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What Are the Key Determinants of Digital Transformation? Empirical Evidence from Spanish Food Units (Mercas) Network*

¿Cuáles son los Factores Determinantes de la Transformación Digital? Evidencia Empírica de la Red de Unidades Alimentarias Españolas (Mercas)

1. INTRODUCTION

In Spain, the public sector company Mercasa plays an essential role in the distribution of fresh products through its network of food units (named Mercas). These Mercas manage the spaces and services in which farmers, wholesale and retail commercial companies, and restaurants, can carry out commercial transactions of fruits and vegetables, meat, fish, and flowers (Poveda-Larrosa and Sogorb-Mira, 2022). Our research delves into the digital transformation of Mercas for three compelling reasons. Firstly, given the significant impact of Mercas' business on the Spanish economy, exploring their digital transformation is pertinent and intriguing. Secondly, we are analyzing a group of 24 companies that engage in similar business activities and share a comparable shareholder composition[1], which helps to eliminate sampling bias and provide more accurate insights into the key drivers of digital transformation. Lastly, as public sector companies, we are interested in discovering any differences between our findings and those of studies conducted on private companies.

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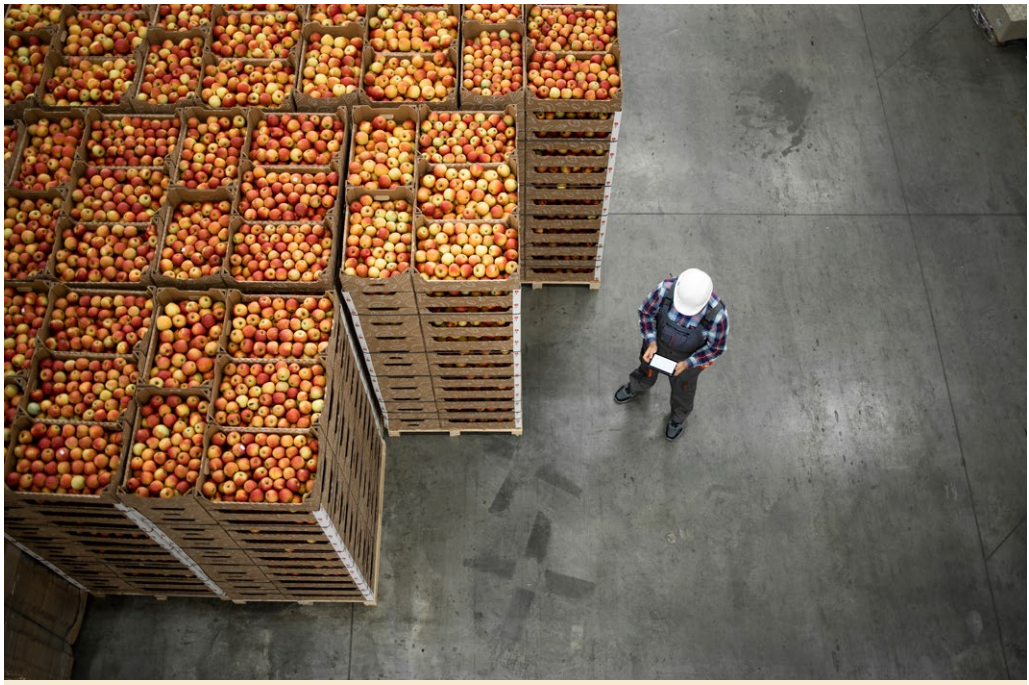

EXECUTIVE SUMMARY

The objective of this study is to examine the digital transformation of the complete population of 24 Spanish food units, named Mercas. We develop an index that gauges the degree of digital transformation of these public sector companies. Using a Tobit panel data model, we identify the main determinants of the Mercas' digital transformation status. Our findings suggest that the size of the Merca, the proficiency of digital technologies by top management, the cooperation between the millennial generation staff and the remaining staff, the business management of buying and selling flowers, fruit and vegetables, and meat, and the utilization of B2B platforms for transactions and information exchange with wholesalers are some of the key determinants of digital transformation. The study also emphasizes the significance of customer demand for the implementation of new technologies as an external factor that influences digital transformation.

RESUMEN DEL ARTÍCULO

Este estudio tiene por objeto examinar la transformación digital de la población completa de 24 unidades alimentarias españolas, denominadas Mercas. Hemos desarrollado un índice que mide el grado de transformación digital de estas empresas del sector público y utilizando un modelo Tobit de datos de panel, identificamos los principales determinantes de la transformación digital de las Mercas. Nuestros hallazgos sugieren que el tamaño de la Merca, el conocimiento de las tecnologías digitales por parte de la alta dirección, la cooperación entre el personal de la generación millennial y el resto del personal, la actividad empresarial de la compraventa de flores, frutas y verduras, y carne, y la utilización de plataformas B2B para transacciones e intercambio de información con mayoristas, son algunos de los determinantes clave de la transformación digital. El estudio también destaca la importancia de la demanda de los clientes para la implantación de nuevas tecnologías como factor externo que influye en el grado de la transformación digital de las Mercas.

The Mercas network is made up of 24 food units which covers all the Spanish territory, namely Badajoz, Barcelona, Basauri (Vizcaya), Córdoba, Santiago de Compostela (La Coruña), Granada, Pamplona (Navarra), Jerez de La Frontera (Cádiz), Las Palmas de Gran Canaria (Las Palmas), León, Algeciras (Cádiz), Alicante, Madrid, Málaga, El Palmar (Murcia), Palma de Mallorca (Baleares), Salamanca, Santander (Cantabria), Sevilla, Llanera (Asturias), Santa Cruz de Tenerife, Valencia, Zaragoza, and Valladolid. At the Merca network's facilities, more than 3,650 wholesale and service companies operate, selling more than 8 million tons of fresh food, fruit, vegetables, fish, seafood, and meat annually. The said sales figure amounts to nearly half of all the consumption of these products in Spain, with a value of more than 16,200 million euros (approximately 1.4% of Spain's GDP). Regarding market share of total demand, the volumes traded in the 24 food units reached 65% of the total fruit and vegetables consumed in Spain, 55% of fish and seafood, and 45% of meat (Mercasa, 2022). The territorial distribution of these food units and the commercial efficiency of the wholesale companies that operate in their facilities are critical to Spain standing out in the European environment for greater decentralisation in terms of the fresh food market. This network of Mercas has also made Spain the leading country in the world in terms of variety in the consumption of fishery and aquaculture products, as well as fruit, vegetables, and meat (Mercasa, 2022).

