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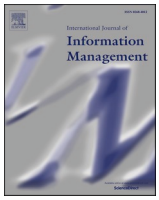

Research Article

Analysing cooperatives' digital maturity using a synthetic indicator

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ABSTRACT

A company's digitalisation journey spans multiple dimensions and processes. However, studies of digital maturity have focused only on certain parts of the process. This study presents a method capable of fully capturing a company's level of digital maturity. A DP2 indicator of digital maturity was constructed. This indicator is based on responses to a company survey of digitalisation in different business areas and processes. Companies with the highest degree of digitalisation are the oldest and largest (most employees). Differences between companies and sectors can be explained by the level of digitalisation in terms of digital management intensity, departmental agility and digital orientation.

1. Introduction

A feature of the current business context is the relentless, rapid technological change within organisations, especially in terms of digitalisation (Li et al., 2021). Vial (2019: 118) defined this digital transformation within firms as a process that "aims to improve an entity by triggering significant changes to its properties through combinations of information, computing, communication, and connectivity technologies". Digital transformation is more than just the implementation of new technologies. It represents a continuous dynamic process whereby an organisation's technologies, business models, culture and workforce adapt to achieve the desired state of digitalisation (Kane et al., 2017). The importance of this change process is beyond doubt. It enables the detection of internal and external opportunities, rapid reaction to risks, the agile assessment of competitors, greater information processing capacity, more agile and efficient processes, and other benefits (Hess et al., 2016; Li et al., 2021; Vogus & Sutcliffe, 2012). This wave of change has been made possible by the recent development of affordable and easy-to-use digital infrastructures based on computers, mobile devices, broadband network connections and advanced application platforms (Saihi et al., 2023). Their omnipresence means that digital technologies have radically changed current forms of communication, production and exchange, revolutionising all sectors of the economy across businesses of all sizes (Raimo et al., 2021).

A survey of the academic literature shows that research on digitalisation processes has paid little attention to differences between heterogeneous groups of firms (Ardito et al., 2021). Studies of digitalisation processes have mostly focused on large firms (Brock & von Wangenheim, 2019; Danso et al., 2020). As noted by Ardito et al. (2021), firm context and firm size matter because the way in which firms develop their strategies is closely linked to their size and industry (Gilman et al., 2015; Ram et al., 2001). Quantitative studies are scarce in the literature. Most are case studies (Arora & Rathi, 2019; Lee et al., 2020), and there is a lack of econometric analysis to provide an accurate picture of the factors that may affect the level of digitalisation of firms (Raimo et al., 2021). Studies have examined the adoption of isolated elements associated with digitalisation (Alonso-Almeida & Llach, 2013; Rahab & Hartono, 2012). The literature also contains analyses of digitalisation processes in companies of a similar size (Raimo et al., 2021). The present study contributes to filling this research gap by offering quantitative analysis of digitalisation process intensity in companies from different sectors and of different sizes and ages. The aim is to provide a ranking based on these three criteria to determine the level of digitalisation by firm sector, size and age. This exploratory study thus seeks to provide empirical evidence that can support or refute existing theories of the digitalisation process. This approach is justified by the fact that research on digital transformation is at an early stage (Kraus et al., 2022). Thus, exploratory studies are suitable.

Building on previous research, this study proposes several representative indicators of the digitalisation process in companies, as

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explained later. This research focuses on defining a synthetic indicator that reflects the level of digitalisation of companies in all relevant aspects. A literature review was performed to determine the relevant indicators for the overall analysis of level of digitalisation. Fieldwork was carried out in 2022 using a sample of Spanish cooperatives. This sample provided the data for the indicator, which can be applied in other contexts. The questionnaire responses cover different aspects of the digitalisation process, thus providing a complete picture. The questionnaire responses reflect the degree of digitalisation in each work area. These responses were then combined into a Distance P2 synthetic indicator (Pena, 1977). This indicator resolves several problems related to data aggregation. The weights of the indicator components are objective. Redundant information is eliminated. These and other advantages are detailed below (Ribeiro-Navarrete et al., 2021).

Section 2 presents a review of the literature on digitalisation processes. Section 3 provides the theoretical background linked to several research questions. Section 4 describes and justifies the method. Section 5 presents the results. Section 6 discusses these results and their theoretical and practical implications. Finally, Section 7 outlines the main conclusions of the study, linking back to the previous literature.

2. Literature review

The importance of digitalisation for firms stems from its ability to influence competitiveness (Hakala, 2011). Digitalisation affects key processes (Nambisan et al., 2020) that can influence profitability (Coreynen et al., 2017; Horváth & Szabó, 2019). Digitalisation can affect all company processes, so a wide range of procedures, strategies and tools are needed to advance towards a fully digital orientation (Akter et al., 2016; Büyüközkan & Göçer, 2018; Matt et al., 2015; Weichhart et al., 2016; Zhu et al., 2015). Given this feature of digitalisation, analysis of the digitalisation process should consider numerous items related to the implementation of technology in different business processes, as proposed in the present study. Pagani and Pardo (2017) identified three types of digitalisation depending on whether it is based on resource ties, activity links or actor bonds. This focus is used as the basis for the proposed synthetic indicator approach.

The literature contains analyses of the adoption of specific elements linked to firms' digitalisation processes (Alonso-Almeida & Llach, 2013; Fosso & Carter, 2016; Rahab & Hartono, 2012). Some of these analyses have revealed a link between the level of adoption of technological improvements and firm size. While scholars have paid little attention to the digitalisation process as a whole (Jones et al., 2014; Lee et al., 2020), the present paper adopts just such a focus. Specifically, the aim is to analyse the adoption of digitalisation as a core element of change rather the adoption of a specific digitalisation-linked element. Analysis of the literature also reveals a shortage of broad studies, especially econometric ones, with many based on case study methodology (Raimo et al., 2021). The present study contributes to the literature in this regard, offering quantitative analysis to propose a mathematically robust synthetic indicator. Data were gathered from primary sources using an ad hoc survey of managers.

