business era, companies and management have increased environmental concerns.

Table 4. Cluster number of cases per sector.

Company's Sector	Environmental Neutral	Environmental Worried	Total
Accommodation	1	0	1
Retail	7	12	19
Communications	2	8	10
Financial services	0	6	6
Business	1	4	5
Engineering	1	2	3
Military/Security	1	5	6
Health services	3	5	8
Public Sector	6	5	11
Technology	28	56	84
Transport	1	0	1
Other	2	0	2
Total	53	103	156

At a confirmatory level, four (4) distinct multiple regression analyses were conducted to reveal whether dependent variables concerning environmental performance are affected by the various research items briefly presented in the previous section and analytically presented in Table A1 (Appendix A). The proposed number of multiple regression analyses conducted derived from the four environmental questions posed, namely:

- 5.1 Our organization reduces the emission of waste (air, water and/or solids).
- 5.2 Our organization reduces the consumption of hazardous and toxic materials.
- 5.3 Our organization reduces the frequency of environmental accidents.
- 5.4 Our organization reduces energy consumption.

As far as the first dependent variable is concerned, namely reducing the emission of waste, results indicate that there exists a strong, positive relationship between reducing the consumption of hazardous and toxic materials, alongside reducing energy consumption. Companies having this triad of environmental practices interconnected are positively affected by emerging technologies in supply chain management, while they have a clear vision of how new digital technologies help the organization create value. At the same time, the more digital marketing technologies and customer service systems are used, the less aware of waste management these companies are. Results indicate that in the Greek

business environment, companies incorporating supply chain activities are more aware of using technological means for waste management, while a clear digital transformation vision further enhances this tension. Moreover, companies that adopt environmental practices for reducing air/water/solid emissions are more likely to do the same for energy and toxic materials. Finally, Greek companies emphasizing on marketing practices and market penetration tend to be less environmentally aware. Results are presented in Table 5 below.

Table 5. Multiple regression analysis for Model 1.

	Dependent Variable: 5.1: Our Organization Reduces the Emission of Waste (Air, Water and/or Solids)						
	R = 0.787, R^2 = 0.619, Adj. R^2 = 0.603 F = 40.317 p = 0.00						
Model 1	**Unstandardized Coefficients**		**Standardized Coefficients**			**Collinearity Statistics**	
Independent Variables	**B**	**Std. Error**	**Beta**	**t**	**Sig.**	**Tolerance**	**VIF**
Constant	**0.406**	**0.569**		**0.712**	**0.477**		
5.2: Our organization reduces the consumption of hazardous and toxic materials.	0.561	0.059	0.519	9.432	0.000	0.845	1.183
5.4: Our organization reduces energy consumption.	0.317	0.054	0.341	5.811	0.000	0.742	1.347
1.21: We have explored or adopted technology in supply chain management.	0.166	0.043	0.200	3.821	0.000	0.932	1.072
8.1: We develop a clear vision of how new digital technologies (social media, mobile devices, analytics, cloud computing) help the organization create value.	0.295	0.070	0.237	4.228	0.000	0.813	1.231
6.5: It uses digital technology for marketing activities.	−0.263	0.088	−0.168	−2.996	0.003	0.818	1.223
6.7: It uses a cloud-based intelligent customer service system to provide real-time user reviews and after-sales product information.	−0.137	0.059	−0.133	−2.335	0.021	0.786	1.272

When it comes to reducing the consumption of hazardous and toxic materials (as a dependent variable), there also exists a strong, positive interconnection with waste management and reducing the frequency of environmental accidents (Table 6). Moreover, it seems that in contrast to the above-mentioned results, digital marketing activities have a positive impact on the environmental practices of companies that are using hazardous and toxic materials. Such tension indicates that these companies are most likely using their environmental awareness as part of their digital marketing strategies. On the other hand, digital technologies are not contributing positively when it comes to increasing performance or adding value to products/services. It should be noted that results indicate that Greek companies related to hazardous and toxic materials are less involved in digital transformation strategies, even though environmental practices are appreciated.

