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Toward sustainable strategies and digitalization: The impact on firm performance in Mexican manufacturing companies

Rumbo a estrategias sostenibles y digitalización: El impacto en el rendimiento empresarial de las empresas manufactureras mexicanas

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Abstract
Sustainable strategies and digitalization play central roles in the transition of manufacturing companies toward the development of sustainable products and services. This study examines whether the implementation of environmental care strategies and the integration of advanced technological tools influence firm performance. It also explores the indirect effect of sustainable strategies on performance through digitalization in manufacturing organizations. To test these relationships, the study applies a partial least squares structural equation modeling (PLS-SEM) technique to a sample of 120 firms in the manufacturing sector in Coahuila, Mexico. The results indicate that when organizations implement energy conservation practices, reduce waste generation, and undertake energy infrastructure projects—combined with the adoption of advanced technologies that support information integration and analysis—they achieve higher levels of performance. These findings offer important implications for managerial decision-making and for the development of public policies aimed at promoting sustainability-oriented strategies and digital transformation in small and medium-sized enterprises in developing countries.

Keywords: sustainability; digitalization; firm performance; technology; environment; manufacturing industry
JEL Classification: O14

Resumen
Las estrategias sostenibles y la digitalización desempeñan un papel fundamental en la transición de las empresas manufactureras hacia el desarrollo de productos y servicios sostenibles. Este estudio examina si la implementación de estrategias relacionadas al cuidado medioambiental y la integración de herramientas tecnológicas avanzadas influyen en el rendimiento de las empresas. También explora el efecto indirecto de las estrategias sostenibles en el rendimiento a través de la digitalización en las organizaciones manufactureras. Para poner a prueba estas relaciones, el estudio aplica la técnica de mínimos cuadrados parciales-modelo de ecuaciones estructurales (PLS-SEM) a una muestra de 120 empresas del sector manufacturero de Coahuila, México. Los resultados indican que las organizaciones que implementan prácticas de conservación de energía reducen la generación de residuos y promueven proyectos de infraestructura energética, en combinación con la adopción de tecnologías avanzadas que apoyan la integración y el análisis de la información, además de lograr niveles más altos de rendimiento. Estos hallazgos ofrecen importantes implicaciones para la toma de decisiones gerenciales y para el desarrollo de políticas públicas destinadas a promover estrategias orientadas a la sostenibilidad y la transformación digital en las pequeñas y medianas empresas de los países en desarrollo.

Palabras clave: sostenibilidad; digitalización; rendimiento empresarial; tecnología; medio ambiente; industria manufacturera
Clasificación JEL: O14

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1. Introduction

For manufacturing firms, reducing environmental impacts has become essential. As a result, many companies are integrating sustainable strategies and digitalization into their manufacturing processes. According to the International Energy Agency (IEA, 2021), the manufacturing industry generates approximately 23% of global carbon dioxide emissions and consumes close to 33% of global energy. In addition, industrial processes are undergoing a transformation toward Industry 4.0, characterized by the use of digital technologies (Chen et al., 2020).

This research focuses on Mexican manufacturing firms, which are considered engines of economic growth (Inegi, 2022) and generate 71% of formal employment (Arellano-Rodríguez, 2024). Despite their importance, these firms face several challenges, including low productivity compared with large foreign companies (Isaac Egurrola, 2025; Landa Díaz & Cerezo García, 2025), limited access to financing and technology (Lozano et al., 2024), and resistance to change among stakeholders and managers (Cuevas-Pichardo et al., 2025). For these reasons, it is essential to promote both the adoption of emerging technologies and the implementation of strategies focused on environmental care.

Several current trends must be considered. Society increasingly values digital and sustainable services (Hallstedt et al., 2020), and digitalization offers new opportunities for environmental sustainability (Al Hawamdeh & Al-Edenat, 2025; de Sousa Jabbour et al., 2018). By fostering digitalization and sustainable strategies in consumption and production processes, manufacturing firms can reduce the adverse environmental effects generated by products and services (Esmaeilian et al., 2016). Digitalization drives innovation in small and medium-sized enterprises through emerging technologies that enable them to compete in dynamic markets (Cassaro et al., 2024). Likewise, integrating the supply chain into a single system promotes the coordinated flow of materials and information (Arellano-Rodríguez, 2024), while sustainable strategies strengthen business proactivity by supporting resource savings and responsible processes (Beltramino et al., 2023). Baumgartner and Rauter (2017) argued that incorporating sustainable management practices positively influences process efficiency and productivity. Organizations must therefore adopt sustainable business models aligned with international markets that foster economic, social, and environmental development (Chabowski et al., 2025; Dam et al., 2024).

