Digital Transformation Leadership and AI Capabilities as Drivers of Sustainable Competitive Advantage: The Mediating Role of Organizational Agility in Spain's New S-Curve Industries

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The modern trend among various industrial companies to adopt digital technologies in their operations through digital transformation and reliance on artificial intelligence has become an imperative, especially with the increasing intensity of competition in global markets. To gain a realistic understanding of the role of digital transformation leadership (DTL) and AI capabilities (AIC) in achieving sustainable competitive advantage (SCA) for organizations, this study employs organizational agility (OA) as a mediating variable, based on data collected from 441 employees in Spanish 'New S-Curve' industries, which are innovative sectors achieving high growth returns within the framework of the 'Spain 5.0' national strategy. The statistical and analytical framework of Structural Equation Modelling (SEM) revealed that DTL has a significant impact on SCA, while the effect of AIC was not significant. Furthermore, OA was found to be an important mediator, reinforcing the indirect effects of both DTL and AIC on achieving SCA for Spanish organizations.

Keywords: digital leadership, artificial intelligence capabilities, organizational agility, sustainable competitive advantage, Spain's S-curve industries
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Introduction

To promote digital transformation and institutional competitiveness, the Spanish government launched the 'Spain Digital Agenda 2020–2030' to support an economy driven by creativity and innovation (Diaz-Saracha-ga 2024). This strategic orientation has created substantial opportunities

for the business sector; however, it has simultaneously introduced significant challenges to future management practices. Within this context, digital transformation leadership emerges as a pivotal factor in enabling organizations – particularly those operating in the industrial sector – to fully harness the benefits derived from the implementation of this initiative (Yang et al. 2024).

In its pursuit of sustaining a high-income economy, the Spanish government introduced the 'Industria Conectada 4.0' strategy to foster digital transformation within the industrial sector, through collaborative support from both public and private entities. In Catalonia, there are 1,447 companies involved in Industry 4.0, a 30.2% rise from 2020, reporting almost €7.2 billion in revenue and generating over 37,000 jobs. However, the proportion of firms that have reached an advanced level of digitalization remains low (around 8% in Spain, compared to a global average of nearly 33%). There are also significant regional differences in digital maturity (Díaz-Chao et al. 2021).

To oversee the transition into Industry 5.0, Spain has focused on what it deems to be key industrial sectors, including the automotive, food, and logistics sectors, into which it is pumping resources through the use of advanced automation technology, artificial intelligence, and collaborative robots (cobots), thus enabling very customised manufacturing. However, this transformation faces challenges such as a digital skills gap and low R&D investment; consequently, spread is still contained. However, future expansion seems quite hopeful.

Companies that want to thrive need to swiftly adjust to change, alongside focusing on advances in AI (Shahverdi et al. 2025). However, to thrive now, businesses must accept the inevitability of embracing technological changes. Moreover, embracing these technological changes plays a key role in achieving a sustainable competitive edge, securing profitability, and outpacing the competition in the market (Hariyani et al. 2025).

In organizations, the primary issue appears to be developing a clear understanding of how leaders may address and adapt to present industrial transformation in order to gain the most from it. Among the leadership styles addressed in recent literature, the concept of strategic leadership stands out as a framework that seeks to align leaders' behavioural patterns and actions with various evolving technologies to maximize benefits and achieve organizational goals (Scuotto et al. 2023). In this context, digital transformation leadership emerges as a critical factor that makes a difference and enables organizations to cope with various rapid

technological and administrative changes. When leaders adapt to digital transformation, they create the foundation for integrating artificial intelligence within their organizations (Ding et al. 2024). This issue is at the core of what emerging sector companies do, as they leverage digital transformation leadership to identify and jump on new opportunities, which in turn preserve their competitive edge.

The results of previous research have shown a positive correlation between several variables under study. For example, Probojakti et al. (2025) found that both transformational leadership and digital transformation directly enhance the agility of banking institutions and strengthen their ability to achieve competitive advantage.

To really make digital changes stick, Sholokwu (2024) points out that companies should focus on growing their leaders – specifically, boosting their tech skills alongside making the whole organization more adaptable. They suggest putting real money into leader training built around what works, yet keeping technology limitations in mind when implementing digital innovations across the organization.

Dobre (2022) demonstrated that small firms that adopt technology enhance their competitiveness, especially when environmental conditions are favourable, the business is prepared, and the external world is supportive. However, we do not fully understand how digital transformation leadership combined with the use of AI can help achieve a sustainable competitive advantage in emerging industries. Therefore, this study aims to address this gap by analysing these relationships and focusing on the mediating role of organizational agility.

Furthermore, Gazi et al. (2024) highlighted the importance of employing artificial intelligence applications to predict organizational agility and sustain competitiveness in both the public and private sectors, especially among organizations with limited financial resources. To move fast, companies build workplaces offering flexibility. This helps them hit targets when things change. Moreover, better talks between teams, quicker choices, less danger, alongside learning from what worked – or did not work – all contribute to bouncing back swiftly.

Better tech and digital tools, alongside ongoing staff development help, people grow their abilities, equipping them to tackle hurdles while striving for top performance via constant study and gaining insight. Over time, these efforts foster an environment of innovation and promote a culture of creativity (Jiménez-Jiménez and Sanz-Valle 2008).

To ensure the generalizability of the findings, the study will be conducted on a sample of emerging 'New S-curve' industries in Spain, since Spain constitutes one of the leading economies in Europe and provides a representative model for analysis.

It is worth noting that despite the growing interest in digital transformation and artificial intelligence in strategic management literature, there is only limited research examining how these factors interact with organizational agility and innovation cultures to enhance sustainable competitive advantage. Furthermore, previous studies have often addressed these concepts in isolation, neglecting the dynamic mechanisms linking digital leadership to long-term competitiveness.

Therefore, this study aims to examine how digital transformation leadership and artificial intelligence capabilities contribute to achieving sustainable competitive advantage through the mediating role of organizational agility, within the broader context of innovation and sustainability culture in Spanish industrial firms.

