Exploring Digitalisation Adaptation of Agro-food Firms: Evidence from Greece

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ARTICLE INFO	ABSTRACT
Article History Received 19 March 2022; Accepted 15 May 2022 *JEL Classifications* E22, L66, M20, O33, Q55 **Keywords:** investment, agro-food industry, business, technological change, technological innovation	**Purpose**: The present study aims to investigate the primary tools and digitalisation applications used by agro-food firms in Greece. These factors encourage or discourage digitalisation and identify which policies are in place to ensure an effective digitalisation in the food sector. **Design/methodology/approach:** Primary data were gathered through a quantitative survey with a structured questionnaire on a sample of agro-food firms in Greece. The sample consisted of 51 executives of firms from the food sector. Data analysis was performed raw data using the SPSS statistical software version 26 and applying a mix of multivariate methods. **Findings:** The results indicate that the implementation of digital technologies in agro-food firms in Greece remains in an embryonic phase, only taking advantage of the key digital platforms and the Internet. **Research limitations/implications:** 1. The coronavirus pandemic (Covid-19) did not allow lifelong data collection. 2. The non-response of some companies to the invitation to participate in the research and their desire not to participate in the research. **Originality/value:** The digital adaptation of the agro-food firms will contribute to the protection of the environment in the context of green growth. We believe that the present study will contribute to shaping the appropriate environment for the adaptation of the food industry to the new conditions.

1. Introduction

Today, technological developments are rapidly reflected globally, in a highly competitive internationalised environment, where digitalisation is gaining interest among firms, as it helps them increase their value (Salvi et al., 2021). Digitalisation is usually defined as the combination of the intensive development of new or significantly modified digital technologies and systems and, at the same time, their intensified diffusion and application at distinct productive levels (e.g., digitalisation and data analysis, digital firm models, digital processes, digital products, and services) in the sectors of economic and social activity (Oliveira et al.,2021). Tilson et al. (2010) state that digitalisation refers to applying digital technologies and infrastructures in business, economy, and society.

Digitalisation offers new technical possibilities and firms opportunities, changing how firms operate in the markets, significantly affecting firms' value chains (Oliveira et al., 2021) and waste management processes (Sarc et al., 2019). It is also one of the main factors in changing how firms operate, evolving firm models through digital processes and influencing employee satisfaction (Bueechl et al., 2021). Digitalisation affects many aspects of organisations, including information technology, strategy and firm models, products and services, internal and external processes, corporate organisation and culture, human resource management resources and employee

satisfaction levels (Parviainen et al., 2017; Bueechl et al., 2021; Oliveira et al., 2021; Ragazou, 2021). Examples include intelligent houses (such as applications for entertainment, security, childcare, electricity, and heating), eHealth, smart mobility, and smart cities (Dudzevičiūtė et al., 2017; Lyons, 2019; Okkonen, 2020). The expansion of digital technology and its emergence in many areas of everyday life ensures better performance in the design of services and the development of environmental infrastructure, as exemplified by the cases of the cities of Tromsø in Norway and Rovaniemi in Finland, combining growth, sustainability, and high prosperity as "smart" cities (Cartaxo et al., 2021). Other known examples refer to smart cities in Canada (Spicer et al., 2021), South Korea (Kim et al., 2021), and in Australia (Yigitcanlar et al., 2021).

Many areas may benefit significantly, since cultural objects and assets (e.g., works of art, historical relics, and documents) can be digitised and preserved over time. In a firm's environment, digitalisation shows how a firm can advertise its assets, produce, and deliver them effectively to the customer, and maintain effective contact with the customer while also involving the customer in the joint creation of the customer value to satisfy his needs (Chernova et al., 2019). In production, digitalisation also means designing products in digital form and the virtual composition of components before producing the product (Meissner et al., 2018) In addition, it affects lean production methods, which can be further improved by using new technologies, achieving a transition to a digital system that opens up new possibilities in the production process As literature supports, both lean manufacturing and factory digitalisation individually contribute to improved operational performance (Buer et al., 2021) Finally, in water and energy supply, as well as in the transport sector, digitalisation can inform the state, physical distribution or location of things and people, providing detailed information on the necessary and future capabilities related to sustainability and scalability in a specific area (Gray and Rumpe, 2015).