The next regression presented in Table 7 is related to reducing the frequency of environmental accidents (as a dependent variable). It is strongly and positively related to the consumption of hazardous and toxic materials, while it is also enhanced by the implementation and development of a digital strategy and an orientation to data analytics technologies. Such a framework implies a strong tension among Greek companies to associate environmental accidents with hazardous/toxic materials and digital transformation is regarded as a solution for risk reduction in the field. In particular, data analytics seem to have been implemented and regarded as part of the company's digital strategy. Finally, a managerial

issue is the absence of clearly defined roles/responsibilities for digital initiatives, which hurts environmental practices as well.

Table 6. Multiple regression analysis for Model 2.

	Dependent Variable: 5.2: Our Organization Reduces the Consumption of Hazardous and Toxic Materials						
	R = 0.748, R^2 = 0.559, Adj. R^2 = 0.548 F = 47.926 p = 0.000						
Model 2	**Unstandardized Coefficients**		**Standardized Coefficients**			**Collinearity Statistics**	
Independent Variables	**B**	**Std. Error**	**Beta**	**t**	**Sig.**	**Tolerance**	**VIF**
Constant	**0.873**	**0.594**		**1.470**	**0.144**		
5.1: Our organization reduces the emission of waste (air, water and/or solids).	0.541	0.053	0.585	10.202	0.000	0.886	1.128
5.3: Our organization reduces the frequency of environmental accidents.	0.373	0.062	0.342	5.971	0.000	0.888	1.126
1.4: We use digital technologies to increase performance or add value to our products and services.	−0.229	0.080	−0.173	−2.868	0.005	0.801	1.249
6.5: It uses digital technology for marketing activities.	0.194	0.086	0.134	2.258	.025	0.832	1.202

Table 7. Multiple regression analysis for Model 3.

	Dependent Variable: 5.3: Our Organization Reduces the Frequency of Environmental Accidents						
	R = 0.627, R^2 = 0.393, Adj. R^2 = 0.376 F = 24.399, p = 0.000						
Model 3	**Unstandardized Coefficients**		**Standardized Coefficients**			**Collinearity Statistics**	
Independent Variables	**B**	**Std. Error**	**Beta**	**t**	**Sig.**	**Tolerance**	**VIF**
Constant	**0.955**	**0.516**		**1.851**	**0.066**		
5.2: Our organization reduces the consumption of hazardous and toxic materials.	0.459	0.060	0.500	7.714	0.000	0.958	1.044
1.19: We have explored or adopted data analytics technology.	0.223	0.052	0.274	4.267	0.000	0.973	1.028
7.4: We have continually evaluated and adapted the digital strategy over time.	0.265	0.081	0.235	3.251	0.001	0.769	1.20
3.4: Roles and responsibilities for managing digital initiatives are clearly defined.	−0.179	0.067	−0.193	−2.683	0.008	0.781	1.281

The last regression used as a dependent variable was the reduction in energy consumption, an issue related to larger number of companies from both the production and services sectors. Of all the above-mentioned dependent variables is the one with the largest number of statistically significant independent variables. As expected, the proposed dependent variable is also positively related to reducing the emission of waste. In this kind of company, there is a strong joint culture of how digital technologies are implemented in business strategy and a constant process of reevaluation and adaptation to changes. Data analysis plays a significant role in decision making and business management as well there is a strong orientation to digital transformation related to products/services research, development and (re)design. Even though such strong tensions exist, companies putting emphasis in reduced energy consumption seem to mainly have an environmental rather than a strong digital transformation vision. Technologies are mainly used as a means to achieve environmental performance and not to improve products/services quality and efficiency. This analysis contributes also to the fact that these companies are negative to

look forward to new ways to improve the effectiveness of the use of digital technology, since their priorities are posed in sustainable management. Results are presented in Table 8.

Table 8. Multiple regression analysis for Model 4.