In Section 2, the key theoretical foundations are reviewed and the relevant hypotheses are developed. Section 3 presents the research methodology, including the sampling strategy and data analysis. In Section 4, the data are summarized using descriptive statistics, a one-way ANOVA test, and standard linear regression. Section 5 analyzes the key findings, and Section 6 concludes by highlighting the principal takeaways along with practical and theoretical implications.

Literature Review and Hypotheses Development

THE BACKGROUND OF INDUSTRIAL RESTRUCTURING IN SPAIN

The World Bank classifies countries by wealth – specifically, how much money each person makes on average. They use this to create four groups: nations with high incomes, those with upper-middle incomes, and places with lower-middle incomes, alongside countries considered low-income (World Bank Data Team 2019).

Achieving higher income levels requires national economic and social leaders to make advanced efforts and to adopt strategies focused on improving infrastructure, diversifying income sources, and leveraging technology (Sant'Anna and Figueiredo 2024). However, many studies have shown that numerous economies have fallen into the middle-income trap, failing to maintain progress toward high-income status (Pruchnik and Zowczak 2017).

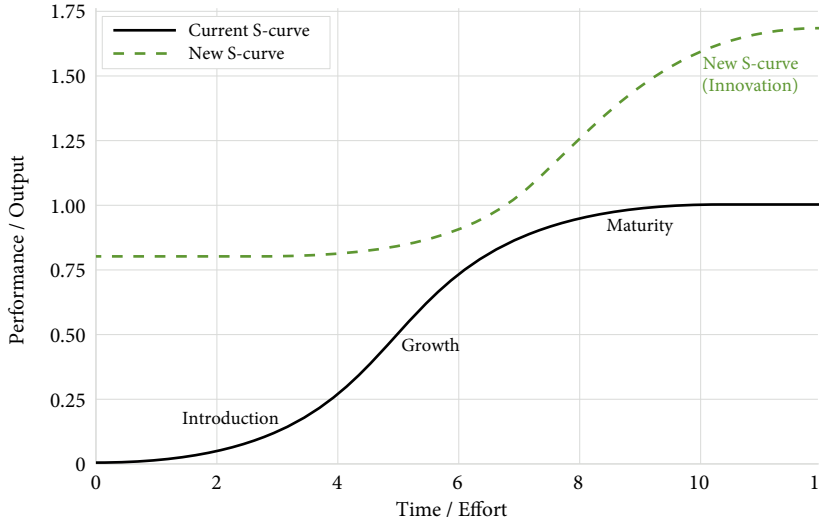

FIGURE 1 Moving from the Current S-curve to the New S-curve: Dynamics of Innovation Renewal in Spanish Industrial firms

SOURCE World Development Indicators (https://databank.worldbank.org/source/world-development-indicators).

To avoid this trap, several Spanish experts have proposed a set of recommendations. This means reshaping the economy, encouraging new ideas, and boosting technological leadership through invention – especially with tools like artificial intelligence. Additionally, successful practices from countries such as Germany and the UK can be considered (Calvo-Gonzalez 2021). Numerous studies show that companies need to reinvent themselves by thinking differently, developing new products and services, and employing cutting-edge technologies in their innovation processes (Nour and Arbussà 2024).

Over the past few decades, the Spanish economy has followed a development pattern similar to the S-curve presented in figure 1. Many industries have passed the early stages of growth and have now reached maturity, where performance and production tend to level off. At this stage, structural issues emerge, particularly dependence on traditional sectors such as tourism – which accounts for about 12% of the economy – making it vulnerable to unexpected shocks (e.g. the COVID-19 pandemic). Another challenge is dependence on energy imports (Guirao 2020).

To achieve sustained economic growth, Spain must initiate a New S-curve based on innovation and technology-driven activities, including digital transformation. This next stage of industrial development will

allow new sectors to lead growth, while companies that fail to adapt will lose their competitive advantage.

This graph illustrates the current S-curve (shown in blue) as it approaches its maturity phase, while the new S-curve (indicated by green dotted lines) represents ongoing innovation and the rise of new technology-intensive industries such as robotics, civil drones, logistics, biofuels, biochemicals, and digital technologies. These industries are expected to become the main drivers of Spain's economic growth in the coming years (2030 Digital Decade. Spain's Strategic Roadmap n.d.).

The vertical axis in figure 1 represents the level of performance or output achieved over time and effort; it clearly demonstrates the transition from the current S-curve to the New S-curve in Spanish industry. In the current S-curve, the performance of industrial enterprises gradually increases from the introduction stage to growth, then reaches the maturity stage, where it stabilizes at a certain level. In contrast, the New S-curve (innovation) shows how new technologies or methods can exceed this level and attain higher levels of performance and productivity. This shift marks a move from traditional capabilities toward broader horizons of industrial development.

SPAIN 5.0 MODEL AND THE NEW S-CURVE INDUSTRIES

In Spain we see the launch of a new strategic direction in industrial policy. This is a shift away from what we have known of past models like Industry 4.0, which made significant advancements in digitization and automation. What is emerging instead is a very different model – a more complete and integrated framework that places Spanish citizens at the centre of policy design, with a strong emphasis on environmental sustainability as well as social and economic resilience in key sectors that form the core of the national economy (Lewandowska et al. 2023). This framework is grounded in substantial investments in New S-curve industries – emerging technological sectors experiencing accelerated growth following an initial phase of slow development, such as artificial intelligence, renewable energy, biotechnology, and the circular economy. Through the integration of these industries into critical sectors, Spain aspires to strengthen its international competitiveness and foster an economy capable of adapting to rapidly evolving environmental and technological dynamics (Diaz-Sarachaga 2024).

Although the Spanish government has launched the 'Spain 5.0' initiative as an advanced strategic framework aimed at fostering genuine integration between modern technologies, sustainability, economic and

social resilience, and other critical dimensions, the currently available statistical data do not yet allow for an accurate assessment of the proportion of companies that have effectively adopted this emerging model (Díaz-Chao et al. 2021).