Bearing in mind the above mentioned, the present work explores the concept of firms' digitalisation in the agri-food sector in Greece. The objective is threefold: first, to investigate the primary tools and digitalisation applications used by firms in the agro-food sector in Greece and the factors that encourage or discourage digitalisation. Second, to identify which policies are in place to ensure effective digitalisation in the agro-food sector and third, to explore whether differences exist regarding the degree of application of the digitalisation tools, depending on the firm's size. The remainder of the paper includes a theory background on the digitilisation of firms in the next section and the materials and methods employed in the third section. Section four presents and discusses the results, and the final section concludes.

2. Digitalisation in the Agri-Food Sector

The food supply sector consists of fresh and processed foods (Weaver et al., 2014), accounting for a significant portion of the household expenditure. Hong Kong has the highest per capita food expenditure globally (the USA $ 5,002.2 in 2018) (Knoema, 2021). According to Eurostat (2020), households in the EU spent 2019 over 956 billion euros (equivalent to 6.8% of EU GDP) on food and non-alcoholic beverages. This accounts for 13.0% of total household expenditure and is the third-largest household expenditure category after housing, water, electricity, gas and other fuels, accounting for 23.5% of household expenditure and transport (13.1%). Households in Romania spent the most considerable amount on food and non-alcoholic beverages, about a quarter of total household consumption (26.0%), followed by households in Lithuania (20.2%) (Eurostat, 2020). Greece's average household budget expenditures for food and non-alcoholic beverages increased to 23.1% from 20% in 2019 (National Statistical Service of Greece, 2021). Agro-food firms confront global challenges, which can be addressed with the support of information technologies (Demartini et al., 2018). For example, intelligent packaging is one of the most critical technologies in food packaging, which is still evolving and offers vast potential for issues related to improving food safety, quality and traceability, and convenience for consumers. Nowadays, such packaging systems protect from chemical, biological and physical alterations. At the same time, it also protects food from mechanical damage against vibrations during distribution, facilitates transportation and storage and reduces the cost of marketing and advertising (Forghani et al., 2021; Ghaani et al., 2016). Due to the growth of the world population (the world population increased from 1 billion in 1804 to 7,794,798,739 today) (Worldometer, 2021), combined with changing customer demands and market dynamics, new challenges arise for the agro-food sector. Among the significant market, challenges are safety standards in the Covid-19 era (Ceniti et al., 2021; Rizou et al., 2020; Trmcic et al., 2021). There is an urgent need for the agro-food sector to ensure compliance with measures to protect food workers from Covid-19 contamination. However, it also prevents exposure or transmission of the virus and enhances food hygiene practices (World Health Organization/ WHO, 2020).

According to Sen et al. (2017), new approaches based on digitalisation can contribute to the practical and reliable coverage of current and future needs, aiming at higher efficiency, productivity, and quality and improving firms' position with simultaneously optimised resource and waste management. Digital processes and automation increase accuracy, convenience, and productivity, while helping to reduce unit costs. Furthermore, the investment and development of digital tools aim to ensure the highest possible food safety. Digital technologies offer an excellent solution for improving the sustainability of food systems (Bahn et al., 2021; Marvin et al., 2022; Samoggia et al., 2021).

Within a turbulent socio-economic and operating environment, there is a strong tendency for firms to exploit the high potential of innovation resulting from the continuing impact of the rapid technological development of information and communication technology in the agro-food sector (Massari, 2021; Oltra-Mestre et al., 2021). Indeed, firms in this sector face global challenges that can be met with the support of information technology and digitalisation and result in improved competitiveness and efficiency (Jorge-Vázquez et al., 2021). According to Annosi et al. (2020), digitalisation can significantly address several current challenges facing the agro-food sector, such as

growing food demand and resource use. Their study showed that the existing challenges in the field affect the sustainable development of digital technology for firms. Additionally, as reported by Ranta et al. (2021), the impact of digitalisation is positive on the adoption of innovation in corporate firm models. It brings significant benefits-improved resource flows, and value creation.