Existing studies of the digitalisation process of companies show the need to consider many processes as representative of the level of digitalisation. Some examples include changes in sales processes (Hagberg et al., 2016; Hinings et al., 2018), the processing of big data from different channels (Frank et al., 2019; Leviäkangas, 2016), the way in which different processes and departments relate to and coordinate with each other (Berman, 2012; Li et al., 2021; Matt et al., 2015), the definition of an efficient customer interface (Berman, 2012; Li et al., 2018; Matt et al., 2015; Pramanik et al., 2019), the use of technology for greater customer orientation (Bharadwaj, 2000), digitalisation-based information exchange (Berman, 2012; Frank et al., 2019), monitoring and analysis of the environment (Li et al., 2021) and support for decision-making processes (Li et al., 2021; Mani et al., 2010). In general, one of the key concepts is that of technical adaptability, flexibility and agility in effectively implementing digital technologies (Frank et al., 2019; Banker et al., 2006; Pramanik et al., 2019). Accordingly, companies can rethink, reimagine and redesign their businesses in the digital age (Hinings et al., 2018; Li, 2020; Li et al., 2018; Matt et al., 2015; Pramanik et al., 2019). Therefore, a study such as the present one, which jointly explores different elements of the company's digitalisation process, is of considerable value.

Research has linked the process of digitalisation to certain characteristics of the firm and has explored its impact on the firm. For instance, the effect of digitalisation on firm performance has been analysed (Ardito et al., 2021), as well as its effect on operational efficiency, environmental performance and even reputation (Coreynen et al., 2017; Roxas et al., 2017; Yu & Huo, 2019). Digital transformation has also been linked to the way in which the firm creates value, redefines its structures and creates synergies (Bharadwaj et al., 2013; Matt et al., 2015; Neirotti et al., 2017). Regarding firm size, there is some disagreement over its influence on the technology adoption process and on the effects of this process. Some studies suggest that large firms find this process easier because of the greater availability of resources (Roy et al., 2001; Westerman & McAfee, 2012). Numerous studies have examined specific aspects of digitalisation of small and medium-sized enterprises (SMEs), although the digital transformation of SMEs remains under-researched (Eller et al., 2020). Alliances between companies can help solve the problems encountered by small-scale SMEs (Fredrich et al., 2022). The present study addresses this research gap by analysing the level of digitalisation according to firm size, age and sector. This approach offers a novel contribution to the academic literature.

Finally, digitalisation assessment systems should be discussed. Scholars have developed scales to assess the digital maturity of organisations. For example, Geissbauer et al. (2016) developed a proposal based on seven dimensions across four levels: digital novice, vertical integrator, horizontal collaborator and digital champion. Perera et al. (2023) characterised the process of the digital maturation of companies. Another noteworthy proposal is the two-dimensional scale developed by the MIT Center for Digital Business and Capgemini Consulting. The scale consists of two dimensions: digital intensity and transformation management intensity (Westerman et al., 2014). The first dimension refers to changes aimed at digitalising the way companies handle their customer commitment, internal operations and business models. The second dimension refers to the leadership capabilities needed to drive the digital transformation of the organisation (Westerman et al., 2014). No proposal for measuring digital maturity has received the consensus of the academic community. In fact, methodological proposals are scant, leaving a research gap. The present study offers a proposal to address this gap. The proposal consists of a synthetic indicator of digital maturity based on data from a broad set of representative indicators of the digital transformation process (Table 1).

3. Theoretical background and development of research questions

This study is primarily exploratory because it seeks to offer empirical evidence to support theoretical development. However, it also seeks to reinforce existing theoretical foundations. These aims are captured in three research questions. By addressing these questions, the study hopes to make a theoretical contribution.

The research questions were formulated based on the research gaps described in the previous section. They were proposed to test the theoretical foundations that support the theory on the digitalisation process. RQ1: Which business sectors are most digitalised?, RQ2: Are the largest companies the most digitalised?, RQ3: Are the newly created companies the most digitalised?

Table 1
Research gap addressed by this study.

Research gap	Proposal	Recent studies that support the proposal
Need for comprehensive analysis of the digital transformation process	Creation of a synthetic indicator that synthesises representative information on the digitalisation process as a whole	Akter et al. (2016); Büyüközkan & Göçer (2018); Matt et al. (2015); Weichhart et al. (2016); Zhu et al. (2015); Pagani & Pardo (2017); Jones et al. (2014); Lee et al. (2020)
Need for econometrics-based quantitative studies	Creation of a synthetic, mathematically robust indicator that synthesises information from numerous variables	Raimo (2021)
Need to study all parts of the digitalisation process together	Proposal of a synthetic indicator that pulls together information on the implementation of digitalisation across a wide range of processes	Hinings et al. (2018); Hagberg et al. (2016); Leviäkangas (2016); Frank et al. (2019); Berman (2012); Matt et al. (2015); Li et al. (2021); Mani et al. (2010); Bharadwaj (2000)
Need to study the digitalisation process not only in similar companies but also in heterogeneous groups of firms	Analysis of the digitalisation process according to company size, age and sector	Eller et al. (2020); Roy et al. (2001); Westerman & McAfee (2012); Bharadwaj et al. (2013); Matt et al. (2015); Neirotti et al. (2017); Ardito et al. (2021); Coreynen et al. (2017); Roxas et al. (2017); Yu & Huo (2019)
Need to propose systems to measure digital maturity	Proposal of a synthetic indicator of digital maturity	Geissbauer et al. (2016); Westerman et al. (2014)

3.1. RQ1: which business sectors are most digitalised?

Digital technologies can blur the boundaries between industrial sectors and organisations (Grover & Kohli, 2013; Lyytinen et al., 2016). The sector structure resulting from digitalisation processes reveals a dynamic environment. In this environment, inter-firm relationships uncover new models. These benefits affect all sectors, without exception (Nasiri et al., 2020). However, the limitations of some sectors and the disruptive nature of organisational transformations might lead managers in certain sectors to overlook these transformations and delay their implementation (Büyüközkan & Göçer, 2018). The positive effect of adopting digital models is widely acknowledged. New digital technologies have the potential to reduce trade distances and a host of barriers, broadening horizons to access otherwise out-of-reach markets (Raimo et al., 2021). However, the speed with which a digital orientation is adopted at an organisational scale differs across sectors. These differences have scarcely been studied in the academic literature. Digitalisation is a complex process for companies that requires firm-specific resources and skills, coupled with country-level systemic conditions that are conducive to digitalisation (Lee et al., 2020).