Recent reports indicate that the degree of full digitization within the Spanish industrial sector remains relatively limited, with the percentage of companies that have achieved comprehensive digital transformation not exceeding 5%. This reflects the reality that the majority of firms are still navigating transitional phases primarily associated with the Industry 4.0 paradigm. Consequently, it can be inferred that the integration of Spanish enterprises into the Spain 5.0 framework is still at an incipient stage, with its contours expected to become more distinct in the coming years, particularly in light of the growing investments in artificial intelligence, renewable energy, the circular economy, biotechnology, and related fields (Europa Press 2025). In this context, many organizations in Spain that continue to rely on legacy systems have now recognized the need to incorporate advanced technologies and innovation across all operational dimensions. This transition brings a great challenge in terms of leading digital transformation. It includes the role of leaders and managers in shepherding their companies through the adoption of digital technologies like artificial intelligence, cloud computing, and big data, which in turn improves process and shows growth in efficient operation and development of new business models. At the same time, it requires that we see staff and culture of the organization to very much buy into and adapt to this large scale change (Expósito and Cebollero 2025).

SUSTAINABLE COMPETITIVE ADVANTAGE

One of the fundamental challenges that organizations must address during their stages of industrial development is the ability to secure a sustainable competitive advantage (SCA), particularly in an environment characterized by increasing global competition. According to the Resource Based View (RBV), we see two types of competitive advantage. The first is temporary, which is when a firm has resources or capabilities that put it ahead of the competition for a time, which in turn produces above-average returns for that firm. However, this advantage is usually short lived as competitors catch up or develop alternative solutions. The second is sustainable competitive advantage, which occurs when an organization possesses valuable, rare, unique, and difficult to imitate (VRIN) resources and capabilities. These characteristics enable it to

maintain its market leadership position over a long period of time, while reducing the opportunity for competitors to imitate the source of this advantage (Banmairuroy et al. 2022).

Several contemporary studies have indicated that organizations that have achieved a digital transformation in their operations by employing artificial intelligence applications and capabilities have the potential to establish a long-term competitive advantage over other organizations. Organizational agility has also been shown to play a crucial role in this context, enabling organizations to operate efficiently and effectively while maintaining balance amidst the dynamic pace of the technology lifecycle (Hariyani et al. 2025).

This study relies on the conceptual framework presented by Namusonge et al. (2016) to assess the extent to which an organization can achieve a sustainable competitive advantage. This framework is based on three basic dimensions:

1. *Organizational Excellence*: A company's achievement of outstanding and lasting results through the adoption of quality practices, fostering of creativity and innovation, and investment in human resources, which should be achieved with care and without bias to all stakeholders (Alshehab 2024).
2. *Organizational Effectiveness*: Refers to a company's performance in achieving what it has put forth to do in a very efficient manner and at the same time also being able to transform and grow in response to environmental changes (Najar 2020).
3. *Organizational Responsiveness*: Refers to a company that is able to transform itself in response to environmental changes while simultaneously addressing current operational needs with high performance and speed (Çakmak 2023).

DIGITAL TRANSFORMATION LEADERSHIP AND SUSTAINABLE COMPETITIVE ADVANTAGE

Exploring the relationship between digital transformation leadership and sustainable competitive advantage has become a major topic in many modern management research studies. In this regard, digital transformation leadership refers to the ability of leaders and managers to integrate and align advanced digital technologies with their organization's strategic vision and long-term objectives, while providing strategic leadership support to employees at all levels (Banmairuroy et al. 2022).

Digital transformation leadership plays a significant role in building a culture of evidence-based decision making and reducing uncertainty, a key factor for an organization's sustainable success in the market. It is also noted that high-performing leaders are able to put together unique and valuable resources and capabilities which competitors may have difficulty in replicating in the long term (Hariyani et al. 2025). Moreover, digital transformation is a key element for any organization to improve its competitive edge and achieve sustainability in dynamic business settings. It also plays a role in improving its ability to adapt to the environment, to better respond to the changes in the market and to achieve strategic pre-eminence (Probojakti et al. 2025).

As part of the New S-curve industrial development programme in Spain, aligned with the Spain 5.0 initiative, managers in these industries are required to develop a comprehensive view of their companies' business value chain, with a strong focus on leveraging the capabilities of smart machines and big data-driven network architectures as key drivers of digital transformation (Diaz-Sarachaga 2024). To that end it is up to Spanish organizations to greatly increase their input into the digital transformation, which they do by way of putting in place employee training programmes for the use of emerging technologies; thus, they acquire the required knowledge and skills. Also included in these efforts is the development of high level technical skills, improving the ability to adopt to as well as drive change; we see a very large role for a culture which is open to scientific and technological innovation (Expósito and Cebollero 2025).

This study hypothesizes that leaders and managers of organizations with advanced digital skills, a clear strategic vision, and effective management support are better positioned to build strong relationships with employees at all organizational levels, as well as with all stakeholders, including suppliers and customers. These connections contribute to the creation of interconnected digital work environments, which are expected to aid in achieving sustainable competitive advantages and enhancing organizational agility in the medium and long term. Building on these theoretical bases, we propose the following hypothesis:

H1 Digital transformation leadership directly impacts sustainable competitive advantage.

AI CAPABILITIES AND SUSTAINABLE COMPETITIVE ADVANTAGE

Artificial intelligence is not just a tool, it is the essence of modern digital transformation, dramatically changing the way organizations are structured, how they operate, and how people behave. A central question raised by a wide range of organizations is how to effectively leverage AI capabilities as a critical technological factor that supports organizational objectives and fosters sustainable competitive advantage (Gazi et al. 2024). Several scholars have highlighted the definitional challenges associated with delineating the scope of these capabilities. A number of studies have concluded that AI capabilities should be conceptualized in relation to a set of key dimensions, most notably (Dzreke 2025):