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The aim of this study is to offer extensive insights into the factors that push Mercas to embark on the path of digital transformation. To achieve our research goal, we established a framework of dimensions and variables to gauge the progress of digital transformation. We then devised a synthetic index and assessed its magnitude for each Merca. Lastly, leveraging firm-level accounting ratios and a questionnaire that delved into the relevant variables, we conducted a panel data Tobit regression analysis to effectively accomplish our research objective.

The resulting empirical evidence suggests that several factors explain why the Mercas have different levels of digital transformation (DT, henceforth). We can highlight the following in order of economic significance: the size of each Merca, customer demand for each food unit to incorporate digital technologies, collaborative work

between Generation Y (or millennials) and the rest of the staff, the existence of a flower market and the knowledge of digital technologies by senior management. On the other hand, not providing digital platforms to interact with their clients (wholesalers), and the lack of competition with strong companies in their area of influence reduce the degree of DT of the Mercas.

The rest of the paper is organized as follows. Section 2 presents the theoretical framework of the study, Section 3 describes the data collection and empirical methodology, Section 4 presents and discusses our results, and Section 5 concludes.

KEYWORDS
Business Performance, Digital Transformation, Food Distribution, Mercas Network, Mercasa.

PALABRAS CLAVE
Desempeño Empresarial, Transformación Digital, Distribución de Alimentos, Red de Mercas, Mercasa.

2. BACKGROUND THEORY

The definition of DT is an area of focus that has been examined by both academic and business communities. To date, a range of definitions have been put forth, as illustrated in **Table 1**.

Table 1. **DT definitions.**

SOURCE/AUTHORS	MUESTRA COMPLETA
Stolterman and Fors (2004)	"*Digital transformation can be understood as the changes that digital technology causes or generates in all aspects of human life*" (p. 687).
Martin (2008)	"*Digital transformation is commonly interpreted as the use of ICTs (Information and Communication Technologies), where no trivial automation takes place and fundamentally new capabilities are created in business, government, people and social life*" (p. 151).
PricewaterhouseCoopers (2013)	DT describes the fundamental transformation of the business world through the implementation of new Internet-based technologies with a fundamental impact on society as a whole.
Fitzgerald, Kruschwitz, Bonnet, and Welch (2014); Hanelt, Piccinini, Gregory, Hildebrandt, and Kolbe (2015); Horlacher and Hess (2016)	DT is the use of new digital technologies (social media, mobile, data analytics or embedded devices) to enable significant business improvements, such as enhancing customer experience, streamlining operations or creating new business models.
Mazzone (2014)	"*Digital transformation is the deliberate and continuous digital evolution of a company, business model, idea process or methodology, both strategically and tactically*" (p. 9).

Biecheler, Leutiger, Colin, Saint-Aubyn and Figar (2016)	"*Digital transformation is the adaptation of the value chains of the different sectors of the economy to this disruptive effect that starts with the digital consumer. Digital transformation is the integral connection of the different areas of the economy and the way in which the players in each sector will adapt to the new conditions prevailing in the digital economy*" (p. 10).
Rowe (2017)	"*Digital transformation is the investment in people and technology to drive a business that is poised to grow, adapt, scale and change in the immediate future*" (p. 31)
Reis, Amorim, Melão, and Matos (2018)	DT can be defined as the use of new technologies that enable significant improvements in business and influence all aspects of consumer life.
Deloitte (2019)	"*Digital transformation is the use of technology to radically improve the performance or scope of an organisation. In a digitally transformed business, digital technologies enable improved processes, engaged talent and new business models*" (p. 3)
Cardona and Mochón (2021)	"*Digital transformation involves reinventing the way we derive value from information, improving connectivity, optimising business processes, redefining the customer experience and embracing the essence of change*" (p.4).
Gegenhuber, Logue, Hinings, and Barrett (2022)	DT is the combined effect of several digital innovations that give rise to new actors (and constellations of actors), structures, practices, values and beliefs that change, threaten, replace or complement existing rules of the game in organisations, ecosystems, industries or fields.