3.2. RQ2: are the largest companies the most digitalised?

As discussed earlier, there is disagreement over the type of companies (in terms of size) that find it easiest to digitalise. SMEs may be more motivated to undergo a digitalisation process and recognise its importance given its potential impact on company survival and growth (Ardito et al., 2021; David et al., 2013; Li et al., 2018; OECD, 2019; Statista, 2016). The increase in the ability to deploy information and communication technologies (ICTs) throughout the organisation (Lucchetti & Sterlacchini, 2004) has revealed the opportunities for SMEs arising from digitalisation. The organisational structure of SMEs can help with these transformations (Moeuf et al., 2019), even though the relatively limited availability of resources (compared to large companies) of these firms affects the transformation process (Ardito et al., 2021; Gatignon & Xuereb, 1997; Omrani et al., 2022; Renko et al., 2009). This study seeks to resolve this debate.

3.3. RQ3: are the newly created companies the most digitalised?

Classic business models have gradually been disappearing, replaced by flexible business models that are agile in their adoption of changes and that respond in real time to changes in the needs and habits of consumers (Ulas, 2019). A virtually unexplored issue in the academic literature is the effect of company age on the adoption of digitalisation. By answering this research question, we can shed light on this issue. Digital transformation has become a cross-industry global trend (Breidbach et al., 2018; McCartney & McCartney, 2020). An interesting question that arises is whether companies born into a digital context attain a higher level of digital maturity than those with a longer history. The COVID-19 pandemic may have substantially accelerated the pace of digital transformation. According to a global survey of executives in 2020 conducted by McKinsey, 85% of respondents indicated that their companies had hastened the adoption of digital technologies since the outbreak of the COVID-19 pandemic (Dua et al., 2021).

4. Method

4.1. Data collection and selection

The fieldwork that provided the data for this study took place in December 2022 and January 2023. Data were gathered on a sample of Spanish companies based on data from two cooperative federations (CIRIEC and FEVECTA). These companies were all cooperatives. They were randomly selected and contacted via email. Managers of these cooperatives were sent a link to a questionnaire, the answers to which reflected the level of digitalisation of their business processes. All items were measured on a 7-point Likert scale.

The questionnaire items assessed traditional dimensions linked to the strategic orientation of the firm, as well as other more novel dimensions (Ardito et al., 2021; Gatignon & Xuereb, 1997). As a whole, the questionnaire items were designed to cover all possible digitalisation eventualities because digital orientation essentially refers to the digitalisation of everything that can be digitalised (Črešnar et al., 2023; Hagberg et al., 2016; Rossmann, 2018). The questionnaire items appear in Appendix A. The scores for each questionnaire item were aggregated into representative dimensions. These dimensions were digital skills and technology application (Ulas, 2019; Venkatraman, 1994), digital management intensity (He et al., 2023; Westerman & McAfee, 2012), the digital business process (He et al., 2023; Nasiri et al., 2020; Westerman & McAfee, 2012), digital innovation performance (He et al., 2023; Liang & Frösén, 2020; Tippins & Sohi, 2003; Vickery et al., 2003), environmental performance (Ardito et al., 2021), digital management and departmental agility (Li et al., 2021), digital vision (Li et al., 2021), and digital orientation (Nasiri et al., 2020). These dimensions were integrated to form the synthetic indicator of digital maturity. The process of selection and design of the questions on the digitalisation process was based on the literature. Among others, research by the following authors was used: Ardito et al. (2021), Li et al. (2021), He et al. (2023), Liang and Frösén (2020), Nasiri et al. (2020), Sok et al. (2013), Tippins and Sohi (2003), Ulas (2019), Venkatraman (1994), Vickery et al. (2003), Westerman and McAfee (2012) and Westerman et al. (2014).

4.2. Creation of the synthetic indicator

A synthetic indicator was created to measure the degree of digitalisation maturity of companies. The indicator was created following the P2 distance method described by Pena (1977). This indicator provides a ranking that synthesises the information from numerous representative indicators of the digitalisation process. These indicators correspond to the responses of the managers included in the survey, who indicated the degree of implementation of digitalisation processes in their companies. Three rankings are formed in which homogeneous groups of companies are ordered by age, size and sector.

The proposed method was developed by Pena (1977), based on the concept of distance defined by Ivanovic (1974). It is adjusted by modifying the weighting system of the variables. Specifically, the coefficient of determination replaces the correlation coefficient, acting as a correction factor (Ribeiro-Navarrete et al., 2021). This modification offers some major advantages over other alternatives for the creation of synthetic indicators, such as principal component analysis (PCA) and data envelopment analysis (DEA). For example, the DP2 method avoids arbitrary assignment of weights to indicators or variables. It also eliminates redundant information provided by simple indicators when added to the synthetic indicator. Finally, it avoids problems associated with aggregating information from variables expressed in different units of measurement (Somarriba & Pena, 2009). This method satisfies all the desirable mathematical properties for a synthetic indicator (Pena, 2009). Further details can be consulted in Guaita et al. (2019), Martín et al. (2019), De Castro et al. (2020) and Rodríguez et al., (2016, 2018).