As Stephens and Barbier (2021) argue, digitalisation brings new perspectives to developing and exploring alternative food networks, offering a decentralised network of local functions that converge around a digital platform and providing innovative virtual hardware intermediation between producers and consumers. This further engages consumers in the cogeneration of products in various sectors and activities and contributes to restructuring global food flows towards sustainability and reduced environmental impacts, as Cronin and Halog (2021) support the case of Australian alternative food networks.

In addition, alternative sourcing becomes more "feasible" through digital platforms allowing consumers to engage in healthier and more sustainable food practices (Dal Gobbo et al., 2021). Digital platforms are also discussed by Shree et al. (2021), stating that their evolution has transformed the way firms operate in business-to-business (B2B) markets. Further, concerning the B2B and B2C sectors, Bernardi and Moggi (2021) showed that digitalisation can play a pivotal role in generating and transferring data, stimulating innovation and sustainability-oriented behaviours; the digitalisation of the agri-food sector is a strategic priority in the political agenda of institutions. Among the highest strategic priorities are investments and funding in the agri-food sector, organic farming and production, energy, sustainability, water resources management, smart farming, food safety and precision agriculture (Andronova et al., 2021; Ehlers et al., 2022; Garske et al., 2021; Şerbănel, 2021). The opportunity to improve the competitiveness and efficiency of the sector offered by new technologies comes in conjunction with the sector's potential to meet new economic and environmental challenges. Such technologies are related to automation, robotics, artificial intelligence and forecasting systems, the blockchain of agricultural products, and cybersecurity issues in the agro-food chain. According to Jorge-Vázquez, et al. (2021), the adoption of digital tools in the food sector, along with other structural and organisational variables, is essential in improving competitiveness, economic efficiency, and growth while contributing to the sustainability of agricultural and food systems. Furthermore, digitalisation may contribute to higher efficiency, productivity, and quality, strengthening the firms' position while optimising resource and waste management and ensuring the highest possible food safety (Sen et al., 2017).

3. Materials and Methods

In the present study, a quantitative survey was used to collect primary data through a structured questionnaire on the digitalisation of firms in the food sector in Greece. The sample consisted of 51 executives of firms from the food sector in Greece. Regarding the data collection process, it is necessary to mention that the respondents agreed to participate voluntarily in the research and were selected via simple random sampling. After telephone communication with the firms, the questionnaire was sent electronically via e-mail and social media to 51 randomly selected firms operating in Greece's agro-food sector and various parts. The data collection lasted from October 5, 2021, to October 15, 2021, and the questionnaire was distributed to the participants through the Google Forms platform. By simple random sampling each unit of the aggregate sample has the same chances of being included in the sample (Singh and Masuku, 2014). A similar method was applied by Salam et al. (2021) to food industry employees with a total of 120 questionnaires answered and by Abd Aziz and Samad (2016) to small and medium-sized food processing companies in Malaysia.

The research methodology was based on exploratory questions stemming from extant digital economy literature (Batt et al., 2020; Cirillo et al., 2021; Kostyaeva and Chernyakov, 2020; Sanchez-Riofrio et al., 2021). The data collected seek to identify the main digitalisation tools and applications firms use in the agro-food sector and the factors that encourage and discourage digitalisation. It is worth noting that they also seek to identify the policies implemented to ensure effective digitalisation in the agro-food sector. These were achieved through the application of descriptive statistics. To investigate whether the factors encouraging and discouraging the implementation of digitalisation in the agro-food sector in Greece depend on the firm's size, a one-way Analysis of Variance was employed. Compared to other statistical methods such as the use of multiple t-tests, one-way and two-way ANOVA require fewer measurements to show significant effects (Burke, 1998). A similar methodology has been applied by Salavou and Sergaki (2013) to identify differences in generic business strategies between 31 companies and 30 organisations in the agro-food sector in Greece.