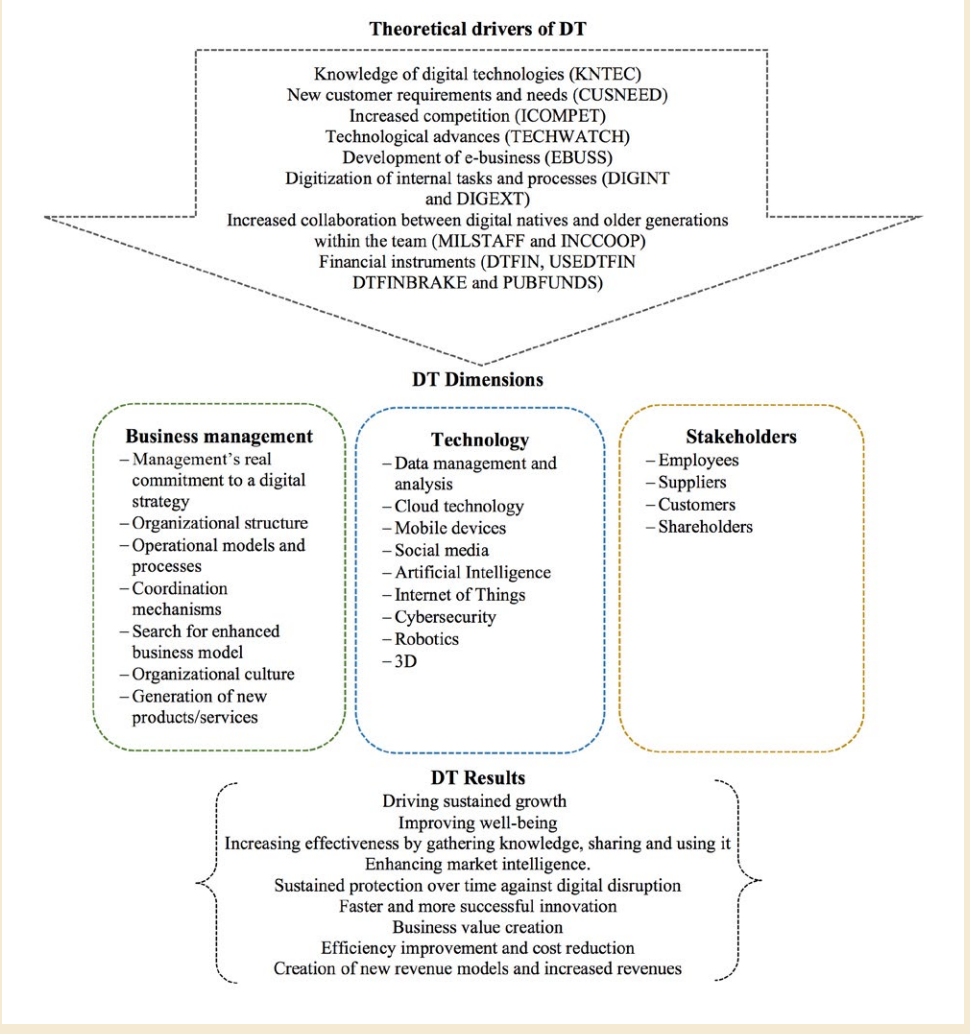
Source: Own elaboration

In the literature, there are two points of view regarding the definition of DT. The first view is contextual, as defined by Stolterman and Fors (2004), and focuses on the changes occurring in the environment where the company operates. The second view is organisational, as defined by Fitzgerald et al. (2014), and defines the phenomenon from the organisation's perspective. Both views, as along with the overall concept, can be understood better by arranging the elements of the definitions into drivers, dimensions, and outputs, as shown in **Figure 1**.

The model's variables have been compiled from multiple literature references and empirical and field studies conducted in the scope of DT. These include Laudon and Laudon (2022), Kraus et al. (2021), Verhoef et al. (2021), Verina and Titko (2019), Reis et al.(2018), Sebastian, Ross, Beath, Mocker and Fonstad (2017), Kane, Palmer, Phillips, Kiron and Buckley, (2015), and Westerman, Calméjane, Bonnet, Ferraris and McAfee (2011). Some of these papers focus

on the conceptual framework of DT and carry out a meta-search in the existing literature, as well as a semantic analysis of the contents found. Their aim is to break down the term DT into different elements, categories, dimensions, etc. Based on these, as well as on other theoretical and empirical research on DT, we have structured the model presented below.

Figure 1. **DT definitions.**



Source: Own elaboration based on the studies of the authors listed above.

This model summarises in a graphic and explanatory way what factors act as drivers that lead companies towards DT processes, what dimensions are necessary for this process to occur (business management, technologies, and people), and what outcomes could be obtained due to this transformation.
In the following, we will delve deeper into this model.

2.1. Drivers of DT

The list of triggers for the transition to DT can be divided into two types: external (exogenous) and internal (endogenous). The former includes new customer requirements and needs, increased competition, technological developments, and financial instruments[2]. Conversely, the latter comprises the development of electronic business (e-business), the digitization of tasks and processes[3] (for employees, suppliers, and customers), and increased cooperation between digital natives (or millennials) and older generations within the team. This means that companies with e-business in place or that have started to digitize processes and tasks have achieved results, and/or those with intergenerational teams are more likely to carry out their DT process (Verina and Titko, 2019).

2.2. Dimensions of DT

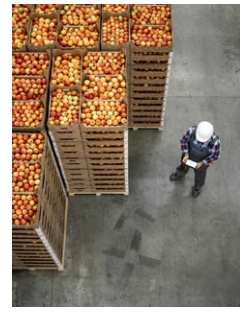
The dimensions discussed below, i.e., business management, technologies, and people, must concur and be aligned for a successful DT to occur. Business management must believe in and drive the DT and culture, technologies must be implemented, and people must use and benefit from them so that the process does not stop and the transformation finally takes place.

2.2.1. Business management

According to Kane et al. (2015), the strength of a digital strategy lies in its scope and objectives. Carr (2003) argues that unless a firm owns a technology, it will not provide a competitive advantage on its own. As in the case of electricity and rail transport, many technologies will be made available to all and thus offer no inherent advantage.
The trap to avoid is to focus on technology as an end. Technology should be a means to empower ends strategically. Indeed, DT is not

achieved by mastery of technologies but by the ability to articulate and link the value of digital technologies to an organisation's future. A clear digital strategy, supported by leaders who foster a culture of embracing change, is fundamental to an organisation's digital reinvention (Leceta, 2019).

While digital strategy is unique to each company, organisations that are mature in their DT process often share some common traits (Deloitte, 2019): they communicate a clear and coherent digital strategy that integrates with their overall corporate strategy; they know that technology alone will not make a difference: people must be inspired and prepared to use it to its full potential; they see the importance of a culture that is agile, collaborative, and open to calculated risk; above all, they know that talent, rather than technology, will take the organisation into the future.



2.2.2. Technologies

The technologies and technological elements currently related to the DT process are data management and analysis, cloud technology, mobile devices, social media, embedded devices, artificial intelligence, Internet of Things (IoT), and cybersecurity. The abovementioned list is backed by Sebastian et al. (2017), who cite these technologies with the acronym SMACIT[4], referring to social media, mobile, analytics, cloud and IoT. The authors also include artificial intelligence, blockchain, robotics and virtual reality in this concept. Likewise, the European Commission's analysis of the state of the EU's DT in 2018 (Probst et al., 2019) uses the following nine critical technologies as a basis: social media, mobile services, cloud technologies, internet of things, cybersecurity solutions, robotics and machine automation, big data and data analytics, 3D printing and artificial intelligence. A new technology appears in this list compared to the Sebastian et al.'s (2017) one, namely 3D printing. The European Commission has focused on three of these: cloud technologies or computing, big data and artificial intelligence, setting a quantitative target of 75% of European companies using these technologies by 2030. Artificial intelligence could boost global GDP by up to 14% more by 2030, the equivalent of an additional $15.7 trillion (Hwang and Kim, 2021).