	Dependent Variable: 5.4: Our Organization Reduces Energy Consumption						
	R = 0.793, R^2 = 0.629, Adj. R^2 = 0.609, F = 31.127, p = 0.000						
Model 4	**Unstandardized Coefficients**		**Standardized Coefficients**			**Collinearity Statistics**	
Independent Variables	**B**	**Std. Error**	**Beta**	**t**	**Sig.**	**Tolerance**	**VIF**
Constant	**0.759**	**0.491**		**1.546**	**0.124**		
5.1: Our organization reduces the emission of waste (air, water and/or solids).	0.402	0.059	0.373	6.851	0.00	0.852	1.174
6.10: We jointly plan how digital technology will enable business strategy.	0.392	0.083	0.321	4.723	0.00	0.547	1.829
8.1: We develop a clear vision of how new digital technologies (social media, mobile devices, analytics, cloud computing) help the organization create value.	−0.387	0.085	−0.289	−4.564	0.00	0.631	1.318
6.3: It uses smart appliances to improve product production quality and efficiency.	−0.277	0.074	−0.217	−3.757	0.00	0.759	1.318
3.2: We have established how we can give data a central role in decision making and business management.	0.217	0.065	0.192	3.343	0.001	0.766	1.306
7.4: We have continually evaluated and adapted the digital strategy over time.	0.249	0.094	0.174	2.66	0.009	0.589	1.698
8.7: We are constantly looking for new ways to improve the effectiveness of our use of digital technology.	−0.171	0.081	−0.144	−2.104	0.037	0.537	1.861
6.4: It uses integrated networked technology: computer-aided design/engineering/ manufacturing and product data management (CAD/CAE/CAM and PDM) for product research, development and design.	0.457	0.061	0.451	7.528	0.00	0.704	1.42

4. Discussion and Conclusions

Society urges companies to take action to incorporate sustainability in their business models. The classic business models have gradually been replaced by flexible ones where companies may respond more quickly to changes in the needs and habits of consumers and emerging environmental issues [75]. The positive economic outcome and the competitive advantage will be achieved with socially responsible economic growth and development [83]. Sustainability and social environmental performance aim to establish a new business model providing information beyond financial performance which will guide the long-term strategy of companies. The occurring transformation can establish new organizational drivers and will most likely generate changes in the way shareholders

evaluate companies' success. Moreover, new models can facilitate companies to exhibit their social responsibility and their actions towards environmental protection, usage of clean technologies, and provision and care for employees and the local community.

At the same time, emerging digital technologies reshape sustainability's spectrum in terms of measures, practices, controls and solutions. Even though such a relationship is accepted, there is a lack of understanding of the parameters of how environmental sustainability is incorporated into digital transformation. Following existing research, the current study evaluated how digital technologies' implementation facilitates companies' environmental practices, a top challenge of sustainability's issue [84]. The proposed research enriched our understanding and highlighted the relationship between digital transformation and the environmental sustainability practices used for reducing waste, pollution, energy consumption and production accidents. The research was conducted in the Greek business environment while results support existing results on how digital technologies facilitate the incorporation of environmentally sustainable practices [85] and on how digital transformation improves environmental sustainability [86]. Moreover, results follow existing studies [87], indicating that different environmental practices can be associated with a selective use of technologies and a variety of business intensity to implement a digital transformation strategy. Reducing emissions of waste and avoiding environmental accidents seem to require the cultivation of digital strategies, while reducing energy consumption just requires using of technologies as a means to enhance convenience and efficiency in the proposed era. Finally, when companies are oriented to reduce the use of hazardous or toxic materials just introduce digitally enabled practices as a means to expand their sustainability boundaries [88].