The survey instrument employed closed-ended questions and was designed in such a way that it is clear and understandable to all individuals surveyed. The questionnaire consisted of five sections. Specifically, the first section of the questionnaire entitled "Demographic Data" aimed to collect demographic information about the participants and some initial data on the characteristics of each company. The second section entitled "Digitalisation tools and applications" comprised three questions to investigate the digital situation of the firm. The first question mentioned nine digital tools and asked each respondent to answer whether these tools were used by each firm. In the second question, respondents were asked whether the company aspired for investments in new technologies, whereas in the third and final question respondents were asked to what extent the company employed a series of digital tools that were given to them. The third section of the questionnaire aimed to identify the factors encouraging the application of digitalisation in the agro-food sector, and five factors and six positive consequences of the implementation of digitalisation were given. The fourth section intended to investigate the factors that discourage the application of digitalisation in the agro-food sector, whereas the last section listed five policies that can be implemented for the effective digitalisation of agro-food firms and respondents were asked to state their degree of agreement with these policies. All questions were gauged through a 5-point Likert scale ranging from 1= "I totally disagree", 2= "I

disagree", 3= Neither agree/nor disagree", 4 = "I agree", 5= "I fully agree", except for the first two questions of the second section that were dichotomous (Yes, No) variables.

Data analysis was performed on raw data using the SPSS statistical software version 26. A specific data collection procedure was performed to ensure the validity and reliability of the questions included in the survey instrument. In particular, the anonymity of the research tool, which was distributed electronically and did not contain any secured branding questions, is one of the most critical factors in ensuring reliability and validity (Willig, 2001). The electronic distribution of the questionnaire was a necessary action in combination with the absence of the researcher when completing the research tool, as it was not possible to intervene in the answers and, therefore, the objectivity and honesty of the responses were encouraged. It is noteworthy that fully informing about the necessity of participating in the research and its objectives, providing clarifications, voluntary participation, and the right to leave at any time desired by the participants strengthened the effort to ensure the validity and reliability of the research tool.

The sample size selected was satisfactory and appropriate for the subject under consideration regarding validity. In addition, there were no extreme values in terms of participants' responses, and the sample was homogeneous in terms of demographic characteristics. To ensure the reliability of this research tool, the reliability index of Cronbach's alpha was calculated. In the present survey for the second-and third-party questions, the reliability index was equal to 0.886, indicating acceptable reliability.

4. Results

Most of the participants in the research were men (52.9%), while 47.1% were women (Table 1) aged 40 to 49 years and 35.3% 50 years old. In addition, the majority had more than twenty years of employment in the agro-food sector (31.4%), whereas 11.8% were young employees with up to 2 years of employment. Regarding the position held by the participants in the firm, most were owners with a percentage of 43.1%, 15.7% were managers and executives, and 41.2% were employees. Most of the firms in the sample were very small (56.95), 5.9% were medium enterprises, 25.5% were small, and 11.8% were large firms (Table 1).

Table 1: Profile of the sample firms

Features of the sample	Number	%
Object of activity of the firm		
Owner / Businessman	22	43.1
Manager / Executive	8	15.7
Employee	21	41.2
Total	51	100.0
Firm size		
Very small	29	56.9
Small	13	25.5
Medium	3	5.9
Big	6	11.8
Total	51	100.0

The second part of the questionnaire examined digitalisation tools and whether firms know and use them. As shown in Table 2, almost all digital tools were used by a few firms. For example, 68.6% of respondents use digital platforms, and 43.1% use the Internet remaining tools to a minimum (Table 2). Regarding digital platforms, most respondents (68.6%) answered that the firm uses them, while 31.4% responded that they do not.

Regarding Artificial Intelligence, most respondents at 96.1% answered that the firm does not use it, while only 3.9% answered it. The same holds for Robotic Systems where 90.2% responded that the firm does not use them, the 3D printers (96.1%) and the cryptocurrencies, which the sample firms do not employ. At the same time, most participants claimed that they do not use the Internet (56.9%), while 43.1% answered that they use it, whilst Cloud Computing was used by only 19.6% of the sample. The rest of the digital applications, i.e., Big Data and Blockchain, are not widespread in the sample agro-food firms, as 90.2% and 98% do not use them.