2.2.3. Stakeholders

The successful implementation of technology can be a daunting

task, but the challenge of transforming culture and people can be even more daunting. Interestingly, the lack of achievement of the transformation objectives and benefits has remained constant at 60-70% since the 1970s (Welbourne, 2014). This suggests that an essential element is missing: the human dimension. It is worth noting that the human dimension includes not only employees but also customers, suppliers, shareholders, and other stakeholders. Therefore, when we speak of this dimension, we refer to all of them. After all, DT processes aim to have an impact both inside and outside the organisation, which means that all stakeholders are involved. The significance of this dimension is evident in the fact that companies operating in countries where a higher percentage of the population has above-average digital skills tend to implement advanced digital technologies more frequently (EIB, 2022).

2.3. DT results

DT has a positive impact on business performance. The conclusions of the study by Biecheler et al. (2016) on the state of DT in Spanish economic activity indicate that DT offers quantitative and qualitative benefits to companies. In the first case, the financial results of companies improve due to the increase in turnover and the optimisation of costs, which can be reduced by up to 20%. As far as the qualitative benefits are concerned, reference is mainly made to improving the level of employee welfare. Furthermore, these authors estimate that, on a macroeconomic level, DT could imply an increase of 120,000 million euros in GVA (i.e., Gross Value Added) in 2025 in the sectors analysed (half of the industrial sector believes in net job creation).

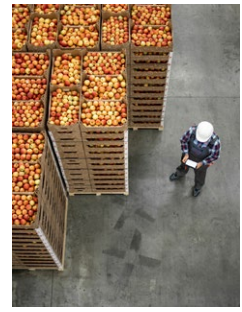
Companies with more advanced DT processes are more optimistic about their industry-specific business prospects and the general economic climate in the next 12 months (EIB, 2022). At the same time, they are less likely to expect the political and regulatory environment to deteriorate. This suggests that lower DT firms see themselves in a more challenging investment situation in the short term, leaving them with a less positive long-term outlook. There is also a risk that the digital divide has widened due to the pandemic (EIB, 2022).

Other potential outcomes generated by the DT of organisations could be generating greater effectiveness by gathering, sharing

and using knowledge, access to global markets, faster and more successful innovation, creation of new revenue models, opening new opportunities for follow-on investments, generating more significant competitive advantage, and increased customer interaction and collaboration. As listed in **Figure 1**.

3. DATA AND RESEARCH METHODOLOGY

The data used in this research come from two primary sources of information. The first one is the surveys conducted with the managers of the Mercas; one of the advantages of surveys is that they allow researchers to ask decision-makers directly how they make decisions (Graham, 2022). The second source is the annual accounts of these food units.



A synthetic index called Digital Transformation Mercas' Index (DTMI) has been developed to evaluate the degree of implementation of DT in the food units. The DTMI employs a range of indicators related to business management, including DT strategy and commitment, the implementation and use of digital technologies, training, communication, and stakeholder involvement. The index has been utilised to rank the 24 Mercas during the period of 2020-2021 and to assess the existence of statistically significant relationships between DT drivers, products traded, accounting variables, and DTMI. The values required to calculate DTMI were collected through surveys[5] completed by CEOs of the 24 food units, which took approximately 35 minutes. Managers demonstrated a keen interest in this research and responded within two weeks of the survey launched, indicating high consistency of responses. The survey consisted of 57 qualitative questions that responded to the dimensions of DT in the model developed. 46 of the questions were closed-ended (Yes/No), 6 were open-ended (descriptive), and 5 were multiple-choice questions related to the knowledge of technologies listed in the model, managers' beliefs in the contribution of these technologies to their business, their implementation and benefits of DT. To ensure reliable and objective results, the utmost consideration was given to simplicity, conciseness, uniqueness, and specificity when formulating the questions. The questions were designed to measure only one variable and to minimise misunderstandings, omissions, or different interpretations.

3.1. Construction ('s) details of the DT synthetic index

DTMI is the sum of all the variables corresponding to the three dimensions, equally weighted, multiplied by a dummy variable called YESDT that is equal to 1 if the Mercas claim to carry out a DT process and 0 otherwise.

$$DTMI_i = (\alpha\ BMD + \beta\ TECHD + \gamma\ STKD)\ YESDT \quad \textbf{[1]}$$

Where BMD is the business management dimension, TECHD is the technology dimension, STKD is the stakeholders dimension, and α, β, γ are their corresponding weights, each equal to 0.33; we give an equal-weighted value of 0.33 because these dimensions must not only converge but also be aligned for true DT to arise. Besides, BMD, TECHD, and STKD must be greater or equal to one.

Regarding the business management dimension, the specific variables that comprise it are the following (**Table A1 in the Appendix** provides details on the variables' definitions):

BMD = TECHIMPROV + NEEDDT + TOPINV + OVERSTRA + LEADT + CHANGORG IMPEFF + IMPCX + MODELIMP + COMDT + INVALL + CHANGCULT + NEWPS

The binary variables (i.e., NEEDDT, TOPINV, OVERSTRA, LEADT, CHANGORG, IMPEFF, IMPCX, MODELIMP, COMDT, INVALL, and NEWPS) add up to one in the case of a "yes" answer and zero in the case of a "no" answer. In the case of the variable TECHIMPROV, it can have a maximum value of 8 as it is calculated based on a multiple-choice question where each option (each digital technology) adds up to one point except for the option "none" which is given a value of zero. Finally, the open-ended question relating to the variable CHANGCULT can obtain a value in a range between zero and one, depending on the answer.

As far as the technology dimension is concerned, its corresponding variables are (**Table A2 in the Appendix** provides details on the variables' definitions):

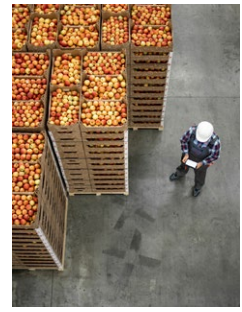
TECHD = SOFTDATA + CLOUDTECH + APPS + SMACTI + TECHDEPLOY + KMS

The binary variables (i.e., CLOUDTECH, APPS, SMACTI, and KMS) add up to one for an affirmative answer and zero for a negative answer. The multiple-choice variables dimension, such as SOFTDATA and TECHDEPLOY, are computed in the following way: Each option adds up to one point except for the option "none", which is given a value of zero.