1. *Data Superiority*: The ability to collect, process, and analyse data in a very highly systematic manner, which improves an organization's performance compared to its competitors or rivals. This helps it make better decisions and achieve long-term strategic success (Dahiya et al. 2022).
2. *Algorithmic Prowess*: This encompasses advances in the design, analysis, and implementation of algorithms to solve problems efficiently and effectively, which are based on a very strong theoretical background. It also refers to the ability of an organization to develop alternative solutions to very complex computational problems (Amaya and Holweg 2024).
3. *Specialized Talent*: In today's world, individuals with in-depth knowledge, special skills, or a large amount of experience in a particular field, discipline, or industry are identified as key to innovation and organizational growth (Osorio et al. 2024).
4. *Scalable Infrastructure*: Technologies and organizational systems (which include hardware, software, networks, and processes) are noted for their flexibility and high performance, by which they adapt to a wide range of dynamic requirements while at the same time not trading off against performance or reliability (Fernández et al. 2024).
5. *Strategic Vision*: This is a dimension of an organization which puts forth a far-sighted point of view that ties in AI projects and tools with long-term goals and which at the same time weaves tech innovation into business strategies. This philosophy ensures that AI adoption is not a short term fix or siloed but instead is made a part

of the company's culture and decision making, which in turn promotes sustainable growth (Patel 2023).

6. *Ethical Governance*: This refers to frameworks, policies and monitoring tools for the responsible development, deployment and use of AI technologies. This dimension looks at transparency, fairness, accountability, ethical compliance and social responsibility issues, which in turn see to it that AI-based decisions earn the trust and legitimacy of stakeholders (Batool et al. 2025).

What is notable is that this framework focuses on what is known as the 'dynamic resource-based and capabilities-based view' theory, and takes into account the key capabilities of artificial intelligence. From this aspect, it can be hypothesized as follows:

H2 *AI capabilities directly affects sustainable competitive advantage.*

BUILDING AN INNOVATION CULTURE

The push for innovation is a key issue for Spanish organizations and requires that they foster an innovation-based culture. This culture is made up of values, beliefs, and practices which promote creativity and which also put up with risk and uncertainty with the end goal of coming up with new products, services, and processes that greatly improve organizations' competitiveness (Jiménez-Jiménez and Sanz-Valle 2008). It is also a requirement that organizations play a proactive role in encouraging and supporting their staff, which they do by giving them a chance to take the initiative and try out innovative solutions, which in turn is expected to greatly affect the degree of actual innovation within the organization (Tuan 2010). This study integrates innovation culture into a framework that comprises five dimensions: Innovation Intention, Innovation Infrastructure, Innovation Influence, Innovation Implementation and Innovation Integration. This approach is consistent with previous research, such as Dobni (2008), Kohli and Jaworski (1990), and Tuan (2010).

A number of previous studies have indicated a link between digital transformation leadership and a culture of innovation, among them Wang et al. (2022) and Vey et al. (2017). These reports posit that what we see is very much a symbiotic relationship between technology and organizational culture. In this setting, digital transformation leadership gives organizations a clear digital strategy and strong technical base as

they move into advanced tech and out of past methods for more flexible and efficient models. In addition, a culture of innovation which we see in these leading companies is very much one that encourages creativity, which in turn breeds risk taking and is a key element of what they do. Through the mix of these elements what we see is that organizational performance improves and there is an increase in sustainability, especially in ever-changing business settings. Based on the above, we propose the following hypothesis:

H3 *Digital transformation leadership has a direct impact on innovation culture.*

On the other hand, there is a limited body of research investigating the impact of AI capabilities on the culture of innovation. Shahverdi et al. (2025) argue that these capabilities significantly support the establishment of a culture of innovation through the use of big data analytics, the generation of new qualitative ideas, and the automation of repetitive activities and processes, which opens the door to digital creativity. Also, we see that these capabilities in turn fortify the partnership between man and machine. Similarly, they put forth the requirement for continuous improvement and ongoing learning, which makes the culture of innovation more flexible and forward looking. This may be put forth as:

H4 *Artificial intelligence capabilities directly contribute to innovation culture.*

ORGANISATIONAL AGILITY'S COMPONENT FACTORS

Organizational agility expresses the ability associated with an organization's efficiency in monitoring and sensing various environmental changes while flexibly responding to them in a timely manner. In the field of organizational management, this concept is closely related to the capabilities of adaptation, innovation, and organizational learning, highlighting its role in supporting the achievement of an organization's strategic objectives (Çakmak 2023).

Sambamurthy et al. (2003) report that agile organizations are able to identify market opportunities more effectively than their competitors, which in turn provides them with a strong position to leverage environmental resources for competitive advantage. It is also noted that these companies maintain a forward-looking vision and a flexible organizational structure, both of which play a key role in enabling them to capital-

ize on such opportunities more effectively than their competitors. What we see in high-performing organizations is that they empower their staff in decision making and in taking responsibility for their actions, which creates a strong sense of commitment and accountability from the medium- to long-term point of view. It is also seen that when employees are allowed to use their talent and skills they in fact do better for the organization. In addition, these companies are successful in building a culture of trust and respect among the employees at all levels of management (Teece et al. 2016).

In the field of management, we must draw a distinction between organizational agility and organizational flexibility. Vinodh et al. (2010) report that what we term agility is in fact an integrated response to a range of business issues which we tend to handle via very quick changes of action to improve performance. As for flexibility, what is usually meant comes within the framework of administrative and organizational changes which take place in the environment of current regulations and procedures. In addition, flexibility is a method which organizations use to constantly try and better their chances of success.

According to some researchers in this field, 'organizational agility' includes two main dimensions: a culture of innovation and a culture of sustainability. These may be presented as follows (Felipe et al. 2017):

1. *Mindset Culture*: Refers to an organization's culture that encourages and supports creativity and the continuous development of new ideas. At the same time, mindset culture fosters an open attitude toward change, growth, and risk-taking, enabling teams and employees to transform their ideas into practical solutions that improve business growth and competitiveness.
2. *Sustainability Culture*: Regarding the organization's principles, this refers to adhering to its environmental and social values, which also support the sustainable use of resources over the long term. It encourages its employees and stakeholders to incorporate sustainability principles into their daily decisions and actions, strengthening their collective commitment to this cause while preserving its assets for future generations.