There is growing academic interest in sustainable strategies, digitalization, and firm performance, particularly in understanding how these concepts are interconnected (Ding et al., 2024; Isensee et al., 2020). The literature identifies several indicators that help manufacturing firms understand these relationships. Some authors have found that firms combining digitalization and sustainable strategies outperform their competitors in profitability, productivity, and revenue generation (Abou-Foul et al., 2021). This study draws on the resource-based view (RBV), integrating a theoretical approach to explain how firms use resources and capabilities to achieve competitive advantages. Accordingly, the aim of this research is to propose that the integration of sustainable strategies and digitalization as strategic capabilities improves the performance of manufacturing firms. The study also seeks to explain the positive relationship between sustainable strategies and digitalization and the mediating effects of digitalization on firm performance.

Previous studies indicate that both digitalization and sustainable strategies function as transmission mechanisms closely linked to the RBV framework because they reconfigure the technological resource base, generate dynamic capabilities with an environmental focus, and create competitive differentiation by enabling access to markets that prioritize sustainability (Horbach, 2024). From the RBV perspective, it is not sufficient for firms merely to possess digital resources; these resources must be integrated and orchestrated through organizational routines that incorporate sustainability as a central component of the business model, reduce risks, and increase profitability (Brenner, 2018; Yiu et al., 2021). Recent literature shows that digital transformation and sustainability are emerging as strategic resources for Mexican small and medium-sized enterprises, generating sustainable competitive advantages based on technological, organizational, and human capabilities (Lozano et al., 2024; Porras Sandoval et al., 2025).

The proposed research hypotheses were analyzed using information collected from 120 manufacturing firms in Coahuila, Mexico. Manufacturing activity is one of the most important pillars of the Mexican economy, accounting for 18.6% of the national GDP (ClusterIndustrial, 2022), and it represents the most significant productive sector in the state of Coahuila, which recorded growth rates exceeding 10% during 2021 and 2022 (Inegi, 2022). The present study employs partial least squares structural equation modeling (PLS-SEM). This investigation addresses the following research questions: What effects do sustainable strategies and digitalization have on the overall performance of manufacturing companies? How do sustainable strategies influence digitalization in manufacturing firms? And is there an indirect effect between sustainable strategies and firm performance resulting from digitalization?

Considering these factors, the present research contributes to the literature by emphasizing the importance of incorporating technology to strengthen digitalization in manufacturing firms. Previous studies have highlighted the role of technology in enhancing firms’ competitiveness and their ability to adapt to changing markets (Yunis et al., 2018). Moreover, digital transformation should be supported by sustainable strategies in the development of environmentally responsible products and services (Burton & Dickinger, 2025; Engert et al., 2016; Potter et al., 2021).

This research offers important implications for managers and policymakers. For managers, incorporating innovative strategies is essential for promoting digital transformation. At the same time, digital transformation should be grounded in sustainable strategies through initiatives such as energy conservation practices, renewable energy projects, investments in energy infrastructure, and scientific research within firms (United Nations, 2020). Policymakers must promote measures and incentives that facilitate firms' adoption of sustainability-oriented strategies and the integration of digital technologies into their management processes. Governments can also support technological development by strengthening digital infrastructure and expanding workforce skills (Ionescu-Feleagă et al., 2023).

The remainder of this article is organized as follows. First, we review the literature related to the proposed hypotheses, analyzing the relationship between digitalization and sustainable strategies and highlighting their influence on the overall performance of manufacturing firms. We then present the methodology, including sample selection, variable definitions, and the research model. Finally, we discuss the results, draw conclusions, and outline the study's contributions.

2. Theoretical framework

2.1 Sustainable strategies and their impact on digitalization

In recent years, information technologies have been widely discussed in the literature for their contribution to more environmentally responsible human activities (Baggia et al., 2019; Dam et al., 2024). Isensee et al. (2020) noted that environmental sustainability and digitalization have a positive effect on the evolution of small and medium-sized enterprises (SMEs). Digitalization is defined as a "tool" that transforms interactions, communications, business functions, and business models into digital environments (I-Scoop, 2021).

The global economic crisis, competitors' strategies, and governmental changes are among the factors that promote the adoption of green technologies (Buchalcevova & Gala, 2013). Cloud-based tools are particularly relevant in this context because they do not require substantial investments in technological infrastructure. Consequently, Yiu et al. (2021) proposed the daily use of cloud-embedded business intelligence systems as a strategic initiative to enhance a firm's resources by adding value to information and aligning objectives with organizational strategies. From this perspective, business intelligence systems can be incorporated into production and operations strategies to generate competitive advantages. Moreover, to align business management with environmental objectives, it is desirable to integrate digitalization with big data analytics and machine learning within business models (Brenner, 2018).