Table 2: Features of the digitalisation tools

Digital tools used by firms		Number	%
Digital Platforms	No	16	31.4
	Yes	35	68.6
Artificial Intelligence	No	49	96.1

	Yes	2	3.9
Robotic Systems	No	46	90.2
	Yes	5	9.8
3D Printing	No	49	96.1
	Yes	2	3.9
Cryptocurrencies	No	51	100.0
	Yes		
Internet	No	29	56.9
	Yes	22	43.1
Cloud Computing	No	41	80.4
	Yes	10	19.6
Big Data	No	46	90.2
	Yes	5	9.8
Blockchain	No	50	98.0
	Yes	1	2.0

Table 3 illustrates the eight digital tools/applications mentioned to the respondents, asking them to state how their firm uses them. For most applications, the average usage rate moved a little closer to 2. The application that stood out was Digital Marketing/Website/social media, where the average score exceeded 3 (M = 3.17, TA = 1.19), and the Digital Procurement / Orders Management that averaged 2.7 (MO = 2.7, TA = 1.28).

Table 3: Statistics for the digitalisation tools

	N	Mean	Std. Deviation
Digital Marketing /Website/social media	51	3.1765	1.19509
Automation Applications in the Production/Commercial Process	51	2.4314	1.23701
Digital Procurement/Order Management	51	2.7059	1.28521
Electronic Sales System/E-Shop	51	2.2745	1.38677
Use Applications for customer experience / profile / needs / behavior	51	2.0196	1.10436
Participation in an Online Platform	51	2.4706	1.17223
Data Processing and Analysis of the Production / Commercial Process	51	2.4902	1.31716
Use Applications for After Sales Services	51	2.2745	1.13276

Respondents were then asked to indicate how they agree with several factors that encourage digital applications in the agro-food sector (Table 4). The most important factors that can act positively in helping a firm to digitise and adopt all the above digital tools were the specialisation/knowledge of entrepreneurs in the sector with new technologies and the digital environment, with an average score of 3,86 (MO = 3.80, TA =. 89). Following, was the increase in the workforce's digital skills employed in the agro-food sector that averaged 3.84 (MO = 3.84, TA =. 89), the special conditions with 3.8 (MO = 3.80, TA = 1.03), the same as the competitive environment. Finally, state aid received the lowest score of 3.6 (MO = 3.60, TA =. 87).

Table 4: Statistics for the factors encouraging the implementation of digitalisation in the Agro-food Sector

	N	Mean	Std. Deviation
State Aid in the Agro-food Sector	51	3.607	0.87358
The competitive environment in the Agro-food Sector	51	3.803	0.89487
The specialisation/knowledge of entrepreneurs in the sector with new technologies and the digital environment	51	3.862	0.80049
Increasing the digital skills of the workforce employed in the agro-food sector	51	3.843	0.88029
Special conditions (e.g., Covid Pandemic 19)	51	3.803	1.03961

As concerns the positive effects of digitalisation on agro-food firms, the respondents gave the highest average score of 3.82 (MO = 3.82, TA = .76) to the increase in the quality of the services provided to the customers, while the lowest was 3.52 (MO = 3.52, TA = .78) in Improving Resource and Waste Management. In these cases, the scores ranged between 3.5 and 3.82 points, with three corresponding to the neither agree nor disagree answer and four respondents to the agree answer. Therefore, the participants' tendency to converge toward the agreement on the following factors had positive consequences for digitising the firms in the sector (Table 5).