Jin et al. (2018) concluded that innovation culture plays a crucial role in fostering the sustainability culture of organizations. Innovation that supports creativity, experimentation, and adaptability to change in line with the organization's strategic plans provides a strong foundation for

developing innovative practices and solutions. It also contributes to the formulation of sustainable strategies, which in turn foster a balance between organizational growth and environmental and social responsibility.

In relation to this review, this study proposes the following hypothesis:

H5 *The innovation culture directly contributes to the sustainability culture.*

It should be emphasized that Gazi et al. (2024) found a direct, statistically significant positive relationship between sustainability culture and organizational agility. Based on these ideas, this study proposes the following hypothesis:

H6 Sustainability culture is clearly reflected in organizational agility.

ORGANIZATIONAL AGILITY AND SUSTAINABLE COMPETITIVE ADVANTAGE

From a business strategy perspective, Smit et al. (2023) found that organizational agility is a key element for organizations to enhance their competitive advantage. Similarly, Satar et al. (2025) argue that organizational agility – reflected in continuous adaptation and responsiveness – constitutes the foundation of sustainable competitive advantage in the long term. They also noted that this allows companies to improve operational efficiency while increasing their innovation, which enables them to better serve the needs of customers and stakeholders. This, in turn, strengthens their position in the business market, which, in a highly dynamic business environment, is seen as an element of the sustainability of their actions.

El Nsour (2021) conducted a study which looked at the issue of what organizational agility does to improve competitive advantage for companies in the communication technology field in Jordan. What they found was a positive statistical correlation between the two variables. The study posited that organizational agility is a key element in the development of a culture of sustainable competitive advantage for these companies, which also operate in info tech and knowledge-intensive sectors. Furthermore, in the context of the industrial development witnessed by Spain in recent years, and within the framework of the Spain 5.0 model, organizational agility is considered an important strategic tool for build-

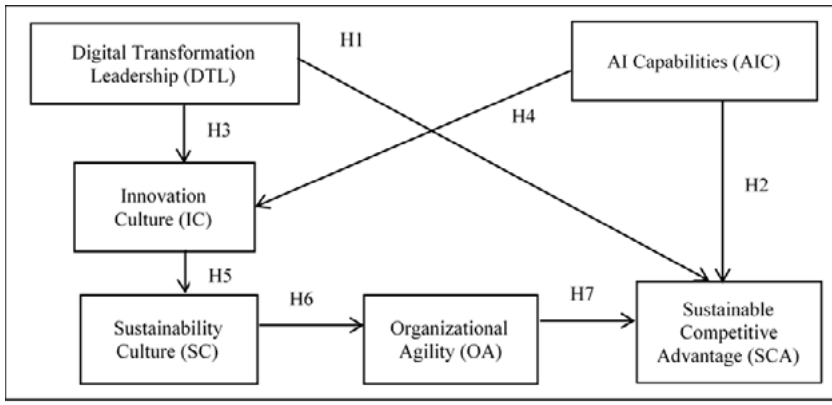

FIGURE 2 Research Framework

ing a sustainable competitive advantage for its industries. From this perspective, the following can be hypothesized:

H7 Organizational agility directly impacts sustainable competitive advantage.

Through the literary arguments outlined above, the framework of this study is shown in figure 2.

Methodology and Sampling

MEASUREMENT

In this study we looked at data which came from individuals that are part of Spanish industries which fall into the category of the New S-curve for the time frame of January to July 2025. We used a structured questionnaire based on a five-point Likert scale that ranges from 1 (strongly disagree) to 5 (strongly agree). We go into detail about the design of the questionnaire and the sources of its items below:

1. *Digital transformation leadership* was measured using six items adapted from Banmairuroy et al. (2022).
2. *AI capabilities* were assessed through nine attributes adapted from Dzreke (2025).
3. *Innovation culture* was evaluated using fifteen attributes adapted from Jin et al. (2018).
4. Measuring the *sustainability culture* variable was based on twelve dimensions according to the study of Gazi et al. (2024).

5. In this study, nine dimensions of *organizational agility* were adopted, according to the study of El Nsour (2021).
6. To measure the *sustainable competitive advantage* variable, nine dimensions were adopted based on the study of Satar et al. (2025).

The reliability of the measurement tool was tested as shown in table 1. Cronbach's alpha coefficients demonstrated that all the main variables had an acceptable level of internal consistency, exceeding the reference threshold of 0.70, as indicated by Taber (2018).

TABLE 1 Results of the Reliability Test

Variable	Cronbach's Alpha
DTL = Digital transformation leadership	0.88
AIC = AI capabilities	0.90
IC = Innovation culture	0.91
SC = Sustainability culture	0.93
OA = Organizational agility	0.92
SCA = Sustainable competitive advantage	0.94

To test the validity of this study's hypotheses, detailed above, a set of advanced statistical methods was employed. Confirmatory factor analysis (CFA) was used to ensure the fit of the measurement indicators with the various theoretical frameworks established, while Structural Equation Modelling (SEM) was applied to test and estimate the causal relationships between the main variables. Furthermore, multiple regression analysis was employed to further understand the structural relationships embedded in this research model.

SAMPLING TECHNIQUE

The study sample consisted of individuals working in several Spanish companies operating in emerging S-curve industries, within the framework of the Spain 5.0 model. These industries include various fields such as medicine, digital and electronic technologies, robotics, logistics, aircraft and drone manufacturing, fuel and refining activities, biochemistry, and others. The Most Diverse Systems Design (MDSD) methodology was used for sampling.

To ensure participants had a sufficient understanding of the strategic and operational dimensions of their companies, the study specifically targeted individuals in senior and middle management positions,

including department heads, project managers, digital transformation officers, and innovation managers, all of whom are directly involved in strategic decision-making and organizational change processes. This selection ensured participants were able to provide informed responses regarding digital transformation leadership, AI adoption, and organizational agility.