Lastly, the stakeholder definition is set up by the following variables (**Table A3 in the Appendix** provides details on the variables' definitions):

$$STKD = CDO + DTEXP + DTECHEXP + NTRAIN + EMKNOW + COMEMP + SUPKNOW + SUPAFFECT + COMSUP + CUSTKNOW + CUSTAFFECT + COMCUST + SHARKNOW + COMSHARE$$

For this dimension, all variables are binary and add up to one for a "yes" answer and zero for a "no" answer.



3.2. Research Methodology

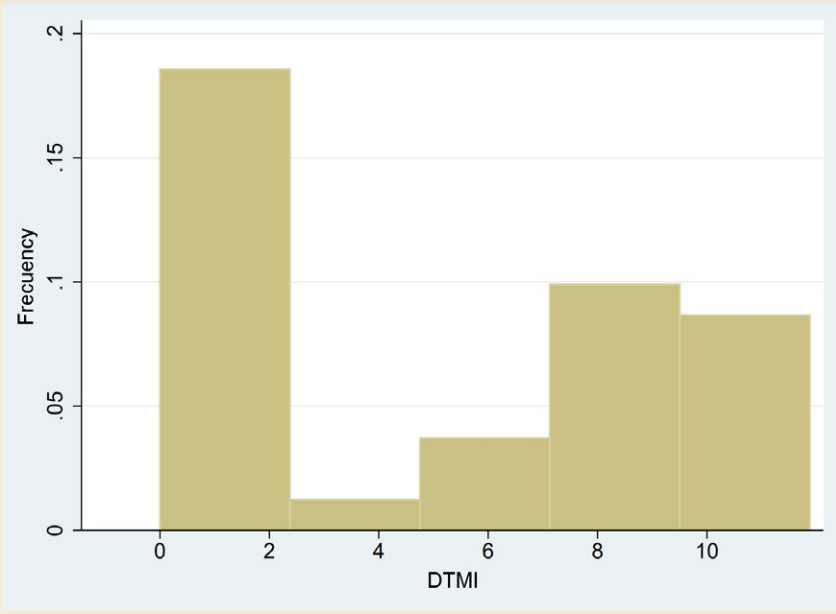
In this section, we describe our empirical approach. Specifically, we use panel data econometrics on a data panel with the food units in a DT process for 2020–2021. Our synthetic DT index is regressed on several explanatory variables with the following specification:

$$DTMI_{it} = \beta_0 + \beta_1 \cdot KNTEC_{it} + \beta_2 \cdot CUSNEED_{it} + \beta_3 \cdot ICOMPET_{it} + \beta_4 \cdot TECHWATCH_{it} + \beta_5 \cdot EBUSS_{it} + \beta_6 \cdot DIGINT_{it} + \beta_7 \cdot DIGEXT_{it} + \beta_8 \cdot MILSTAFF_{it} + \beta_9 \cdot INCCOOP_{it} + \beta_{10} \cdot DTFIN_{it} + \beta_{11} \cdot USEDTFIN_{it} + \beta_{12} \cdot DTFINBRAKE_{it} + \beta_{13} \cdot PUBFUNDS_{it} + \beta_{14} \cdot FISH_{it} + \beta_{15} \cdot FRUVEG_{it} + \beta_{16} \cdot MEAT_{it} + \beta_{17} \cdot FLOW_{it} + \beta_{18} \cdot SIZE_{it-1} + \beta_{19} \cdot SOFTW_{it-1} + \beta_{20} \cdot PROF_{it-1} + \beta_{21} \cdot AGE_{it-1} + \beta_{22} \cdot LEVER_{it-1} + \beta_{23} \cdot WORKCAP_{it-1} + \varepsilon_{it} \quad \textbf{[2]}$$

Where ε_{it} is the error term, and the explanatory variables could be categorised into three groups. The objective is to find out whether the DT status of the Mercas is influenced by (a) the so-called drivers of the model depicted in **Figure 1** (i.e., KNTEC, CUSNEED, ICOMPET, TECHWATCH, EBUSS, DIGINT, DIGEXT, MILSTAFF, INCCOOP, DTFIN, USEDTFIN, DTFINBRAKE, and PUBFUNDS; (b) the type of markets that are operating in each food unit (i.e., FISH, FRUTVEG, MEAT, and FLOW); and (c) the experience and company background, financial status, and business performance

of each food unit (i.e., SIZE, SOFTW, PROF, AGE, LEVER, and WORKCA). **Table A4 in the Appendix** summarises the definitions of all the variables included in our DT model specified by **Equation [2]**. **Figure 2** depicts the histogram of DTMI. As observed, we are dealing with a censored variable with a minimum value of 0 and a maximum of around 12. Therefore, following prior validated methodology (McDonald and Moffitt, 1980; Tobin, 1958), we use a panel data Tobit estimation approach for our empirical research.

Figure 2. **DTMI Histogram**



Frequency distribution of the DT Merca's Index with the rectangular bars representing frequencies.

3.3. Summary Statistics

Table 2 provides summary statistics of all the variables across companies and time included in the DT model of **Equation [2]**.

The minimum value of DTMI is 0, while its maximum score is 11.88. By construction, the maximum value of our DT index could be 16.50, but no food unit achieves during the study period.