In this case, the DP2 method was used to establish differences in the digitalisation of groups of companies of different sizes, sectors or ages. Under this system, these differences can be analysed using deviation to the minimum. This procedure is based on the comparison of each group of companies with a fictitious reference group with a minimum score on all indicators or dimensions (Ribeiro-Navarrete et al., 2021). In this case, the value of the indicator would be zero. The use of the standard deviation resolves the problem of working with data in different units. Using this procedure, variables are converted into abstract units (Somarriba & Zarzosa, 2016). However, in this particular case, all variables expressed the same thing, namely a score on a Likert scale measuring the implementation of digital tools. Following the method proposed by Pena (1977), the synthetic DP2 indicator for the j^{th} group of companies is calculated as follows:

$$DP_2 = \sum_{i=1}^{n} \frac{d_{ij}}{\sigma_i} \quad \left(1 - R^2_{i,i-1,\ldots,1}\right) con \quad i = 1, \ldots, n; j = 1, 2, \ldots, m$$

Here, X_{ij} is the value of the ith dimension for the jth group; $d_{ij} = |x_{ij} - x_{i*}|$ is the difference between the value of the indicator of the ith dimension for the jth group and the minimum score for the ith dimension across all groups; n is the number of partial indicators or dimensions used; σ_i is the standard deviation of the ith partial indicator; and $R^2_{i,i-1.i-2,\ldots1}$ is the coefficient of determination of the partial indicator x_i on $x_{i\text{-}1}$, $x_{i\text{-}2}$,., x_1, which have already been included, such that $R^2_1 = 0$.

The coefficient of determination $R^2_{i,i-1.i-2,\ldots1}$ is used to measure the proportion of the total variance of the variable x_i explained by the linear regression with respect to dimensions $x_{i\text{-}1}$, $x_{i\text{-}2}$,., x_1, which have previously been included in the synthetic indicator. Pena (1977) proposed the correction factor $(1 - R^2_{i,i-1.i-2,\ldots1})$, which eliminates duplicate information already provided by other partial indicators. This duplication of information occurs as a result of the correlation between variables (Zermeño et al., 2020). This process ensures that only new information to that previously provided by other indicators is included in the DP2 indicator (Somarriba et al., 2015). The assignment of weights to the partial variables is objective, using the correction factors as a reference (Ribeiro-Navarrete et al., 2021). The DP2 calculation method is based on an iterative process where the partial indicators are included in order depending on the amount of information they provide. The absolute correlation coefficient of each simple variable is taken as a reference. It is ordered from highest to lowest correlation, which creates a series of iterations until the values of the synthetic indicator converge, as described in detail by Zarzosa (1996, 2005).

4.3. Amount of relative information contributed to the DP2 indicator by each partial dimension and discriminatory power of each dimension

The method to construct the DP2 indicator also enables identification of the variables (aggregate dimensions of variables) that provide the most relative information to the synthetic indicator. It is thus possible to determine which dimensions are most relevant in explaining the variability of the synthetic indicator. To determine the amount of partial information provided by each dimension, the discriminatory power must first be calculated. The discrimination coefficient defined by Ivanovic (1974) is used for this purpose. This coefficient makes it possible to estimate the degree of inequality in the distribution of the values taken by each simple indicator (dimensions) across the groups of companies. It is defined as follows:

$$DC = \frac{2}{m(m-1)} \quad \sum_{j,l>j}^{k_i} m_{ji} m_{li} \left| \frac{x_{ji} - x_{li}}{\overline{X}_i} \right|$$

Here, m is the number of groups of companies in the set P; x_{ji} is the value of the simple indicator X_i for group j; x_{li} is the minimum value taken by the simple indicator X_i for group l; m_{ji} is the number of company groups where the value of X_i is x_{ji}; $\overline{X}_i$ is the average value of X_i; and k_i is the number of different values that X_i takes in the set P.

The Ivanovic-Pena global information coefficient can be estimated by combining the discrimination coefficient defined by Ivanovic (1974) and the correction factor proposed by Pena (1977). This coefficient can be used to calculate the amount of overall information that the indicators or partial dimensions contribute to the synthetic DP2 indicator. The coefficient is calculated as follows:

$$CIP = \sum_{i=1}^{n} DC(1 - R^2_{i,i-1,i-2,\ldots1})$$

Here, n is the total number of partial indicators, $(1\text{-}R^2_{i,i-1,i-2,..1})$ is the Pena correction factor and DC_i is the Ivanovic discrimination coefficient. Finally, following the indications of Zarzosa (1996), the relative individual information coefficient is defined as follows:

$$\alpha_i = \frac{DC_i(1 - R^2_{i,i-1,i-2,\ldots1})}{CIP}$$

This coefficient measures the relative importance of each partial indicator with respect to the synthetic DP2 indicator. It does so by assessing the amount of useful information provided by each subvariable, as well as the discriminatory power. This coefficient takes values between 0 and 1. It gives an intuitive explanation of differences between groups of companies in relation to the aim of creating a digital maturity ranking.

5. Results

Using the method described in the previous section, a synthetic indicator of digital maturity was constructed. Tables 2–4 show the partial indicators or dimensions that provided the information for the indicator. Each dimension has a score, which is derived from the self-assessment of company managers on the state of the digitalisation process. This score is the average of the scores for the questionnaire items associated with that dimension. Accordingly, each dimension is built from a set of questions on the adoption of a specific element of the digitalisation process. These questionnaire items are listed in Appendix A. These items can be consulted to see exactly what information is included in each

Table 2
Partial indicators by groups of companies grouped by sector.