Digitalization has become a transformative trend reshaping business models and society. It is altering how firms in the digital economy produce and deliver high-quality products and services (Horbach, 2024; Trașcă et al., 2019). The era of the Sustainable Development Goals has also reshaped organizational strategies, emphasizing the need for socially responsible firms that invest in technological infrastructure and motivate others to do the same, thereby fostering a more global and sustainable environment (Di Vaio et al., 2020).

Intangible resources—such as human capital and reporting systems based on environmental, social, and governance performance—constitute critical assets within the resource-based view (RBV). Ecological knowledge within management teams can be shared with stakeholders, promoting sustainable organizational routines (Gómez Martínez et al., 2024; Wicaksari et al., 2024). Digitalization is also recognized as an intangible resource that strengthens competitiveness by optimizing processes through digital tools and facilitating decision-making via business intelligence systems, consistent with the RBV (Pérez Escutia & Fischer de la Vega, 2023). Yiu et al. (2021) further argued that the RBV supports the integration of business intelligence systems into organizational operations through the coordination of certified capabilities and processes. Brenner (2018) complemented this view by emphasizing that digital technologies—such as artificial intelligence and big data—must be aligned with sustainable strategies that foster green innovation and organizational resilience.

Research also highlights managers as key promoters of digitalization in organizations, as they communicate its benefits to employees (Baggia et al., 2019; Isensee et al., 2020). However, the relationship between digitalization and sustainable strategies remains complex. Oláh et al. (2020) examined the relationship between sustainability objectives and digitalization in organizational processes, proposing relevant policies for governments and stakeholders. Gobbo et al. (2018) identified several benefits associated with the incorporation of cloud computing, artificial intelligence platforms, and big data—such as intelligent energy and resource distribution—which contribute to fewer failures in industrial processes, machinery, and supplies. In contrast, some researchers argue that the use of such technologies increases emissions and consumes additional resources and energy (Chiarini et al., 2020). The adoption of clean energy technologies also depends on economic indicators such as taxes, public spending, and trade (Bashir et al., 2023). Despite these divergent perspectives, there is clear academic interest in the relationship between digital technologies and environmental sustainability.

Based on the above arguments, we propose the following hypothesis:

Hypothesis 1 (H1): *Sustainable strategies promote the integration of digitalization in manufacturing firms*.

2.2 Sustainable strategies and their relationship with performance

To implement sustainable strategies and translate them into improved financial performance, stakeholder involvement is essential—particularly that of investors, governments, employees, suppliers, and customers. Adopting sustainable strategies requires developing specific programs aimed at reducing emissions, improving operational efficiency, and minimizing waste (Eccles et al., 2013). Sustainable firms must assess their sustainability performance by adopting innovative tools and organizational initiatives. According to Engert et al. (2016), the integration of business processes and sustainability provides a path to stability in rapidly changing markets. A strategic focus on sustainability and organizational flexibility also strengthens dynamic business competencies (Meflinda et al., 2018).

Researchers have increasingly adopted the resource-based view (RBV), which emphasizes the efficient and innovative use of energy, resources, and labor to manufacture products and achieve sustainable development in a constantly evolving environment (Cagliano & Behnam, 2019). Recent studies argue that the RBV offers a strategic framework for implementing sustainable strategies that not only reduce environmental impacts but also enhance organizational reputation and create new market opportunities (Barragán-Hernández & Aguilar-Fernández, 2024). Moreover, when these strategies are combined with emerging technologies, they become even more valuable in resource-constrained economies (Cuevas-Pichardo et al., 2025). Gómez Martínez et al. (2024) reported empirical evidence that stronger sustainability performance is associated with improved corporate reputation, greater stakeholder trust, and enhanced firm performance. Thus, sustainable strategies represent not only an ethical responsibility but also a strategic resource that drives profitability and competitiveness. Organizational learning further reinforces dynamic capabilities from the RBV perspective (Beltramino et al., 2023), and sustainable strategies can therefore be adopted to develop business resources and secure competitive advantages (Barney, 1991).

Existing research supports the view that managers should prioritize sustainable strategies to achieve stronger financial performance (Gorondutse et al., 2020; Ukko et al., 2019). Santis et al. (2016) identified a positive relationship between financial performance and social practices, demonstrating that organizations committed to sustainability improve their financial outcomes over time. Although sustainable management practices are more firmly established in large firms, both small and large organizations continue to make important efforts to enhance performance and incorporate social objectives (Falle et al., 2016).

Based on this evidence, the research proposes the following hypothesis:

Hypothesis 2 (H2): *Sustainable strategies positively influence business performance in manufacturing firms*.