Table 5: Statistics for the positive effects of business digitalisation in the Agro-food Sector

	N	Mean	Std. Deviation
Increase Business Efficiency	51	3.7255	0.80196
Increase business productivity	51	3.7059	0.67213
Increasing the profitability of the firm	51	3.6471	0.74360
Increasing the quality of services provided to customers	51	3.8235	0.76696
Improving the business position of the firm	51	3.7647	0.76389
Improving resource and waste management	51	3.5294	0.78366

Table 6 shows the average degree of agreement of the respondents on the four factors that are reported to discourage firms from digitising. Lack of funding seems to be the first inhibitory factor with an average score of 3.86 (MO=3.86, TA =.82), while the least important factor is the lack of specialised skills in human resources with a score of 3.6 (MO=3.60, TA =.98). Also, the second important factor is the high cost of purchase and maintenance of digital systems and applications, with an average score of 3.82 (MO = 3.82, TA =. 97). Finally, the lack of information structures and guidance received a score of 3.70 (MO = 3.70, TA =.92). Again, it is important to mention that the respondents were asked to choose from the possible answers 1 = I do not agree at all, 2 = I agree a little, 3 = I agree moderately, 4 = I agree, 5 = I agree. Therefore, the answers that moved close to 4 answered that they agreed with the respective statement.

Table 6: Statistics for the factors acting as barriers to the digitalisation of firms in the Agro-food Sector

	N	Mean	Std. Deviation
Lack of Funding	51	3.8627	0.82510
High cost of purchasing and maintaining digital systems and applications	51	3.8235	0.97377
Lack of information structures and guidance	51	3.7059	00.92291
Lack of specialised skills in human resources	51	3.6078	0.98140

Concluding, the descriptive analysis regarding the policies that should be followed to help agro-food firms in their digitalisation revealed that the most important policy was the subsidised programs for the digital upgrade of firms with an average score of 3.98 (MO. = 3.86, T.A. =. 73). The result shows that respondents agreed on the importance of this policy. On the contrary, the Digital Economy Fund set up received an average score of 3.47 (MO = 3.47, TA =. 87), which means that respondents neither disagreed nor agreed with the importance of this policy. Also, the Tax Incentives for firms investing in digital technologies and the Configuration of digital centres and infrastructure of education and training received an average score of 3.76. Finally, the Collaboration Platforms - development of new digital collaboration schemes received an average score of 3.60 points (Table 7).

Table 7: Statistics for the policies for the effective digitalisation of firms in the Agro-food Sector

	N	Mean	Std. Deviation
Establishment of a Digital Economy Fund	51	3.4706	0.87984
Tax Incentives for Businesses Investing in Digital Technologies	51	3.7647	0.95054
Configuration of digital centres and infrastructure of education and training	51	3.7647	0.78964
Collaboration Platforms - development of new digital collaboration schemes	51	3.6078	0.82652
Subsidised programs for the digital upgrade of businesses	51	3.9804	0.73458

In the second part of the analysis, the aim was to control the effect of the views regarding the factors encouraging and discouraging the implementation of digitalisation in the agro-food sector in Greece, depending on the firm's size. Accordingly, the results of Table 8 indicate that the implementation of digitalisation tools differs statistically significantly depending on the size of the firm (very small/small/medium/large) (p-value> .00).

Table 8: One-way ANOVA for factors that discourage the implementation of digitalisation tools depending on the size of the business

		Sum of squares	df	Mean square	F	Sig.
State Aid in the Agro-food Sector	Between groups	2.374	3	.791	1.040	.384
	Within groups	35.782	47	.761		
	Total	38.157	50			
The competitive environment in the Agro-food Sector	Between groups	1.272	3	.424	.514	.675
	Within groups	38.767	47	.825		
	Total	40.039	50			
The specialisation/knowledge of entrepreneurs in the sector with new technologies and the digital environment	Between groups	.899	3	.300	.452	.717
	Within groups	31.141	47	.663		
	Total	32.039	50			
Increasing the digital skills of the workforce employed in the agro-food sector	Between groups	1.553	3	.518	.654	.584
	Within groups	37.192	47	.791		
	Total	38.745	50			
Special conditions (e.g., Covid Pandemic 19)	Between groups	2.119	3	.706	.639	.593
	Within groups	51.920	47	1.105		
	Total	54.039	50			
Increase Business Efficiency	Between groups	.454	3	.151	.224	.879
	Within groups	31.703	47	.675		
	Total	32.157	50			
Increase business productivity	Between groups	.960	3	.320	.695	.560
	Within groups	21.629	47	.460		
	Total	22.588	50			
Increasing the profitability of the firm	Between groups	.755	3	.252	.440	.725
	Within groups	26.892	47	.572		
	Total	27.647	50			
Increasing the quality of services provided to customers	Between groups	1.127	3	.376	.624	.603
	Within groups	28.285	47	.602		
	Total	29.412	50			
Improving the business position of the firm	Between groups	2.614	3	.871	1.542	.216
	Within groups	26.562	47	.565		
	Total	29.176	50			
Improving resource and waste management	Between groups	2.734	3	.911	1.531	.219
	Within groups	27.972	47	.595		
	Total	30.706	50			