	Digital skills and technology application	Digital management intensity	Digital business process	Digital innovation performance	Environmental performance	Digital management and departmental agility	Digital vision	Digital orientation
Accommodation	2.2917	4.4000	4.0000	4.5714	7.0000	4.0909	2.8000	4.1429
Wholesale	1.8333	2.9000	2.5000	2.8571	3.5000	1.1818	3.8000	1.0000
Retail	4.5000	4.8000	4.2500	1.4286	7.0000	4.1818	4.4000	4.2857
Communications	6.4583	6.9000	6.2500	4.7143	7.0000	6.1818	6.8000	6.8571
Construction and remodelling	3.6667	3.8000	4.5000	1.7143	5.7500	4.5455	4.2000	4.4286
Education	3.2478	4.5579	4.2500	3.2256	5.3026	4.1053	4.5263	4.1504
Energy	3.7745	4.8118	4.4559	3.1933	6.0588	4.3797	5.0235	4.4034
Financial services	3.5265	4.5909	4.2727	3.2208	6.1591	4.3306	4.9636	4.5325
Food production	3.6250	4.2000	4.0000	3.2857	5.0000	3.5455	3.6000	2.7143
Manufacturing	2.8750	4.6000	6.0000	5.0000	5.0000	5.0000	5.0000	5.0000
Clothing and footwear	2.7083	4.0000	4.0000	4.0000	3.2500	4.0909	4.0000	4.0000
Insurance	3.7917	4.0000	5.0000	2.0000	5.0000	4.0000	4.0000	4.0000
Business services	3.5000	5.0600	4.2500	3.3429	5.0000	4.2364	4.6400	4.5429
Engineering and architecture services	2.7083	6.0000	4.7500	3.5714	7.0000	5.9091	4.2000	6.0000
Health and social services	1.0000	1.0000	1.0000	1.0000	4.7500	1.0000	1.6000	1.0000
Technology	3.4167	5.2000	2.5000	1.0000	6.0000	4.0909	5.4000	6.1429
Transport	3.6228	4.7737	4.3289	3.3233	5.8158	4.1435	4.6842	4.1654

Table 3
Partial indicators by groups of companies grouped by size (number of employees).

	Digital skills and technology application	Digital management intensity	Digital business process	Digital innovation performance	Environmental performance	Digital management and departmental agility	Digital vision	Digital orientation
1–3	3.4321	4.7889	4.3796	3.3122	5.5648	4.2054	4.6593	4.2804
4–7	3.4500	4.7600	4.3600	3.4057	5.5700	4.2327	4.6160	4.3200
8–15	3.7292	4.5333	4.2500	3.0000	5.5417	3.9242	4.6333	3.8571
16–25	3.4148	4.6773	4.3750	3.4221	5.6136	4.1570	4.6364	4.1818
26–40	3.4625	4.4500	4.1000	3.1714	6.1500	4.2909	4.8600	4.4429
41–60	2.0000	4.2000	1.7500	3.7143	3.0000	2.3636	1.0000	1.0000
61–90	2.2500	5.0000	4.7500	3.1429	3.7500	3.5455	4.8000	4.5714
91–100	1.7500	3.7000	3.2500	2.2857	5.0000	3.6364	4.0000	4.0000
> 100	2.7083	6.0000	4.7500	3.5714	7.0000	5.9091	4.2000	6.0000

Table 4
Partial indicators by groups of companies grouped by company age.

	Digital skills and technology application	Digital management intensity	Digital business process	Digital innovation performance	Environmental performance	Digital management and departmental agility	Digital vision	Digital orientation
1–3 years	3.2337	4.6783	4.2609	3.3354	5.5326	4.2292	4.4870	4.3043
4–5 years	3.1042	4.7375	4.2188	3.2946	5.0625	4.0909	4.4125	4.1964
6–10 years	3.7396	4.7250	4.3125	2.8929	5.5000	4.2500	4.7000	4.0714
11–15 years	2.8565	4.6333	4.3333	3.6190	4.4722	3.8788	3.9556	3.9683
16–25 years	3.4691	4.7519	4.3241	3.3757	5.5093	4.1717	4.6370	4.2540
26–40 years	3.3986	4.6217	4.2717	3.3727	5.5000	4.0949	4.5304	4.1056
41–50 years	3.6667	4.6091	4.2955	3.2727	6.2045	4.0496	4.7818	4.0909
51–70 years	4.1667	6.0000	6.0000	3.7143	6.2500	4.7273	6.0000	5.4286
71–90 years	3.8750	5.8000	6.5000	3.0000	7.0000	6.0000	6.0000	5.7143
91–100 years	4.5556	5.2000	5.2500	3.3810	6.5833	5.2424	5.2000	5.2381
> 100 years	4.5000	6.3000	5.5000	4.0000	7.0000	4.7273	6.0000	5.4286

dimension.

Table 2 groups the surveyed companies by sector. For each sector, the value of each partial indicator is given. For example, the accommodation, engineering and architecture, retail, and communications sectors had high scores in the environmental performance dimension of digitalisation. Digitalisation processes related to the company's digital vision and digital management intensity were also well developed in the communications sector.

Table 3 groups companies by size (number of employees). Groups of companies of the same size were defined. The average score from the self-reported responses for the companies in each group was then calculated for each dimension. Large companies had high values for digitalisation processes in environmental performance. These companies also had high values for the implementation of digitalisation in the dimensions of digital management intensity and digital management and departmental agility. In general, the digitalisation of environmental processes was also well developed in small companies.

The last grouping of companies was by age. Each group consisted of companies of a similar age. For each group, an average value was also calculated to reflect the level of digitalisation in each dimension. Environment-related digitalisation was more well developed in older companies. Similar trends were observed for the scores for the dimensions of digital vision and digital management intensity.

Tables 5–7 show the absolute correlation coefficients for the three groups of companies. These coefficients show the order with which each dimension was included in the indicator construction process. The correction factors express the amount of new, non-redundant information that each of the partial indicators contributed when included in the synthetic indicator construction process. When sector was used to group the companies, the first variable included in the indicator construction process was digital management intensity. In the ranking based on company size, the first variable was digital management and departmental agility. In the ranking based on company age, the first variable was digital orientation. Because the first variable took a value of 1 in all three cases, 100% of the information provided by this variable (partial indicator) was included in the synthetic DP2 indicator of digital maturity. In the case of sector, the other partial indicators that provided the most information were environmental performance (38.3%) and digital innovation performance (30.3%). In the case of size, these partial indicators were digital orientation (18.6%) and the digital business process (16.5%). In the case of age, these partial indicators were digital skills and technology application (16.4%) and digital vision (12.0%).