2.3 Digitalization and its effect on performance

The literature recognizes that digital technologies that support production processes and product offerings have a direct effect on firm performance (Di Vaio et al., 2022; Restrepo-Morales et al., 2024). By anticipating the benefits of digitalization, firms can transform their operational and strategic processes through Industry 4.0, which involves integrating smart technologies and enhancing traditional management systems (Manresa et al., 2021). Digitalization enables employees to collaborate across departments, improve productivity and work quality, and coordinate more effectively with external business partners across the broader industry ecosystem (Ruivo et al., 2020). Digital information is also central to decision-making, as it allows leaders to visualize strategies and anticipate scenarios (Teerasoponpong & Sopadang, 2022).

Digitalization—particularly through business intelligence systems—provides a tool for analyzing organizational challenges and responding to them in a timely manner (Chen & Lin, 2021). The reasons for implementing information systems vary depending on each organization’s needs, and the perceived benefits differ accordingly.

The incorporation of digital technologies improves profitability by enhancing efficiency, expanding market coverage, and reducing operational costs (Chege & Wang, 2020). Given the economic potential of digitally enabled tools, a central challenge for organizations lies in motivating stakeholders to adopt and use these systems to strengthen analytical capabilities (Kohtamäki et al., 2020). Porter and Heppelmann (2015) argued that, in addition to adopting digital technologies, firms must develop capabilities in research and development, modify routines, and generate new solutions to improve performance.

The positive effect of digitalization on firm performance has been documented across several domains, including product manufacturing, customer service development, competitiveness, and the creation of new business models (Joensuu-Salo et al., 2018). Similarly, Weill and Woerner (2015) reported increases in profit margins and revenue among firms that adopt digital technologies and operate within digital ecosystems. Attewell (1992) demonstrated that firms adopting an absorptive capacity strategy are able to acquire new resources and recognize the value of information generated through digitalization. Innovation becomes the primary mechanism for leveraging knowledge to achieve business success, in alignment with the resource-based view (RBV).

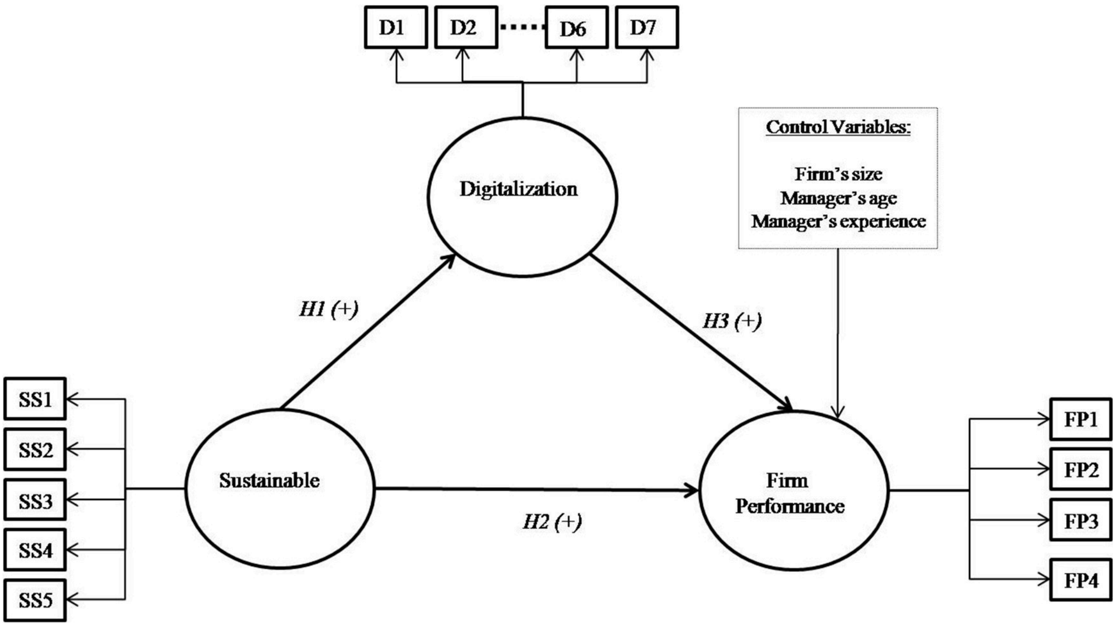
Digitalization also strengthens organizational visibility, understood as the ability to generate, share, and use strategic information. Within the RBV framework, visibility is considered an intangible resource that enhances information-based decision-making (Lopez-Torres et al., 2025). The adoption and implementation of digital technologies drive firm performance by optimizing production processes and improving resource efficiency. Under the RBV, the combination of technological resources creates new dynamic capabilities, particularly in firms located in emerging economies (Cuevas-Pichardo et al., 2025). Firm performance is not determined solely by the implementation of technology; it also depends on a small or medium-sized enterprise's ability to absorb and apply external knowledge to digital processes (Cuevas-Vargas & Fernández-Escobedo, 2025). Within this framework, advanced technologies applied to manufacturing firms have been shown to positively influence performance through cost reduction, automation, product innovation, and organizational resilience—even during periods of crisis (Madrid-Guijarro et al., 2025).