These variations on how digital technologies are used for different kinds of environmental sustainability practices, indicate the dynamic business nature and its effect on companies' capabilities to recognize threats, to seize opportunities and maintain competitive advantages by reshaping the actual use of its tangible and intangible assets [89]. Under this framework, it is of great importance to understand how companies implement digital transformation as a vital part of their sustainability practices from the dynamic capabilities perspective [90]. The Greek business ecosystem seems to follow the global tension to recognize digital strategies/technologies as a key element for achieving the United Nations Sustainable Development Goals [91]. In most cases, to reach sustainable market activities, companies face the challenge of developing digital business models [92,93] and implementing emerging technologies capable of reducing waste in the supply chain, minimizing resource consumption, alternating the value creation/capture models and enforcing customer interaction with environmental practices [44,94–96]. The proposed research added significant information by providing novel insights about the usage of digital technologies and the development of digital strategies when implementing specific environmental practices, expanding the body of knowledge [45,97,98] regarding the complementarities between "sustainable" and "digital". Moreover, research contributes theoretically and empirically to how sustainable management can be implemented in the Greek entrepreneurial context considering emerging technologies [99–102], that could provide environmental enhancement and environmental protection, energy independence, and improvement of quality of life among motives that contribute to economic development [103].

As with any research, the current study faces some limitations. The first limitation derives from collecting data under a certain business environment, namely the Greek business ecosystem. As part of future research, we could expand the research sample to various European Union member states' business ecosystems to develop a more holistic approach regarding the existence of a "sustainable digital" strategy. Moreover, it should be mentioned that the proposed quantitative results have not been validated with qualitative research by interviewing business stakeholders to gain novel insights that are transferable to other contexts [104,105]. Expanding research towards such a direction can help transfer results, for example to the small–medium enterprises (SMEs) level and to family businesses.

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Appendix A

Table A1. Research items.

Part	Question Code Number	Question
Part 0. Initial questions	0.1	Company age (in years).
	0.2	Company size (number of employees).
	0.3	Turnover of sales revenues (in million euros).
	0.4	Company sector.
	0.5	The organization is mature at the moment.
	0.6	The organization has a digital transformation strategy.
Part 1: Digital skills and application of technology	1.1	We use digital technologies (social media, mobile devices, analytics, cloud computing, etc.) to understand our clients and make better operational decisions.
	1.2	We use digital channels (social media, mobile devices, analytics, cloud computing, etc.) to market and distribute products and services.
	1.3	We use digital channels in our customer service.
	1.4	We use digital technologies to increase performance or add value to our products and services.
	1.5	We have launched new business models based on digital technologies.
	1.6	We have explored or adopted the Internet of Things (IoT).
	1.7	We have explored or adopted smart manufacturing application technology.
	1.8	We have explored or adopted computer-aided office technology.
	1.9	We have explored or adopted cloud computing technology.
	1.10	We have explored or adopted customer relationship management (CRM) technology and/or product data management (PDM) technology.
	1.11	We have explored or adopted artificial intelligence (AI) technology.
	1.12	We have explored or adopted blockchain contract management technology.
	1.13	We have explored or adopted 5G.
	1.14	We have explored or adopted customer to organization radio frequency identification (RFID) technology.
	1.15	We have explored or adopted blockchain technology.
	1.16	We have explored or adopted robotic process automation technology.
	1.17	We have explored or adopted big data technology.
	1.18	We have explored or adopted data visualization technology.
	1.19	We have explored or adopted data analytics technology.
	1.20	We have explored or adopted data warehousing technology.
	1.21	We have explored or adopted technology in supply chain management.
	1.22	We have explored or adopted wireless local area network (WLAN) technology.
	1.23	We have explored or adopted information and communications technology (ICT).