The proposed method shows which indicators explain most of the difference between groups of companies in the ranking of digital maturity. The relative individual information coefficient (Zarzosa, 1996) was used for this purpose. To estimate this coefficient, the useful information provided by each partial indicator (reflected by the correction factors) and its discriminatory power (reflected by the Ivanovic discrimination coefficient) were combined. This information is presented in Tables 5–7. In the first case, the companies were grouped by sector. One partial indicator, digital management intensity, had a

Table 5
Structure of synthetic indicator and relative importance of partial indicators for grouping based on sector.

	Absolute correlation coefficient	Correction factor	Ivanovic discrimination coefficient	Relative individual information coefficient
Digital management intensity	0.977606	1	0.02306	34.6%
Digital management and departmental agility	0.934475	0.19230	0.02310	6.7%
Digital orientation	0.901305	0.11176	0.02994	5.0%
Digital business process	0.822776	0.16646	0.02394	6.0%
Digital vision	0.817832	0.16948	0.02322	5.9%
Digital skills and technology application	0.805101	0.28425	0.02939	12.5%
Environmental performance	0.663993	0.38370	0.02037	11.7%
Digital innovation performance	0.520854	0.30360	0.03840	17.5%

Table 6
Structure of synthetic indicator and relative importance of partial indicators for grouping based on company size.

	Absolute correlation coefficient	Correction factor	Ivanovic discrimination coefficient	Relative individual information coefficient
Digital management and departmental agility	0.993868	1	0.11741	71.7%
Digital orientation	0.928492	0.18673	0.11928	13.6%
Environmental performance	0.912387	0.14581	0.08479	7.5%
Digital business process	0.815080	0.16483	0.04878	4.9%
Digital management intensity	0.764439	0.01659	0.07168	0.7%
Digital vision	0.677973	0.00083	0.04417	0.0%
Digital skills and technology application	0.458598	0.00335	0.06051	0.1%
Digital innovation performance	0.106119	0.07464	0.03103	1.4%

Table 7
Structure of synthetic indicator and relative importance of partial indicators for grouping based on company age.

	Absolute correlation coefficient	Correction factor	Ivanovic discrimination coefficient	Relative individual information coefficient
Digital orientation	0.994502	1	0.03796	59.8%
Digital vision	0.961137	0.12076	0.04174	7.9%
Digital business process	0.949509	0.07408	0.03904	4.6%
Digital management intensity	0.936481	0.09874	0.04759	7.4%
Environmental performance	0.885703	0.07793	0.03886	4.8%
Digital management and departmental agility	0.869825	0.05100	0.02542	2.0%
Digital skills and technology application	0.836120	0.16488	0.04545	11.8%
Digital innovation performance	0.290254	0.02986	0.03636	1.7%

relative individual contribution of 34.6%. The next most important partial indicator was digital innovation performance (17.5%). These partial indicators explain differences in the degree of digital maturity to the greatest extent. In the second grouping, companies were grouped according to size. Two partial indicators (digital management and departmental agility and digital orientation) together explain 85.3% of differences. These dimensions explain most of the differences between groups in terms of digital maturity. Finally, in the third ranking, companies were grouped by their age. Digital orientation explains almost 60% of total differences, followed by digital skills and application of technology (11.8%).

Finally, the values of the DP2 digital maturity ranking are given for each of the three company groupings. Table 8 shows that when sector was used to group companies, the most digitalised sector was communications, followed by engineering and architecture services and manufacturing. The lowest positions in the ranking were the sectors clothing and footwear, wholesale, and health and social services.

When company size was used to group companies (Table 9), the companies with the greatest digital maturity were those with more than 100 employees. The third and fourth positions were occupied by micro-enterprises. Finally, when company age was used to group companies (Table 9), those with the most advanced digital maturity were the oldest, particularly those founded more than 50 years ago.

6. Discussion

Conceptualising digitalisation is a complicated task (Fitzgerald et al., 2014). In addition to the absence of a widely accepted definition, there is also no system for measuring the digital orientation of companies (Lee et al., 2020). This study enriches the academic literature by proposing a framework of analysis in which several representative indicators of the digitalisation process are combined into a single synthetic indicator. In addition to providing this analytical framework, this study focuses on the process of adopting digital solutions as a whole, rather than centring on a specific aspect. This approach contrasts with that of most studies to date on the degree of implementation of specific tools (Lee et al., 2020). A related issue is the limited availability of proposals of scales for measuring digital maturity (Azhari et al., 2014). Ideally, proposals for measuring digital maturity would provide not only an effective scale but also guidance on how to enhance the process (Leipzig et al., 2017). Through the analysis of discriminatory factors, the present study makes just such a contribution.

Studies have examined the implementation of digital tools by firms, showing a number of factors that affect digitalisation processes. These factors can be classified into three groups: firm characteristics (including size and type of business), experience, and privacy and security (Ndayizigamiye & Khoase, 2018). Other factors that have been shown to influence digitalisation include the lack of a technology roadmap and an ecosystem for digital transformation, the lack of information exchange programmes, the need for legislation in response to digital transformation, and the consolidation of a reliable environment (Dholakia & Kshetri, 2004). The results presented in this study add to the evidence of the role of these factors. For example, the study shows that the factors that lead to the greatest differences between companies in terms of their degree of digitalisation are digital management intensity, digital innovation performance, digital management and departmental agility, digital orientation, and digital skills and technology application. The creation of formalised strategies can drive digitalisation, a process that requires constant innovation (Forliano et al., 2023; Pesch et al., 2021).

Table 8
Synthetic indicator of digital maturity based on company sector.

Sector	DP2
Communications	11.261
Engineering and architecture services	8.562
Manufacturing	7.202
Energy	7.163
Retail	7.049
Financial services	6.928
Transport	6.917
Business services	6.869
Technology	6.692
Accommodation	6.650
Education	6.399
Food production	5.736
Construction and remodelling	5.722
Insurance	5.653
Clothing and footwear	5.156
Wholesale	2.918
Health and social services	0.521

Table 9
Synthetic indicator of digital maturity based on company size and on company age.