Based on the above arguments, we propose the following hypothesis:

Hypothesis 3 (H3): *Digitalization fosters business performance in manufacturing firms*.

This research therefore proposes that sustainable strategies and digitalization positively influence firm performance. Likewise, sustainable strategies have a positive effect on digitalization (see Figure 1).

Figure 1. Conceptual research model



Source: Authors' elaboration

3. Methodology

This section explains how the sample was prepared and how the information was obtained and reviewed. It also describes the measurement of the conceptual variables and the relationships among them, identifying the dependent, independent, and control variables. The section concludes with the proposed research model using the partial least squares structural equation modeling (PLS-SEM) technique.

3.1 Sample and data

The study focuses on small, medium-sized, and large manufacturing firms. To construct the database, we followed the criteria established by the National Statistical Directory of Economic Units (Denue, 2019). This official source provides information on the identification, location, economic activity, and size of more than five million active economic units across Mexico. All information is validated by the National Institute of Statistics and Geography (Inegi, 2021).

Manufacturing firms with 11 or more employees located in the state of Coahuila, Mexico, were selected. Applying these criteria yielded a population of N = 1,270 companies. A pre-test was conducted with directors and managers from different manufacturing firms to ensure that the questionnaire items were clear, understandable, and aligned with the study's objectives.

A total of n = 120 valid responses were retained for analysis, although more responses were initially received. To ensure data quality and consistency, incomplete questionnaires and responses with inconsistent information were excluded. Participants were individuals responsible for decision-making within their firms (directors and managers).

Data were collected through an online questionnaire distributed directly to each company. The data collection period lasted eight months, beginning in December 2020 and ending in July 2021. The overall sample design was based on the principles of stratified sampling. To accomplish this, stratification criteria were defined according to the study's objectives, the availability of information, the structure of the population, and feasibility for fieldwork.

3.2 Measurements

The study adopts the structural equation modeling methodology using partial least squares (PLS-SEM), which requires defining and formalizing the nature of the research constructs. The model is composed of reflective composites (Jarvis et al., 2003). The unobserved variables analyzed are sustainable strategies, digitalization, and firm performance. Each construct is composed of the manifest indicators required to specify and measure the model (Willems, 2000). These composites were developed based on an extensive review of the literature, with an emphasis on empirical studies in various application contexts that provide sufficient support for their measurement (see Table 1).

3.3 Independent variables

Independent variables produce indirect or direct effects on other variables (Nitzl et al., 2016). Sustainable strategies serve as an independent variable that captures the extent to which a firm incorporates global sustainability indicators into its operations and departments. This variable was measured using five indicators (see Table 1) on a Likert scale ranging from 1 to 5, where 1 represents minimal integration and 5 represents maximum integration. Adopting sustainable strategies reflects an innovation process that improves the business model and internal processes, thereby influencing financial performance (Grayson et al., 2018).

Table 1. Composites and indicators of the model

Composite	Indicator	Reference
Sustainability strategy	SS1: Energy conservation methods	Baggia et al. (2019); United Nations (2020)
	SS2: Renewable energy projects	
	SS3: Investment in energy infrastructure	
	SS4: Information and communication technologies	
	SS5: Research and development	
Digitalization	D1: Big data	Abou-Foul et al. (2021); Dalenogare et al. (2018); Eller et al. (2020)
	D2: Cloud computing	
	D3: Predictive analytics	
	D4: Integrated technology platforms	
	D5: Business intelligence system	
	D6: Enterprise resource planning system	
	D7: Artificial intelligence system	
Firm performance	FP1: Increase in profitability	Elbashir et al. (2008); Gunday et al. (2011)
	FP2: Increase in market share	
	FP3: Enabling cost savings and more competitive pricing	
	FP4: Integration of the value chain into a single system	

Source: Authors' elaboration
Detailed information on the composites (Sustainability strategy: SS1–SS5; Digitalization: D1–D7; Firm performance: FP1–FP4) and their indicators is displayed

3.4 Dependent variables

Dependent variables are a central component of the study (Nitzl et al., 2016). Firm performance is one of the primary dependent variables (see Table 1). It consists of four indicators that capture an organization's performance over the past two years, focusing on profitability, market share, competitive price management, and value chain integration within a unified system (Elbashir et al., 2008; Gunday et al., 2011). Firm performance was measured on a Likert scale ranging from 1 to 5, where 1 represents very unfavorable performance and 5 represents very favorable performance. These indicators are based on prior empirical studies and measurement standards widely accepted in organizational research (Powell, 1995).