Finally, at the level of statistical significance $\alpha = 0.05$, none of the factors discouraging the implementation of digitalisation tools differs significantly depending on the firm's size (very small/small/medium/large), as indicated in Table 9.

Table 9: One-way ANOVA for factors encouraging the implementation of digitalisation tools depending on the size of the business

		Sum of squares	df	Mean square	F	Sig.
Lack of Funding	Between groups	1.501	3	.500	.723	.543
	Within groups	32.538	47	.692		
	Total	34.039	50			
High cost of purchasing and maintaining digital systems and applications	Between groups	6.946	3	2.315	2.689	.057
	Within groups	40.466	47	.861		
	Total	47.412	50			
Lack of information structures and guidance	Between groups	6.022	3	2.007	2.580	.065
	Within groups	36.566	47	.778		
	Total	42.588	50			
Lack of specialised skills in human resources	Between groups	1.727	3	.576	.583	.629
	Within groups	46.430	47	.988		
	Total	48.157	50			
Establishment of a Digital Economy Fund	Between groups	3.400	3	1.133	1.509	.224
	Within groups	35.305	47	.751		
	Total	38.706	50			
Tax Incentives for Businesses Investing in Digital Technologies	Between groups	1.097	3	.366	.390	.761
	Within groups	44.080	47	.938		
	Total	45.176	50			
Configuration of digital centres and infrastructure of education and training	Between groups	.225	3	.075	.114	.952
	Within groups	30.951	47	.659		
	Total	31.176	50			
Collaboration Platforms – development of new digital collaboration schemes	Between groups	.545	3	.182	.254	.858
	Within groups	33.611	47	.715		
	Total	34.157	50			
Subsidised programs for the digital upgrade of businesses	Between groups	.425	3	.142	.251	.860
	Within groups	26.555	47	.565		
	Total	26.980	50			

5. Discussion

According to the analysis, most of the participants in the research were men aged 40 and over, employees with more than 20 years of employment in the sector, mainly owners. In addition, 56.9% of the participants worked in very small enterprises, 25.5% worked in small enterprises, 5.9% in medium enterprises and 11.8% in large enterprises. When it comes to digitalisation tools and how well firms know and use them, almost all digital tools are operated by a few firms. The low digitalisation of firms in Greece was also confirmed in the literature (Laitsou et al., 2020; Organization for Economic Co-operation and Development/OECD, 2019). Most respondents use digital platforms and the Internet, a finding that is consistent with Demartini et al. (2018) and Kosior (2018). The rest of the tools are used to a minimum (Artificial Intelligence, Robotic Systems, 3D Printing, Cloud Computing, Big Data, Blockchain), while Cryptocurrencies are not used.

In contrast, other research in the literature reports extensive use of the above tools (Demartini et al., 2018; Kosior, 2018; Liu et al., 2021). Digital Marketing / Website / social media stood out among the digital applications used and Digital Procurement / Order Management. Firms using digitised technologies in the Middle East and North Africa (MENA) appear to be reaping the benefits of increased productivity and resource efficiency. In contrast, digital technologies are already being used in Morocco's National Land Registry (Bahn et al., 2021).

Regarding the factors that encourage the use of digital applications in the agro-food sector, it seems that the specialisation/knowledge of entrepreneurs in the sector with new technologies and the digital environment is the most essential factor. Therefore, there is an increase in the workforce's digital skills in the agro-food sector, special conditions, and a competitive environment. At the same time, state aid seemed to encourage less than all other actors.