Table A1. *Cont.*

Part	Question Code Number	Question
Part 2: Digital management intensity	2.1	Senior managers take a transformative approach to the organization's digital future.
	2.2	Digital initiatives are assessed using a common set of key performance indicators (KPIs).
	2.3	Information technology (IT) and business leaders work together as partners.
	2.4	The performance of the IT unit meets the needs of the organization.
	2.5	Senior executives and middle managers share a common digital transformation vision.
	2.6	There is scope for all members to participate in the digital transformation discussion.
	2.7	We have explored or adopted smart manufacturing application technology.
	2.8	The organization is investing in the development of the necessary digital skills.
	2.9	Digital initiatives are coordinated using criteria such as roles and responsibilities.
	2.10	Roles and responsibilities for managing digital initiatives are clearly defined.
Part 3: Digital business process	3.1	We have digital solutions that connect core business activities with customers, suppliers, employees and organization resources.
	3.2	We have established how we can give data a central role in decision making and business management.
	3.3	We use an open digital platform to put innovative ideas into practice and quickly gain support.
	3.4	Roles and responsibilities for managing digital initiatives are clearly defined.
Part 4: Digital innovation performance	4.1	We bring more digital solutions to market than our competitors.
	4.2	We have a larger number of successful digital solutions than our competitors.
	4.3	The time to market of our digital solutions is inferior to that of our competitors.
	4.4	The quality of our digital solutions is superior to that of our competitors.
	4.5	Our digital solutions are superior to those of our competitors.
	4.6	The applications of our digital solutions are totally different from those of our competitors.
	4.7	Some of our digital solutions are new to the market at the time of launch.
Part 5: Environmental performance	5.1	Our organization reduces the emission of waste (air, water and/or solids).
	5.2	Our organization reduces the consumption of hazardous and toxic materials.
	5.3	Our organization reduces the frequency of environmental accidents.
	5.4	Our organization reduces energy consumption.
Part 6: Digital management and departmental agility	6.1	It uses technologies and other digital resources to improve proactive and strategic decision-making systems.
	6.2	It uses technology and other digital resources to improve decision support systems.
	6.3	It uses smart appliances to improve product production quality and efficiency.
	6.4	It uses integrated networked technology: computer-aided design/engineering/manufacturing and product data management (CAD/CAE/CAM and PDM) for product research, development and design.
	6.5	It uses digital technology for marketing activities.
	6.6	It uses a digital logistics system so that all nodes in the logistics service process are dynamically connected and can provide real-time feedback.
	6.7	It uses a cloud-based intelligent customer service system to provide real-time user reviews and after-sales product information.
	6.8	We integrate digital technology and business strategy to achieve a strategic balance.
	6.9	We create a shared vision of the role that digital technology should play in business strategy.
	6.10	We jointly plan how digital technology will enable business strategy.
	6.11	We consult with others before making strategic decisions.

Table A1. *Cont.*

Part	Question Code Number	Question
Part 7: Digital vision	7.1	We have a clear vision to stay competitive with respect to the 5- to 10-year digital strategy.
	7.2	We have a clearly defined digital strategy.
	7.3	We have implemented a digital strategy in all business units.
	7.4	We have continually evaluated and adapted the digital strategy over time.
	7.5	We have established new business models based on digital technology.
Part 8: Digital orientation	8.1	We develop a clear vision of how new digital technologies (social media, mobile devices, analytics, cloud computing) help the organization create value.
	8.2	We integrate business and digital strategy.
	8.3	We develop the ability for functional and management areas to understand the value of new investments in digital technology.
	8.4	We always stay abreast of digital technology innovations.
	8.5	We have the capacity to test and continue testing new digital technologies as much as necessary.
	8.6	We have an environment that is conducive to trying new ways of using digital technologies.
	8.7	We are constantly looking for new ways to improve the effectiveness of our use of digital technology.

Appendix B

Table A2. Factor analysis.

Factor	Measures	Factor Loadings
Digital orientation (Eigenvalue =12.830, % of variance explained = 27.297)	4.5 Our digital solutions are superior to those of our competitors.	0.747897
	2.6 There is scope for all members to participate in the digital transformation discussion.	0.69558
	1.19 We have explored or adopted data analytics technology.	0.680334
	2.5 Senior executives and middle managers share a common digital transformation vision.	0.652203
	1.17 We have explored or adopted big data technology.	0.64956
	1.3 We use digital channels in our customer service.	0.647165
	1.18 We have explored or adopted data visualization technology.	0.64253
	4.4 The quality of our digital solutions is superior to that of our competitors.	0.635501
	8.6We have an environment that is conductive to trying new ways of using digital technologies.	0.625392
	2.7 We have explored or adopted smart manufacturing application technology.	0.598398
	4.7 Some of our digital solutions are new to the market at the time of launch.	0.57889
	8.5 We have the capacity to test and continue testing new digital technologies as much as necessary.	0.507291
	6.7 It uses a cloud-based intelligent customer service system to provide real-time user reviews and after-sales product information.	0.464042
	4.3 The time to market of our digital solutions is inferior to that of our competitors.	0.409649