Digitalization is also treated as a dependent variable and is composed of seven indicators that capture the integration of various technological platforms and tools. The key objective of digitalization is to enhance internal process capabilities and generate competitive advantages in the marketplace. Digitalization was measured on a Likert scale ranging from 1 to 5, where 1 represents minimal integration and 5 represents maximum integration. The measurement of this variable is supported by previous field studies examining the application of technological tools to improve business processes, which in turn positively affect the supply chain and overall firm performance (Hennelly et al., 2020).

3.5 Control variables

This research examines firm size, manager age, and manager experience as control variables to better understand their influence on the use of sustainable strategies and digitalization in manufacturing firms. These variables have been widely used in previous studies (Cenamor et al., 2019; Chen & Lin, 2021; Heredia-Calzado & Duréndez, 2019; Peters et al., 2016).

Firm size, measured by the number of employees, may indicate business stability and sustained growth (Kohtamäki et al., 2020) and may also serve as a proxy for technological infrastructure (Abou-Foul et al., 2021). Prior studies have identified a negative impact of older managers on organizational performance, largely attributed to resistance toward adopting new digital technologies (Kunze et al., 2013). In contrast, years of managerial experience in manufacturing firms are generally considered a positive factor for decision-making.

Dummy variables were created to measure two of the control variables. For manager age, individuals aged 25 to 49 were coded as 0, and those aged 50 or older were coded as 1. For managerial experience, those with 1 to 15 years of experience were coded as 0, while those with more than 15 years of experience were coded as 1. Firm size was measured using the total number of employees.

3.6 Research model

The research model applies multivariate analysis to examine the relationships among composites formed by multiple observable indicators, allowing the study hypotheses to be tested (Monecke & Leisch, 2012). Marcoulides (1998) demonstrated that structural equation modeling is widely used in the social sciences because many conceptual variables cannot be directly observed. The conceptual model (see Figure 1) was assessed using the SmartPLS software (SmartPLS, 2020) and the partial least squares algorithm.

4. Analysis of results

4.1 Measurement model assessment

Model estimation begins by running the PLS algorithm and refining the external model to remove indicators with standardized loadings lower than 0.707 (Carmines & Zeller, 1979). The communality of an indicator (λ^2) represents the proportion of an item's variance explained by the composite; values of $\lambda^2 \geq 0.707$ are considered acceptable. Indicators with loadings above 0.40 may be retained if the overall reliability, validity, and quality thresholds of the model are satisfied and if their removal does not improve the measurement model. For this reason, traditional measures of internal consistency, reliability, and validity remain appropriate for composite-based analysis (Henseler, Ringle, et al., 2016).

The quality criteria for the measurement models are presented in Table 2. Composite reliability values exceed the required threshold, supporting the internal consistency of each construct. Composite reliability is preferred over Cronbach's alpha in PLS modeling (Marcoulides, 1998) and is generally considered a more consistent estimator (Dijkstra & Henseler, 2015).

Cronbach's alpha ranges from 0 to 1. Darren and Mallery (1995) suggested that values below 0.50 are unacceptable, values between 0.80 and 0.90 are considered good, and values above 0.90 indicate excellent reliability. Table 2 reports the Cronbach's alpha values along with their corresponding assessments.

The average variance extracted (AVE), proposed by Fornell and Larcker (1981), is a more conservative measure than composite reliability. An AVE value greater than 0.50 indicates that each composite explains at least 50% of the variance of its manifest indicators. As shown in Table 2, the latent variables achieve convergent validity because their AVE values exceed the recommended threshold.

Table 2. Outer model validation and confirmatory composite analysis

Composite	Indicator	Loadings	Cronbach's α	Composite Reliability	Average Variance Extracted (AVE)
Sustainable strategy	SS1	0.809	0.882	0.913	0.679
	SS2	0.852			
	SS3	0.895			
	SS4	0.789			
	SS5	0.770			
Digitalization	D1	0.829	0.924	0.939	0.688
	D2	0.747			
	D3	0.872			
	D4	0.868			
	D5	0.842			
	D6	0.800			
	D7	0.841			
Firm performance	FP1	0.854	0.898	0.929	0.765
	FP2	0.914			
	FP3	0.870			
	FP4	0.860			

Loadings represent the absolute contribution of an indicator to the composite (dimension); they reflect the bivariate correlation between each indicator and its composite)

Table 3 presents the Fornell and Larcker (1981) criterion used to assess discriminant validity. According to this criterion, the correlations among latent variables must be lower than the square root of the average variance extracted (AVE) for each construct. In this study, all constructs satisfy this requirement, indicating that discriminant validity has been achieved.