The companies under study were divided into three different size categories, based on their total fixed assets, according to a set of criteria adopted by the Spanish Ministry of Economy (2030 Digital Decade. Spain's Strategic Roadmap 2025): small companies (less than 10 million Euros), medium companies (10–50 million Euros), and large companies (more than 50 million Euros), so that the final sample included 142 small companies, 187 medium companies, and 112 large companies, totalling 441 companies. This distribution reflects the diversity of the New S-curve sectors in Spanish industries, and thus allows for a more balanced representation of regulatory contexts.

Völter et al. (2006) reported that the MDSD model is widely employed across a broad range of scientific fields, including political and social sciences. This model is particularly suitable for studies addressing heterogeneous groups, as it identifies key issues that are similar across different domains. The selection of this approach stems from its capacity to enable comparisons between diverse industrial sectors while accounting for variations in firm size and activity, maintaining consistency with the structural equation modelling framework adopted in the present study, and considering the unique contextual elements that influence outcomes. Based on this premise, the current research adopted this model in light of the diversity among the Spanish firms under investigation in terms of size and sector of activity. Firm size was measured by the total value of fixed assets, and the required data were obtained from the Business Development Department of the Spanish Ministry of Commerce.

The respondents were selected through purposive sampling within the participating firms to ensure that they possessed relevant managerial knowledge and experience related to digital transformation and innovation processes. Potential respondents were contacted via email, using the official communication channels of each company, after obtaining formal approval from the management departments. The questionnaire was administered electronically via a secure online platform (Google Forms), allowing respondents to complete it at their convenience. This method facilitated wider geographic coverage and ensured confidentiality and

TABLE 2 Results of the Reliability Test for the Study Variables

		Frequency	Percentage
Gender	Male	281	63.71
	Female	160	36.28
Age	Less than 20 years	00	00
	20–30 years	186	42.17
	31–40 years	179	40.59
	41–50 years	64	14.51
	51–60 years	12	2.72
	Over 60 years	00	00
Industry Sector	Medical	86	19.50
	Digital	95	21.54
	Robotics	85	19.27
	Logistics	90	20.40
	Biochemical	85	19.27
Position Level	Senior Management	198	l44.90
	Middle Management	243	55.10
Firm Size	Small Size (< €10 million)	142	32.20
	Medium Size (€10–50 million)	187	42.20
	Large Size (> €50 million)	112	25.40

NOTE Total of observations: 441. Firm size classification follows the criteria of the Spanish Ministry of Commerce based on total fixed assets.

voluntary participation. A total of 441 valid responses were collected between January and July 2025.

Regarding the total sample size for this study, it was not possible to determine it precisely due to the change in the classification of industries according to the new S-curve adopted by the Spanish government (2030 Digital Decade. Spain's Strategic Roadmap 2025). In the context of structural equation modelling, the literature recommends that the sample size should be at least 10 to 20 times greater than the number of observed variables in the model (Hair 2009). Based on this criterion, a sample of 441 respondents for the observed variables was considered adequate for model construction in the present study. The descriptive statistics of the respondents are reported in table 2.

Although the sample included firms of different sizes and from various industry sectors, the primary objective of this study was not to test inter-group differences. Instead, the research design focused on examining the structural relationships among the main constructs – digital transformation leadership, AI capabilities, organizational agility, and sustainable competitive advantage – within a unified analytical frame-

work. Therefore, no statistical comparison (e.g. ANOVA or t-tests) was conducted between firm size classes or industry sectors. Future studies could extend this work by applying multi-group analysis (MGA) or other comparative techniques to explore whether the structural relationships vary across organizational contexts.

Results

DESCRIPTIVE STATISTICS OF THE STUDY VARIABLES

Table 3 presents descriptive statistics for each dimension of the study separately. The results show that study participants expressed a high degree of support for digital transformation leadership and organizational agility in the organizations under study, while they expressed a level of agreement regarding artificial intelligence capabilities, a culture of sustainability, and a sustainable competitive advantage.

TABLE 3 Descriptive Statistics Results for the Variable

Variable	Mean	S.D	Description
DTL = Digital transformation leadership	4.25	0.56	Strongly agree
AIC = AI capabilities	3.95	0.46	Agree
IC = Innovation culture	4.09	0.46	Agree
SC = Sustainability culture	4.09	0.45	Agree
OA = Organizational agility	4.27	0.48	Strongly agree
SCA = Sustainable competitive advantage	4.19	0.67	Agree

NOTE Total observations: 441.

Since the data collection in this study relied on self-assessment, which could potentially introduce common methodological bias, Harman's one-factor test was conducted to verify its validity. According to Aguirre-Urreta and Hu (2019), a single factor exceeding 50% of the variance is an indicator of common method bias. The study found that the first factor accounts for only 25.03% of total variance, which indicates that common method bias is not a large issue in our study. This in turn supports the validity of the survey data for use in the present research.

CONFIRMATORY FACTOR ANALYSIS (CFA)

This study employed confirmatory factor analysis (CFA) to verify the consistency of the measurement indices with the established theoretical frameworks. The results showed that, for each theoretical construct, all observed variables used to represent the latent variables were retained, with factor loadings exceeding the minimum acceptable value of 0.55 (Hair 2009).

This confirms that all the variables under study were reliable indicators of their own structure. The detailed results are reported in table 4.

TABLE 4 The Goodness of Fit of Confirmatory Factor Analysis (CFA)

	P-value	Chi-square / degrees of freedom	Root Mean Square Error of Approximation	Incremental Fit Index	Comparative Fit Index	Goodness of Fit Index
	> 0.05	< 2.00	< 0.05	0.90-1.00	0.90-1.00	0.90-1.00
DTL	0.28	1.33	0.05	1.00	1.00	1.00
AIC	0.51	0.80	0.00	1.00	1.00	1.00
IC	0.31	1.34	0.03	1.00	1.00	1.00
SC	0.76	0.11	0.00	1.00	1.00	1.00
OA	0.38	0.11	0.00	1.00	1.00	1.00
SCA	0.14	1.45	0.05	1.00	0.99	0.99

NOTE DTL = Digital transformation leadership; AIC = AI capabilities; IC = Innovation culture; SC = Sustainability culture; OA = Organizational agility; SCA = Sustainable competitive advantage.