Size (number of employees)	DP2	Age since founded (years)	DP2
> 100 (large enterprise)	6.196	71–90 years	4.2411
26–40 (small enterprise)	3.764	> 100 years	3.9761
4–7 (micro-enterprise)	3.705	51–70 years	3.7643
1–3 (micro-enterprise)	3.654	91–100 years	3.2924
16–25 (small enterprise)	3.607	16–25 years	0.9668
8–15 (small enterprise)	3.176	1–3 years	0.93
61–90 (medium-sized enterprise)	2.746	41–50 years	0.8251
91–100 (medium-sized enterprise)	2.445	6–10 years	0.7305
41–60 (medium-sized enterprise)	0.287	26–40 years	0.6619
		4–5 years	0.6511
		11–15 years	0.0883

The answer to RQ1 is given below, the differences between sectors are notable. There is a link between the level of digitalisation and sectors where technology can offer a greater competitive advantage or is a basic productive resource. Examples of such sectors are communications, engineering and architecture, and manufacturing. This study shows that environmental digitalisation is one of the most developed areas within firms. This finding is consistent with those of previous studies that have shown the positive direct effects of digital and environmental transformation on innovation performance (Claudy et al., 2016; Dibrell et al., 2015; Nambisan et al., 2020). This link between digitalisation and green transformation in business has been extensively analysed in the academic literature, thus highlighting the relevance and interest around this relationship (Capelle-Blancard & Petit, 2017). The economics literature documents synergies between actions in companies focused on sustainability, innovation, digitalisation and economic growth, even when the main findings are verified at the macro level (Broccardo et al., 2023; Holzmann & Gregori, 2023; Pérez-Martínez et al., 2023). Implementing improvements in sustainability clashes with the different interpretations of the process. Some consider that sustainability is incompatible with a model of continuous endless growth. In many cases, degrowth is considered the most sensible option. Others argue that growth is compatible with sustainability if appropriate measures are taken. This second view is aligned with soft sustainability, where there are fewer constraints and a confident belief that technology can limit the impacts of potentially harmful activities. In contrast, the hard approach is more conservationist, with an irreplaceable feature being the maintenance of natural capital. Recent policies linking sustainability and digitalisation in the European Union are framed within a soft sustainability approach (Martín, 2023).

The academic literature offers conflicting views on the effect of firm size on the digitalisation process. Quantitative studies of the degree of digitalisation of SMEs are scarce, even though the specific features of these companies mean that analysis is needed to detect the factors that affect their digitalisation processes (Gilman & Edwards, 2008). Traditionally, large companies are described as being better equipped for digital and environmental transformation given their greater availability of resources (Roy et al., 2001; Westerman & McAfee, 2012). The

results of this study add to the level of disagreement in this regard. High rates of digitalisation are observed in both large firms and micro-enterprises. Therefore, RQ2 can be answered affirmatively, albeit partially, because the level of digitalisation in micro-enterprises is also high. By contrast, RQ3 cannot be answered affirmatively. Newly established companies are not the most digitalised. Instead, the oldest are the most digitalised. The reason for these high rates of digitalisation in large and older firms is perhaps the greater availability of resources and greater consolidation of the business.

6.1. Theoretical contributions and implications

The results strengthen the existing theoretical foundations. They confirm postulates found in the academic literature on this topic. The largest companies are the most digitalised. This finding is consistent with the importance of their greater availability of resources. However, micro-enterprises are also found to have a high level of digitalisation (Scuotto et al., 2021), possibly because their small structure makes digitalisation easier. In the academic literature, differences have been found in the way in which digitalisation is managed or implemented depending on the size of the company (Zoppelletto et al., 2023). Likewise, the results confirm that the oldest companies are the most digitalised. This finding may be related to their greater size or degree of consolidation. Therefore, this theoretical contribution has direct applications for the design of public policies to promote digitalisation because it reveals what types of companies are the least digitalised. Likewise, the sectors where companies are most digitalised are also identified by the results. Companies with the highest degree of digitalisation are those in the communications, engineering and architecture services, manufacturing, energy, retail, and financial services sectors. The digitalisation ranking is also useful to indicate which sectors have the lowest degree of digitalisation. This insight can improve the existing understanding of digitalisation processes and the factors that hinder them. It can also help in the design of effective public policies to promote digitalisation.

6.2. Practical implications

Most studies of digital transformation have addressed the concept of digitalisation from a technical perspective (Lyytinen et al., 2016). Few have adopted a managerial perspective applied to strategy development, even though digitalisation has not only technological but also strategic benefits for companies (Kane et al., 2015). The present study makes an interesting practical contribution by revealing the business areas where digitalisation is least well developed. The results highlight the low level of digitalisation in areas related to digital skills and technology application and digital innovation performance.

From the point of view of practical implications, one of the most relevant contributions of this study is to show which variables explain differences in the degree of digitalisation of different companies. In the case of differences between sectors, the key indicator is digital innovation performance. Therefore, digitalisation can be encouraged through strategies to promote innovation. Regarding the degree of digitalisation based on company size, the key factors are digital management and departmental agility and digital orientation. Seemingly, the differences between companies of different sizes can be explained by the determination of the company management to target digitalisation as a cross-cutting goal within the firm. Finally, with regard to differences in digitalisation based on company age, the key indicators are digital orientation, digital skills and application of technology. Once again, a digital orientation within the company is important, as is achieving an effective application of technology in business processes. The role of digital skills and social capital has been highlighted in the academic literature as a key factor in digitalisation processes (Švarc et al., 2021).