Table 3. Fornell–Larcker criterion

	Digitalization	Firm performance	Sustainable strategy
Digitalization	0.829		
Firm performance	0.486	0.875	
Sustainable strategy	0.717	0.523	0.824

The Fornell–Larcker criterion evaluates discriminant validity by confirming that the square root of each construct's AVE (diagonal values) exceeds its correlations with other constructs

Henseler, Hubona, et al. (2016) conducted simulation research demonstrating that discriminant validity is most effectively assessed using the heterotrait–monotrait ratio (HTMT). This ratio is calculated by dividing heterotrait correlations by monotrait correlations. When all HTMT values fall below 0.90—or below 0.85 under more conservative criteria—the constructs are considered to have achieved discriminant validity. As shown in Table 4, all constructs in the proposed conceptual model meet this requirement.

Table 4. Heterotrait–Monotrait ratio

	Digitalization	Firm performance	Sustainable strategy
Digitalization	—		
Firm performance	0.527	—	
Sustainable strategy	0.787	0.566	—

The heterotrait–monotrait ratio of correlations (HTMT) is based on the multitrait–multimethod matrix and is used to assess discriminant validity

4.2 Structural model assessment

In this section, the proposed structural model is evaluated using the bootstrapping procedure to determine its reliability. To ensure robust results, 10,000 subsamples were generated (Hair et al., 2013, 2014, 2017; Marcoulides, 1998; Monecke & Leisch, 2012).

The standardized root mean square residual (SRMR), the unweighted least squares discrepancy (d_ULS), and the geodesic discrepancy (d_G) all fall within acceptable ranges. For each index, the original value is compared with the confidence interval derived from the bootstrapping distribution. The confidence interval must include the original value for the model to be considered a good global fit. Confidence intervals based on the 95% or 99% levels are typically used to evaluate model adequacy (Henseler, 2017; Henseler, Hubona, et al., 2016). Both the unweighted least squares discrepancy and the geodesic discrepancy are expected to fall within their respective bootstrapped confidence intervals (Dijkstra & Henseler, 2015). Table 5 presents the global model fit results.

Table 5. Global model adjustment

Measure	Model	Original Sample	95% Level	99% Level
SRMR	Saturated model	0.063	0.057	0.064
	Estimated model	0.067	0.064	0.071
d_ULS	Saturated model	0.814	0.722	0.824
	Estimated model	0.847	0.786	0.951
d_G	Saturated model	0.446	0.442	0.510
	Estimated model	0.446	0.454	0.522

Values of the original sample are presented for both the saturated and estimated models

The dominant model-fit criterion is the standardized root mean square residual (SRMR). This statistic reflects the square root of the sum of squared differences between the observed correlations and the model-implied correlations. According to Hu and Bentler (1998), an SRMR value below 0.08 indicates an adequate model fit, and Williams et al. (2009) noted that values below 0.10 can also be considered acceptable. The obtained value of SRMR = 0.063 is therefore well below the recommended threshold (see Table 5). Overall, the global model fit indices suggest a satisfactory model fit. Both the unweighted least squares discrepancy (d_ULS) and the geodesic discrepancy (d_G) meet the required criteria and fall within the corresponding bootstrapped confidence intervals.

The structural model becomes particularly relevant when examining the predictive capacity of the constructs and their interrelationships. The evaluation of the path coefficients (β), together with the F^2 and R^2 values, provides insight into the strength and explanatory power of the model (see Figure 2).

The path coefficients serve as construct-specific measures used to evaluate the study's hypotheses. Table 7 reports these results.

Hypothesis 1 (H1) is supported: sustainable strategies positively influence digitalization, with $\beta = 0.717$, $p = .000$, and a confidence level above 99% (Baumgartner & Rauter, 2017; Ukko et al., 2019). This finding aligns with Isensee et al. (2020), who argued that environmentally oriented strategies shape the extent of digitalization by aligning the firm's mission, vision, routines, and actions with sustainability and technological development.

Hypothesis 2 (H2) is also supported: sustainable strategies have a positive effect on firm performance, with $\beta = 0.368$, $p = .005$, and a confidence level above 99% (Gorondutse et al., 2020; Santis et al., 2016). This finding is consistent with Meflinda et al. (2018), who noted that organizational success depends on balancing environmental, social, and economic goals while cultivating knowledge creation and dynamic capabilities.

Hypothesis 3 (H3) is confirmed as well: digitalization positively influences firm performance, with $\beta = 0.225$, $p = .049$, and a confidence level above 95% (Abou-Foul et al., 2021). As Martín-Peña et al. (2019) suggested, manufacturing firms benefit from integrating digital technologies into their business models by responding more effectively to evolving customer expectations.