These findings are consistent with extant literature (Bičkauskė et al., 2020; Jorge-Vázquez et al., 2021; Anastasiou et al., 2021).

Regarding the consequences of digitalisation in agro-food firms, the respondents highlighted the most substantial increase in the quality of the services provided to the customers. In general, the tendency of the participants converges towards the agreement on the positive effects of the digitalisation of the enterprises of the sector, concerning the increase of the efficiency and productivity of the enterprise, its profitability, the quality of the services provided to the customers, the improvement of firm positioning and improving resource and waste management. These findings align with other research, which emphasises that digitalisation contributes to increasing productivity and enhancing competitiveness and efficiency in the sector, ensuring more sustainable use of resources, transforming production, promoting agro-food safety etc. (Debrenti 2020; Jorge-Vázquez et al., 2021). As for the factors that are reported to discourage firms from going digital, the lack of funding was the main one, followed by the high cost of purchasing and maintaining digital systems and applications, the lack of information and guidance structures, and the lack of specialised skills, consistent with the study of Bičkauskė et al. (2020). In addition, the logistics departments play a strategic role in the agro-food industry. Therefore, digitisation technologies and, more specifically, blockchain technology can have many uses. A typical example is the management of transport documents, the monitoring of transport progress and the corresponding deliveries, the geolocation as well, and the statistical analysis of all digital data in real-time (Remondino and Zanin, 2022; Dobrovnik et al., 2018; Al-Rakhami and Al-Mashari, 2021; Borowski, 2021; Adamashvili et al., 2021).

As for the policies that should be followed to help agro-food firms in their digitalisation, the most important was the subsidised programs for the digital upgrade of firms. Furthermore, according to Jorge-Vázquez et al. (2021), there is a need to promote public policies that guarantee high-performance digital connectivity, improve digital skills training, and promote collaborative integration processes. Under these policies, digitising and upgrading firms will be feasible. Finally, according to the analysis, none of the factors encouraging or discouraging the application of digitalisation tools differs statistically depending on the firm's size (very small/small/medium/large). In contrast, the international literature reports differentiation in the adoption of digitalisation according to the size of firms (Jorge-Vázquez et al., 2021).

Another typical example that highlights the importance and significance of using digital technologies is that of Spain. Research shows the importance of these technologies, but Spanish cooperatives do not invest in this direction (Marín and Gómez, 2021). While according to Bernal-Jurado et al. (2021), wine cooperatives should use digital technologies to be more competitive.

Conclusively, the main tools and digitalisation applications used by firms in the agro-food sector in Greece are primarily the digital platforms and the Internet. Digital Marketing / Website / social media and Digital Procurement / Order Management dominate the digital applications used. The factors that most encourage digitalisation are first the specialisation/knowledge of entrepreneurs in the sector with new technologies and the digital environment and then the digital skills of the staff. On the other hand, factors that discourage digitalisation mainly lack of funding and high purchase costs. The most crucial policy implemented to ensure effective digitalisation in the agro-food sector is the subsidised programs for the digital upgrade of firms. The respondents' views do not differ as to the degree of application of the digitalisation tools in the agro-food sector in Greece, depending on the size of the firms.

6. Conclusion

The objective of the present study was to investigate the primary tools and digitalisation applications used by firms in the agro-food sector in Greece. These factors encourage or discourage digitalisation and identify which policies are in place to ensure effective digitalisation in the agro-food sector. The results indicate that the implementation of digital technologies in Greece remains in an embryonic phase, only taking advantage of the key digital platforms and the Internet. Other digital applications that may facilitate the operation of these firms in a rather turbulent and competitive environment remain unexploited. Practical, the specialisation/knowledge of entrepreneurs in the sector with new technologies and the digital environment and the digital skills of the staff should be strengthened through training programs and seminars offered by the state and the competent commercial bodies. In addition, funding needs to be found to improve firms' digitalisation efforts. Possible avenues for future research may include a larger sample that could reveal more reasons for not adopting digital tools and targeted policies for amelioration.

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