The managers of the food units present a good level of knowledge of the 8 digital technologies (the average is 7.354 out of 8); however,

Table 2. **Descriptive statistics***

VARIABLE	MEAN	ST. DEV.	MIN.	P25	P50	P75	MAX.
DTMI	4.881	4.713	0.000	0.000	5.445	8.910	11.880
KNTEC	7.354	1.263	3.000	7.000	8.000	8.000	8.000
CUSNEED	0.436	0.5023	0.000	0.000	0.000	1.000	1.000
ICOMPET	0.447	0.504	0.000	0.000	0.000	1.000	1.000
TECWATCH	0.171	0.382	0.000	0.000	0.000	0.000	1.000
EBUSS	0.061	0.242	0.000	0.000	0.000	0.000	1.000
DIGINT	0.830	0.380	0.000	1.000	1.000	1.000	1.000
DIGEXT	0.689	0.468	0.000	0.000	1.000	1.000	1.000
MILSTAFF	0.550	0.504	0.000	0.000	1.000	1.000	1.000
INCCOOP	0.436	0.502	0.000	0.000	0.000	1.000	1.000
DTFIN	0.475	0.506	0.000	0.000	0.000	1.000	1.000
USEDTFIN	0.306	0.467	0.000	0.000	0.000	1.000	1.000
DTFINBRAKE	0.171	0.382	0.000	0.000	0.000	0.000	1.000
PUBFUNDS	0.206	0.410	0.000	0.000	0.000	0.000	1.000
FISH	0.917	0.277	0.000	1.000	1.000	1.000	1.000
FRUVEG	0.958	0.201	0.000	1.000	1.000	1.000	1.000
MEAT	0.458	0.500	0.000	0.000	0.000	1.000	1.000
FLOW	0.125	0.332	0.000	0.000	0.000	0.000	1.000
SIZE	16.465	1.081	14.693	15.556	16.449	16.921	18.859
SOFTW	0.001	0.002	0.000	0.000	0.001	0.001	0.009
PROF	0.059	0.0383	-0.063	0.035	0.0581	0.0834	0.132
AGE	3.624	0.388	2.197	3.496	3.784	3.850	3.989
LEVER	0.081	0.141	0.004	0.017	0.0253	0.0685	0.719
WORKCAP	0.134	0.105	-0.0214	0.060	0.132	0.178	0.740

*Table A4 in the Appendix provides definitions of all the variables. The variables SIZE, SOFTW, PROF, AGE, LEVER and WORKCAP have been winsorized at the 1% and 99% levels to mitigate the impact of outliers.

practically no technological surveillance systems are used even though competence is increasing in most of the food units.

It should be noted that although there is a good level of digitization of internal processes (0.830 out of 1), this level drops somewhat when it comes to digitizing external processes (0.689 out of 1) and falls (0.061 on average out of 1) when we measure the degree of implementation of B2B platforms aimed at wholesalers in the markets.

For its part, the presence of inter-generational teams and collaboration between them is a variable with an average value of 0.550 and 0.436, respectively.

Regarding financial instruments, there does not seem to be any obstacle to the financing of DT (a mean value of 0.171 out of 1). However, the use of financial instruments or public funds does not have high mean values either (<0.4).

Concerning the activities of buying and selling fresh products, those most present in the markets are fish and fruit and vegetables, with meat in third place and flowers in fourth place with a very low value.

Investment in software scaled by total assets is very low in almost all cases, with an average of 0.1% and a maximum value of 0.9%.

The variance inflation factor (VIF) was calculated (not tabulated). This measures the correlation and strength of correlation between explanatory variables in a regression model. An average VIF of 2 was obtained, indicating a moderate correlation between each explanatory variable and other explanatory variables in the model.

4. EMPIRICAL TESTS AND DISCUSSION OF RESULTS

Panel data capture unobservable heterogeneity (μ_i), but it is necessary to check whether individual effects, considered unobservable and time-constant factors, are specific to each food unit and may be correlated $COV(x_{it}, \mu_i) \neq 0$ with the explanatory variables (x_{it}), which implies treating them as fixed effects. Or on the contrary, if these unobservable characteristics are not correlated $COV(x_{it}, \mu_i) = 0$ with the explanatory variables, the individual effects are considered as random.

We use the Hausman test (Hausman, 1978) to determine which effects, i.e., fixed or random, are more appropriate in our context. The chi-square value obtained after the Hausman test shows that we cannot reject the null hypothesis of equality of estimates, and the most efficient estimator is that of random effects.

Table 3 presents estimated coefficients from the multivariate Tobit regression model with DTMI as the dependent variable. The first regression (R1) was calculated with the variables related to the drivers of the conceptual model depicted (see **Figure 1**) and the variables related to the buying and selling activities carried out in the food units. In the second regression (R2), however, the variables relating to the accounting of each market, as well as the size and

age, lagged by one period, have been included. The last regression (R3) incorporates all the variables from R1 and R2.

Table 3. **Estimation results of the DT model of Equation [2]**

EXPLANATORY VARIABLES	R1	R2	R3
KNTECt	2.2572538** (0.010)		3.0643582***(0.00)
CUSNEEDt	8.2125383*** (0.001)		9.9012511***(0.00)
ICOMPETt	-4.8995822 (0.127)		-25.257781***(0.00)
TECWATCHt	10.178923** (0.017)		29.94059***(0.00)
EBUSSt	-3.1232822 (0.589)		-27.376338***(0.00)
DIGINTt	3.8484659 (0.233)		15.972886***(0.00)
DIGEXTt	5.4040902*** (0.001)		10.112361***(0.00)
MILSTAFFt	-1.4571774 (0.591)		11.762907***(0.00)
INCCOOPt	0.71499363 (0.801)		-5.9474632***(0.00)
DTFINt	10.200342*** (0.001)		20.672747***(0.00)
USEDTFINt	-9.7163904*** (0.000)		-15.679463***(0.00)
DTFINBRAKEt	3.3394292 (0.219)		13.654714***(0.00)
PUBFUNDSt	-4.4932626 (0.118)		-15.24021***(0.00)
FISHt	38.516.381 (0.961)		3,9373677(.)
FRUVEGt	-5.8837871 (0.188)		-34.118127***(0.00)
MEATt	-8.7954991*** (0.000)		-27.907027***(0.00)
FLOWt	11.104114*** (0.000)		46.035292***(0.00)
SIZEt-1		3.0054811**(0.019)	2.1637479***(0.00)
SOFTWt-1		791,85463(0.184)	-8459.2784(.)
PROFt-1		-17.424.251(0.662)	15.329.862(.)
AGEt-1		-3,26232(0.387)	12.84919***(0.00)
LEVERt-1		-18.97568*(0.091)	11.74376***(0.00)
WORKCAPt-1		-29.292961*(0.099)	-17.922.083(.)
Number of firms	24	24	24
Log-likelihood	-44.638898	-71.220453	293.10338
Likelihood ratio test	.	53.16 (0.000)	.
Hausman test	1.54	0.21	1.82

Panel data Tobit regression coefficients estimated from the DT model specified by Equation [2] with p-values in parentheses. Table A4 in the Appendix provides definitions of all the variables. Superscript asterisks indicate statistical significance at 0.01(***), 0.05(**) and 0.10(*) levels. The likelihood ratio test compares the pooled estimator with the panel estimator with the null hypothesis that there are no panel-level effects; in this case, the test supports the rejection of the null hypothesis, and accordingly, a panel data estimation is performed, as it is more appropriate (Green, 2018). Hausman test refers to the null hypothesis that fixed effects and random effects are equivalent (Hausman, 1978).