STRUCTURAL EQUATION MODELLING (SEM)

To examine the impact of digital transformation leadership and AI capabilities on sustainable competitive advantage through the mediating role of organizational agility, a structural equation modelling (SEM) approach was employed. The model was iteratively estimated and refined until all statistical values and indicators reached acceptable levels. The final model is illustrated in figure 3, while the criteria for indicator values, model fit, and acceptance are summarized in table 5.

TABLE 5 The Goodness of Fit of Structural Equation Modelling (SEM)

Statistics to measure consistency	Degree of acceptance	Result
Probability	≥ 0.06	0.16
CMIN/DF (Chi-square/df)	≤ 2.01	1.09
GFI	≥ 0.91	0.97
CFI	≥ 0.91	0.98
TLI	≥ 0.91	0.98
IFI	≥ 0.91	0.98
RMSEA	≤ 0.06	0.02

NOTE CMIN/DF (Chi-square/df) = Degrees of Freedom; GFI = Goodness of Fit Index; CFI = Comparative Fit Index; TLI = Tucker–Lewis Index; IFI = Incremental Fit Index; RMSEA = Root Mean Square Error of Approximation.

Table 6 reports that which in the SEM all paths were of statistical significance except for that related to the effect of AI competencies on sustainable competitive advantage. This we see from the critical ratio (CR) value of 1.27 (less than 2) and *p* value of 0.209 (greater than 0.05) in the model. Also, in the standardized solution the factor loading is 0.12 which

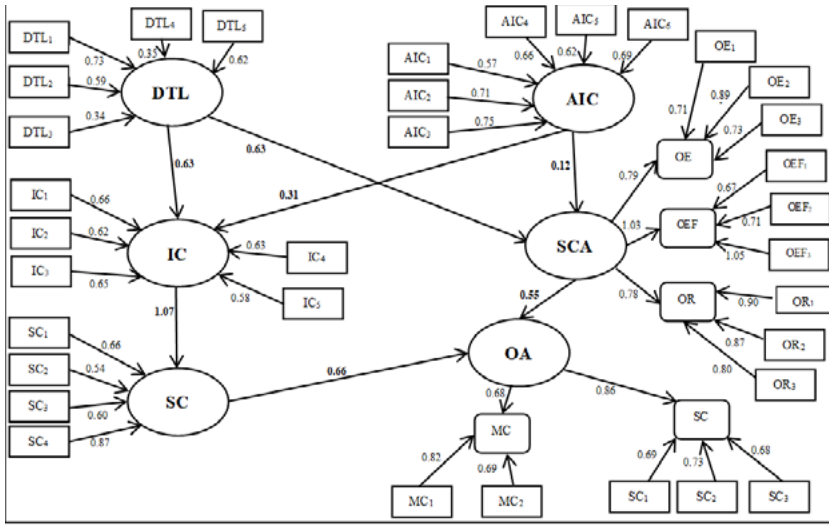

FIGURE 3 The Results of the Structural Equation Model (SEM)
SOURCE World Development Indicators

in turn indicates that AI competencies do not have a direct and statistically significant effect on sustainable competitive advantage. Hence, only the study hypothesis H2 was rejected.

Table 6 also indicates that AI capabilities do not exert a direct impact on sustainable competitive advantage. Instead, through the mediating action of organizational agility which we see to be a factor of 0.12, we have this result. This finding highlights the significant value of organizational agility as a mediating element. In the absence of this mediating effect, achieving a sustainable competitive advantage becomes less attainable.

TABLE 6 Direct Effects Among Variables Researchf

Variable	Std. Regression Weight	Estimate	SE	CR	*P*	Hypothesis
DTL → SCA	0.63	3.28	0.77	4.4	***	1
AIC → SCA	0.12	0.31	0.25	1.27	0.289	2
DTL → IC	0.63	0.83	0.19	4.51	***	3
AIC → IC	0.31	0.22	0.08	2.908	**	4
IC → SC	1.07	0.98	0.12	9.02	***	5
SC → OA	0.66	2.58	0.39	6.86	***	6
OA → SCA	0.56	0.60	0.13	4.91	***	7

NOTE DTL = Digital transformation leadership; AIC = AI capabilities; IC = Innovation culture; SC = Sustainability culture; OA = Organizational agility; SCA = Sustainable competitive advantage.
SE = Standard Error; CR = Critical Ratio. ***: $p < 0.001$ **: $p < 0.01$

Discussion

THE EFFECT OF DIGITAL TRANSFORMATION LEADERSHIP ON SUSTAINABLE COMPETITIVE ADVANTAGE

This study investigates the impact of digital transformation leadership on sustainable competitive advantage. The 'New S-curve' framework suggests that digital transformation leadership plays a central role in strengthening a firm's sustainable competitive advantage. This occurs through the effective direction of digital resources and capabilities toward the development of more adaptive and efficient business models, which better enables companies to respond to technological changes. Digital transformation leadership also contributes to higher levels of innovation and improved responsiveness to labour market demands. Moreover, it facilitates the diffusion of new knowledge within Spanish organizations and support the growth of what may be termed 'New S-curve' industries, which inherently require advanced technological and innovative structures. In light of the accelerated pace of technological change, leaders oriented toward digital transformation assume a pivotal role in expanding the strategic horizons of organizations (2030 Digital Decade. Spain's Strategic Roadmap 2025).

In Spain, national industries are influenced by their counterparts in European countries (France, UK, etc.). This supports the response of various Spanish institutions to external factors, such as changes that are part of creating a sustainable competitive advantage. This is supported by Diaz-Sarachaga (2024), who emphasized that knowledge exchange within organizations influences their ability to respond to changes in the business environment in order to seize potential opportunities. This ability, referred to as 'organizational responsiveness', represents one of the key dimensions of sustainable competitive advantage.