Table A2. *Cont.*

Factor	Measures	Factor Loadings
Business strategy (Eigenvalue = 3.719, % of variance explained = 7.913)	7.4 We have continually evaluated and adapted the digital strategy over time.	0.735214
	7.1 We have a clear vision to stay competitive with respect to the 5 to 10-year digital strategy.	0.691871
	7.3 We have implemented a digital strategy in all business units.	0.651797
	6.10 We jointly plan how digital technology will enable business strategy.	0.642018
	7.5 We have established new business models based on digital technology	0.629528
	8.1 We develop a clear vision of how new digital technologies (social media, mobile devices, analytics, cloud computing) help the organization create value.	0.582692
	6.8 We integrate digital technology and business strategy to achieve a strategic balance.	0.557856
	8.7 We are constantly looking for new ways to improve the effectiveness of our use of digital technology.	0.538586
Innovativeness (Eigenvalue = 2.904, % of variance explained = 6.178)	1.6 We have explored or adopted the Internet of Things (IoT).	0.730645
	1.15 We have explored or adopted blockchain technology.	0.711037
	1.12 We have explored or adopted blockchain contract management technology.	0.668383
	1.8 We have explored or adopted computer-aided office technology.	0.638336
	1.7 We have explored or adopted smart manufacturing application technology.	0.620426
	1.20 We have explored or adopted data warehousing technology.	0.589115
	1.11 We have explored or adopted artificial intelligence (AI) technology.	0.526167
	6.3 It uses smart appliances to improve product production quality and efficiency.	0.511099
	1.16 We have explored or adopted robotic process automation technology.	0.473953
	1.4 We use digital technologies to increase performance or add value to our products and services.	0.421848
Customer Centricity (Eigenvalue = 2.333, % of variance explained = 4.964)	1.10 We have explored or adopted customer relationship management (CRM) technology and/or product data management (PDM) technology.	0.669982
	3.1 We have digital solutions that connect core business activities with customers, suppliers, employees and organization resources.	0.663128
	2.2 Digital initiatives are assessed using a common set of key performance indicators (KPIs).	0.64101
	1.22 We have explored or adopted wireless local area network (WLAN) technology.	0.545914
	4.2 We have a larger number of successful digital solutions than our competitors.	0.507784
	1.23 We have explored or adopted information and communications technology (ICT).	0.490572
	0.8 The organization has a digital transformation strategy. (according to my personal opinion)	0.467147
	2.1 Senior managers take a transformative approach to the organization's digital future.	0.463247
	1.5 We have launched new business models based on digital technologies.	0.445315
Environmental orientation (Eigenvalue = 1.984, % of variance explained = 4.222)	5.2 Our organization reduces the consumption of hazardous and toxic materials.	0.802512
	5.1 Our organization reduces the emission of waste (air, water and/or solids).	0.770194
	5.3 Our organization reduces the frequency of environmental accidents.	0.607582
	5.4 Our organization reduces energy consumption.	0.527312
Organizational Structure (Eigenvalue = 1.681, % of variance explained = 3.576)	2.9 Digital initiatives are coordinated using criteria such as roles and responsibilities.	0.767824
	2.10 Roles and responsibilities for managing digital initiatives are clearly defined.	0.719686

Kaiser–Meyer–Olkin measure of sampling adequacy = 0.841; Bartlett's test of sphericity = 4306.733.

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