This study also offers a tool that can help in the design of public policies to promote digitalisation by identifying the sectors that lag furthest behind and that should therefore be prioritised. The proposed method offers an effective monitoring system in the sense that it synthesises a large amount of representative information on the overall digitalisation process. This feature can also be useful for public agencies, as well as trade associations. The results of the study also reveal the age and size profile of the least digitalised companies. This insight complements the results by sector. Together, these findings could be used to develop programmes that target the companies most in need of support. For example, digitalisation support programmes should target SMEs, start-ups and companies in less digitalised sectors. The results of this study are useful for more than just public policy planning. Companies can also use these results to guide their digitalisation processes and learn from companies that have already achieved high levels of digitalisation. As a reference, it is advisable to take the indicators that are most effective at explaining the differences in digitalisation between the different groups of companies studied in this research. These indicators can be useful to build truly effective digitalisation strategies. The results highlight the importance of technology in processes of sustainability improvement (George et al., 2021). This finding is aligned with the way of thinking known as techno-optimism. According to techno-optimism, the path to improving sustainability lies in the application of technology to industrial, consumer and mobility processes (Königs, 2022).

6.3. Limitations and future research directions

Ideally, this study would be complemented by future lines of research. These future lines of research should focus on applying the same analysis structure in other contexts. It would be of great interest and value to replicate this study in different countries. The main limitation of this study stems from its use of data on a single country. Therefore, broadening the research focus by comparing data from different countries is recommended. Specifically, it is important to use a set of representative data from companies located in countries with different levels of economic and technological development. The results of such studies could show whether the findings presented in the current paper can be extrapolated or whether they are affected by environmental factors. The role of the environment is fundamental in digital transformation processes (Davison et al., 2023). Likewise, this research should be supplemented with complementary qualitative research. Such studies should focus on establishing the underlying factors that limit or delay digitalisation processes. It would also be of interest to link the findings to public programmes aimed at promoting digitalisation because the public sector plays a key role in driving these processes (Skare et al., 2023). This proposal highlights the main limitation of the present study. The set of surveyed companies must be broadened to ensure more robust results.

7. Conclusions

This study makes several novel contributions to the academic literature. First, it provides support for the idea that the degree of digital maturity of companies should be measured comprehensively using a set of indicators that correspond to each of the areas where digitalisation can take place. The results of the study show that the variables that provide the most information for the construction of the synthetic indicator relate to digital management intensity, digital management and departmental agility, and digital orientation. Differences between companies and sectors can be explained in terms of degree of digitalisation in digital management intensity, digital management and departmental agility, and digital orientation. The most digitally mature companies are the largest and the oldest (i.e. the most well established). The most digitalised sectors are communications, engineering and architecture, and manufacturing. The least digitalised sectors are clothing and footwear, wholesale, and health and social services.

CRediT authorship contribution statement

Belén Ribeiro-Navarrete: Conceptualization, Data curation, Funding acquisition, Investigation, Resources, Validation, Writing – original draft, Writing – review & editing. **Jose María Martín Martín:** Conceptualization, Investigation, Project administration, Visualization, Writing – original draft. **José Manuel Guaita-Martínez:** Formal analysis, Investigation, Methodology, Software, Supervision, Writing – original draft, Writing – review & editing. **Virginia Simón-Moya:** Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Project administration, Supervision, Validation, Writing – review & editing.

Declaration of Competing Interest

None.

Appendix A. Questionnaire

Digital skills and application of technology (Ulas, 2019; Venkatraman, 1994)

1. Please indicate your level of agreement with each of the following sentences regarding the cooperative's digital skills and application of technology, using a scale ranging from 1 (*completely disagree*) to 7 (*completely agree*).
    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 cooperative 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 visualisation 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).

Digital management intensity (He et al., 2023; Westerman & McAfee, 2012)

2. Please indicate your level of agreement with each of the following sentences regarding the cooperative's digital management intensity, using a scale ranging from 1 (*completely disagree*) to 7 (*completely agree*).
    2.1. Senior managers take a transformative approach to the cooperative'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 cooperative.
    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. The cooperative promotes the cultural changes that are needed for digital transformation.
    2.8. The cooperative 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.

Digital business process (Nasiri et al., 2020; He et al., 2023; Westerman & McAfee, 2012)

3. Please indicate your level of agreement with each of the following sentences regarding the cooperative's digital business process, using a scale ranging from 1 (*completely disagree*) to 7 (*completely agree*).
    3.1. We have digital solutions that connect core business activities with customers, suppliers, employees and cooperative 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.

Digital innovation performance (He et al., 2023; Liang & Frösén, 2020; Tippins & Sohi, 2003; Vickery et al., 2003)

4. Please indicate your level of agreement with each of the following sentences regarding the cooperative's digital innovation performance, using a scale ranging from 1 (*completely disagree*) to 7 (*completely agree*).
    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.

Environmental performance (Ardito et al., 2021)

5. Please indicate your level of agreement with each of the following sentences regarding the cooperative's environmental performance, using a scale ranging from 1 (*completely disagree*) to 7 (*completely agree*).
   5.1. Our cooperative reduces the emission of waste (air, water and/or solids).
   5.2. Our cooperative reduces the consumption of hazardous and toxic materials.
   5.3. Our cooperative reduces the frequency of environmental accidents.
   5.4. Our cooperative reduces energy consumption.

Digital management and departmental agility (Li et al., 2021)

6. Please indicate your level of agreement with each of the following sentences regarding the cooperative's digital management agility, using a scale ranging from 1 (*completely disagree*) to 7 (*completely agree*).
   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.

Digital vision (Li et al., 2021)

7. Please indicate your level of agreement with each of the following sentences regarding the cooperative's digitalisation vision, using a scale ranging from 1 (*completely disagree*) to 7 (*completely agree*).
   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.

Digital orientation (Nasiri et al., 2020)

8. Please indicate your level of agreement with each of the following sentences regarding the cooperative's digital orientation, using a scale ranging from 1 (*completely disagree*) to 7 (*completely agree*).
   8.1. We develop a clear vision of how new digital technologies (social media, mobile devices, analytics, cloud computing) help the cooperative 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.

Information used to group companies

9. Company name
10. Company age (in years)
11. Company sector
12. Company size (number of employees)

Appendix B. Supplementary material

Supplementary data associated with this article can be found in the online version at doi:10.1016/j.ijinfomgt.2023.102678.

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