THE EFFECT OF AI CAPABILITIES ON SUSTAINABLE COMPETITIVE ADVANTAGE

Although AI capabilities are a strategic resource that plays a crucial role in fostering sustainable competitive advantage – by enabling organizations to improve operational efficiency, support data-driven decision-making, and develop innovative products and services that more effectively meet customer needs (Davtyan et al. 2024) – the results of this study did not reveal any significant impact. As we see in table 6, the standardized regression coefficient is 0.12, which has a CR (Critical

ratio) of 1.27, that is, below the required minimum of 2, and a significance level of $p = 0.289$, which is greater than the 0.05 criterion. Thus we see that there is no direct and statistically significant impact of AI on the achievement of sustainable competitive advantage. We reject the hypothesis related to this relationship (H2), which was that there is a direct impact. From a theory point of view this suggests that in New S-Curve Spanish industries which are implementing AI solutions, sustainable advantage is not a given and that these solutions have to be put in the context of a larger set of organizational strategies which include an innovative culture, robust digital infrastructure and the ability to very quickly adapt to market changes.

Innovation culture is put forth as a very important element which supports organizational agility. It is a primary element in the development of creative thinking and in the support of initiatives at both individual and group levels. Also, it cultivates a work environment which puts forward experimentation and learning from past failures, as well as the adoption of flexible operational structures that enable organizations to quickly change in response to various environmental shifts. In this setting it is proposed that AI capabilities in and of themselves do not guarantee organizations' sustainable competitive edge, which is what they are after, in particular in the still very early stages of technology and innovation which we see play out along the New S-curve. Rather, the effectiveness of these capabilities is determined by their integration into a comprehensive and clearly defined strategic vision focused on developing the digital infrastructure of organizations, establishing an organizational culture based on creativity and innovation, and enhancing adaptive capabilities to keep pace with the ongoing transformations of the labour market.

THE ROLE OF ORGANISATIONAL AGILITY'S COMPONENT FACTORS TO SUSTAINABLE COMPETITIVE ADVANTAGE

In this study, it was found through structural equation modelling that both digital transformation leadership and AI practices contribute to the sustainable competitive advantage of the organizations examined, operating through what is referred to as organizational agility.

In the course of the great change which in recent years has befallen the Spanish economy and technology, large groups of Spanish workers in growing sectors report a great interest in developing advanced digital skills, in participating in continuous training programmes, and being able to adapt to flexible work structures. These practices enhance their

ability to support innovation and development strategies, while balancing operational efficiency and organizational agility in the face of various future variables.

The culture of innovation within organizations – including its intent to innovate, infrastructure, influence, implementation, and integration – is a driving force motivating Spanish employees in these sectors to engage more actively and creatively in developing organizational solutions. This is a sign of a very proactive corporate approach, which is an element of a strategy for development and transformation into a sustainable model. Also as a culture of sustainability, which we may term as the base structure for environmental, social, and corporate governance issues, develops in an organization, employees are better placed to put into practice new ideas and innovations, which in turn is a key element of our sustainable competitive advantage. We see this play out in the work of Huang et al. (2022), which reported that an innovative organizational culture greatly supports employee creativity which in turn plays a large role in the long term in building sustainable competitive advantage.

From the above, it can be argued that these findings are consistent with the Resource Based View (RBV), which asserts that sustainable competitive advantage stems from valuable and unique resources. In this research, digital transformation leadership and AI capabilities represent strategic resources that enable companies to restructure their operations and maintain competitiveness. Furthermore, the mediating role of organizational agility aligns with the dynamic capabilities perspective, highlighting the organization's ability to sense, leverage, and transform resources to adapt to various environmental changes.

Conclusion: Contributions and Recommendation

Overall, the findings of this study confirm that digital transformation leadership exerts a significant direct influence on achieving sustainable competitive advantage, while AI capabilities do not show a direct effect. However, both variables indirectly contribute to sustainable competitive advantage through the mediating role of organizational agility. This highlights the strategic importance of agility as a mechanism that enables organizations to convert digital and technological resources into long-term competitiveness.

The current study generally enriches strategic management theory by elucidating how digital transformation leadership (DTL) and artificial intelligence capabilities (AIC) operate within emerging S-curve industries

in Spain. It also expands the resource-based perspective by demonstrating that DTL functions as a high-level strategic resource, enabling organizations to transform digital tools into scarce competitive assets.

Furthermore, this study reinforces dynamic capability theory by proving that organizational agility is the fundamental mechanism through which digital and AI capabilities generate a sustainable competitive advantage. AI capabilities alone do not produce a competitive advantage unless they are embedded in flexible, innovation-oriented structures. This establishes a crucial condition, demonstrated by the current study's sample, that has been overlooked in much of the relevant previous literature. Overall, the current study presents an enhanced integrative model that explains how intangible technological resources evolve into long-term strategic value.

This study sought to provide clear guidance for managers in emerging S-curve industries in Spain, emphasizing the crucial role of digital transformation leadership – not just technology – as the primary driver for fostering a sustainable competitive advantage. Therefore, the organizations studied should continue investing in developing leaders capable of crafting a digital vision, enabling coordination across different functional levels, and supporting technology-driven decision making.

The study also found that agile organizations are those that recognize the value of digital tools and artificial intelligence in terms of performance, and that managers should focus on flexible tools, rapid decision-making processes, and a culture that encourages innovation and collaboration. Furthermore, Spanish economic policymakers are urged to promote the growth of national programmes that foster digital skills, leadership development, and innovation systems, thereby accelerating the transition to what are known as New S-curve industries.

In future research, it is recommended that studies should examine the factors that influence or are likely to influence the variables of the current study (such as leadership style, level of innovation, level of technology adoption (including artificial intelligence), environmental changes and uncertainties, etc.). Furthermore, conducting comparative studies (such as research on different industrial or service sectors, company sizes, ownership (private or public), company presence in different countries, etc.) will undoubtedly broaden the scope of research to better understand how digital transformation impacts different work environments.

In addition, it is suggested that hybrid research methodologies be used, combining quantitative and qualitative analysis, including, for ex-

ample, market research, qualitative interviews, and other scientific research methods. This will help uncover more about the deep relationships between behavioural and organizational elements, enriching future research.

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