The last regression (i.e. R3) shows high statistical significance values for almost all the variables in the model except for FISH, SOFT, PROF and WORKCAP.

To understand the importance of our empirical results and ease their interpretation, we follow Mitton's (2022) recommendation of using measures of economic significance scaled by the standard deviation of the dependent variable. Accordingly, we transform all the estimated coefficients of the regressions into their corresponding standardized beta coefficients.[6]

Based on their measures of economic significance, the most determinant factors in the DT index of each Mercas are the following. First and foremost is the size of the Merca (SIZE). A one standard deviation increase in the Merca's size is associated with a 4,962 standard deviation increase in the Merca's DT. Secondly, the customers' demand for digital technologies (CUSNEED). The value obtained is high and indicates that the CUSNEED variable is economically significant because its coefficient is above the standard deviation of our index. Thirdly, the greater collaboration between Generation Y staff and the rest (INCCOOP). The existence of a flower market (FLOW), the knowledge of digital technologies by top management (KNTEC) and the horticultural (FRUVEG) and meat and slaughterhouse (MEAT) activity also contribute significantly to our index.

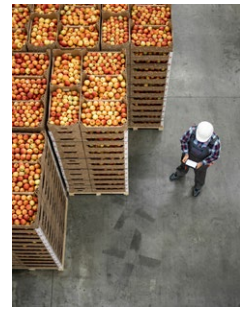
There is a second group of variables (ordered from most relevant to least) that also impacts the degree of DT of food units. These are the use of B2B platforms by the Mercas (EBUSS), the increase in competition (ICOMPET), the availability of resources for DT (DTFIN), the digitization of internal activities (DIGINT), the use of financing for DT (USEDTFIN), the lack of brakes to finance DT (DTFINBRAKE), the presence of millennials among the staff (MILSTAFF), the digitization of external activities (DIGEXT), the availability of technological surveillance systems (TECWATCH), the existence of public funds for DT (PUBFUNDS), the trajectory of each Merca (AGE) and its leverage (LEVER).

5. CONCLUDING REMARKS

This research is the first attempt to investigate the DT of Spanish food units, and the specific factors that impact their degree of DT. We have analysed the whole population of food units (24 in total),

which constitute a network that facilitates spaces for the distribution of fresh food in Spain.

The analysis of the findings indicates that DT occurs when there is a strategic commitment from the management, whereby knowledge and belief in the potential of digital technologies serve as a foundation. The different studies examined confirm that this commitment is critical for the CEOS of organizations. To achieve this, continuous training and technology watch must be on the agendas of CEOs. A company cannot be managed by turning its back on a changing and hypercompetitive environment. The European Union, aware of this issue, has been promoting training in digital technologies by different programs aimed at the DT of the member countries.



Secondly, the size of the food units is a key determinant in their ability to undertake DT, as the availability of resources and/or the complexity of their business may be the cause. Nonetheless, some studies such as the Digital Transformation Scoreboard (Probst et al., 2019), suggest that smaller and startup private companies in the food and construction industries are more likely to adopt digital technologies than their larger counterparts. Perhaps the low age of these private companies (and their founders) and private capital are the factors that make the difference.

Thirdly, we find that customer demand is a fundamental driver in DT. This factor is not surprising if we understand that the purpose of companies is to satisfy their customers and grow with them. Company managers could go a step further in this direction. They could try to anticipate their customers' demands through active listening by conducting regular meetings or surveys.

Fourthly, the human team plays a vital role in DT, and the resistance to the adoption of digital technologies is much lower if they are individuals from the so-called "digital natives" generation. Indeed, they can be vital in helping the rest of the team to challenge the status quo and roll out the changes. Many startups are born with a DT culture in their DNA primarily because their founders are Generation Y people.

Finally, the presence of flower markets is the fifth aspect with a relevant weight in the degree of DT of the Mercas. This may be due to the idiosyncrasy of the activity itself. Flowers are seasonal and highly perishable, which means that demand estimation, logistics, distribution, and supplier management must be very efficient

processes (and digitalization comes in) to avoid losses. This need for control and efficiency may affect (positively) the degree of DT of the Mercas in which this activity is carried out.

Moreover, the Mercas that have already embraced technological solutions such as B2B platforms for their customers and tools that digitize internal (accounting, invoicing, personnel control...) and external activities (access to the Merca, weighing of incoming products, etc.) also present a higher rate of DT.

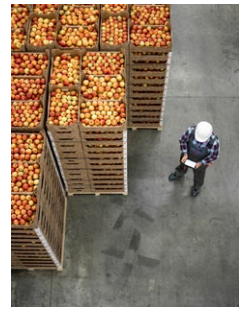
The availability of financial resources, whether internal or external, also influences the DT of the Mercas. The European Union is providing funds to ensure that the lack of these resources does not hinder the progress of companies, whether public sector or privately-owned.

Lastly, the longevity of each Merca (20 of them were founded between the 1960s and 1980s and three in 2002, 2009 and 2017, respectively) and their leverage also affect their DT status. However, in certain industries such as Information Technology, the youth of the companies (startups) is the determining factor in their degree of DT (Probst et. al, 2019).

Our research is no exception when it comes to limitations. The variables used in the study were based on a literature review of DT, and the review itself is based on the authors' subjectivity in the research process. Furthermore, since the concept and vision of DT are relatively new, the available period of study of the Mercas is limited. As these are public sector companies, there may be no pressure to innovate and lead as private companies do, at least in the short term.

On the other hand, the use of surveys as a research tool also has its drawbacks (Graham and Harvey, 2001; Graham, 2022). Although the survey was conducted on the entire population and answered by all 24 Mercas' managers, the veracity of the answers is difficult to determine. Respondents may not understand the questions or may answer what is theoretically correct, which can result in biased survey results. Surveys measure beliefs and not actions, so it is challenging to detect bias at this point. Nevertheless, to reduce this potential problem, we have structured the survey very specifically and provided clear definitions of confusing or abstract concepts. Participants were also informed that the confidentiality of their responses would be maintained.

Finally, due to limited available data, certain variables such as investment in R&D&I (i.e., research, development, and innovation) in each Merca's area of influence were not incorporated into the econometric model. Future research should extend the study over several years to learn about the state of DT and corporate economic and financial results. Research could also incorporate economic variables that could indicate whether periods of stability or turbulence are factors that affect the DT of the companies. Local legislation and the business environment, such as innovation hubs, technology centres, etc., where the companies are located could also be considered.



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NOTES

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1. Each Merca is co-owned by the local council of the municipality where it is located, and by Mercasa (a public sector firm), with the respective ownership proportions typically being 50-50, 40-60, or 60-40.
2. The European Commission considers this lever to be fundamental as reflected in its Digital Transformation Scoreboard 2018 report (Probst, Lefebvre, Martinez-Diaz, Unlu-Bohn, Klitou, and Conrads, 2019).
3. Early stage of the DT (Verhoef et al. 2018).
4. This acronym is pronounced "smack it" and in English-speaking countries is used to assess the score or success of a digital strategy. When you SMACIT it means "you've hit a home run off a baseball field". SMACIT is shorthand for the entire suite of powerful and easily accessible digital technologies (Sebastian et al., 2017).
5. Measuring and tracking DT across all sectors of the economy, including the public sector, is challenging because of the difficulty of capturing all the data required and doing so in a standardised way (OECD, 2019). This lack of specific data is the main reason for using the survey as a research technique.
6. In particular, we compute a measure of economic significance for our continuous explanatory variables which is the change in the dependent variable, as a percentage of its standard deviation, associated with a one-standard-deviation change in the explanatory variable, based on the estimated regression coefficient. Regarding the dummy explanatory variables, we use a measure of economic significance that is the change in the dependent variable, as a percentage of its standard deviation, associated with a change from zero to one in the explanatory variable. The untabulated standardized beta coefficients are available upon request to the authors.

APPENDIX

Table A1. **Concepts and variables of business management dimension (BMD)**

CONCEPT	DEFINITION OF THE VARIABLE	NAME OF THE VARIABLE
Management's knowledge and real commitment to a digital strategy	Digital technologies that improve processes and/or services	TECHIMPROV
	Need for DT	NEEDT
	Top management involvement in DT	TOPINV
	DT is part of the overall strategy	OVERSTRA
Organisational structure with qualified staff	Recruitment to lead DT	LEADT
	Change of structure or organisational chart	CHANGORG

Pursuit of improvement of the business model, operational processes and business activities and customer experience	Using DT to improve processes and efficiency	IMPEFF
	Using DT to improve customer experience	IMPCX
	Pursuit of business model improvement	MODELIMP
Organisational culture and coordination mechanisms (communication) to believe in and drive DT	Communication of DT to the whole organisation	COMDT
	Involvement (DT) of the whole organisation	INVALL
	Change of the organizational culture due to DT	CHANGCULT
Willingness to create new products/services or new ways of delivering services	New products/services	NEWPS

Table A2. **Variables of technological dimension (TECHD)**

CONCEPT	NAME OF THE VARIABLE
Types of data management and analysis software	SOFTDATA
Cloud technology	CLOUDTECH
Mobile devices – Mobile Apps	APPS
Social media activities	SMACTI
Deployment of Artificial Intelligence, Internet of Things, Cybersecurity, Marketplaces, Robotics, 3D	TECHDEPLOY
Knowledge management systems	KMS

Table A3. **Variables of stakeholders' dimension (STKD)**

DEFINITION OF THE VARIABLE	NAME OF THE VARIABLE
Existence of a CDO-type position	CDO
Incorporation of DT experts	DTEXP
Expert in some digital technology/ies	DTECHEXP
New technologies training	NTRAIN
Every employee knows the DT process	EMKNOW
DT results are communicated to employees	COMEMP
Suppliers know their DT process	SUPKNOW
DT affects the management of suppliers	SUPAFFECT
DT results are communicated to suppliers	COMSUP
Customers know the DT process	CUSTKNOW
DT affects the management of customers	CUSTAFFECT
DT results are communicated to customers	COMCUST
Shareholders are aware of the DT process	SHARKNOW
DT results are communicated to shareholders	COMSHARE

Table A4. **Variables' definitions of the data panel regressions**

VARIABLE	DEFINITION
KNTEC	The CEO knows and understands digital technologies.
CUSNEED	Customers require and need new digital solutions
ICOMPET	Increase of competition in the area of influence
TECHWATCH	Use of technology watch systems
EBUSS	E-business development with Merca´s customers
DIGINT	Digitization of internal tasks and processes
DIGEXT	Digitization of external tasks and processes
MILSTAFF	There are digital natives (Generation Y or Millennials) in the staff
INCCOOP	Increasing cooperation between digital natives and older generations
DTFIN	Availability of DT financing
USEDTFIN	Use of DT financing instruments
DTFINBRAKE	Lack of finance has been a brake on the DT process
PUBFUNDS	Use of public funds to promote DT
FISH	Presence of wholesalers selling fish
FRUVEG	Presence of wholesalers and farmers selling fruits and vegetables
MEAT	Presence of wholesalers selling meat or existence of slaughterhouse service
FLOW	Presence of wholesalers selling flowers
SIZE	Natural logarithm of total assets
SOFTW	Ratio of software applications assets to total assets
PROF	Ratio of earnings before interest, taxes, depreciation, and amortization (i.e., EBITDA) to total assets
AGE	Natural logarithm of the age of each Merca
LEVER	Ratio of total debt to total assets
WORKCAP	Ratio of working capital to total assets