The mediation analysis was conducted by examining both the statistical significance and the magnitude of the indirect effects (Hayes, 2009). The results indicate a significant indirect effect linking the predictor variables—sustainable strategies and digitalization—to firm performance. The bootstrapping procedure shows that digitalization partially mediates the relationship between sustainable strategies and firm performance, with an indirect effect of $\beta = 0.162$ and a total effect of $\beta = 0.691$, supported by $p = .048$ (see Table 6).

Table 6. Estimated mediation effects

Mediation Effect	Indirect Effect	Total Effect
Sustainable strategy → Digitalization → Firm performance	0.162**	0.691**

Values represent standardized indirect effects obtained through bootstrapping. Significance levels: $p < .10$ (*), $p < .05$ (**), $p < .01$ (***)

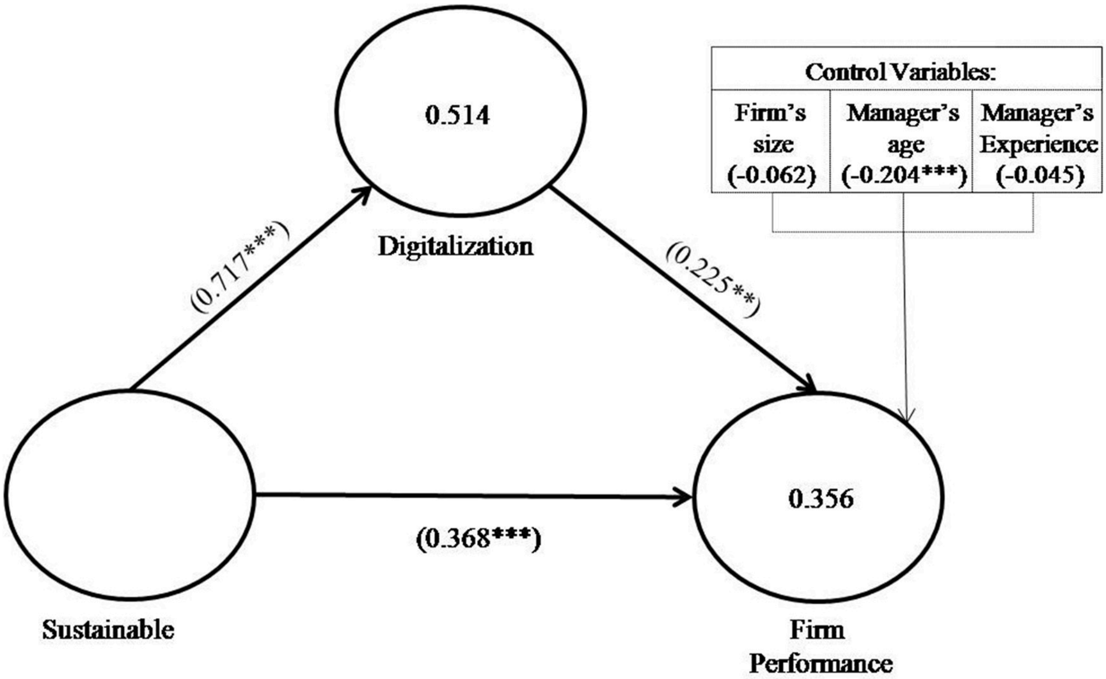
Regarding the control variables (see Figure 2 and Table 7), manager age shows a negative and significant influence on firm performance, with a coefficient of $\beta = -0.204$. This suggests that younger managers—who tend to be more open to technological change—are more likely to promote the use of digitalization and sustainable strategies within their organizations. Top management guidance is an essential factor in cultivating an information-technology-oriented culture (Stewart & Gapp, 2014). In contrast, managerial experience (measured in years leading the firm) and firm size (measured by number of employees) exhibit negative but non-significant relationships with firm performance, with coefficients of β = –0.045 and β = –0.062, respectively.

Table 7. Results of the structural model

Model Hypotheses	R^2	F^2	β	Significance (p)	Results
Sustainable strategy → Digitalization (H1)	—	1.058	0.717***	0.000	Accepted
Sustainable strategy → Firm performance (H2)	—	0.096	0.368***	0.005	Accepted
Digitalization → Firm performance (H3)	—	0.038	0.225**	0.049	Accepted
Firm size → Firm performance	—	0.006	-0.062	0.176	—
Manager's age → Firm performance	—	0.053	-0.204***	0.004	—
Manager's experience → Firm performance	—	0.002	-0.045	0.262	—
Digitalization	0.514	—	—	—	
Firm performance	0.356	—	—	—	

The table presents path coefficients (β) with associated *p*-values. F^2 indicates the relative effect size of each predictor within the structural model. R^2 reflects the model's explanatory power. Significance thresholds: $p < .10$ (*), $p < .05$ (**), $p < .01$ (***)

Figure 2. Research model results

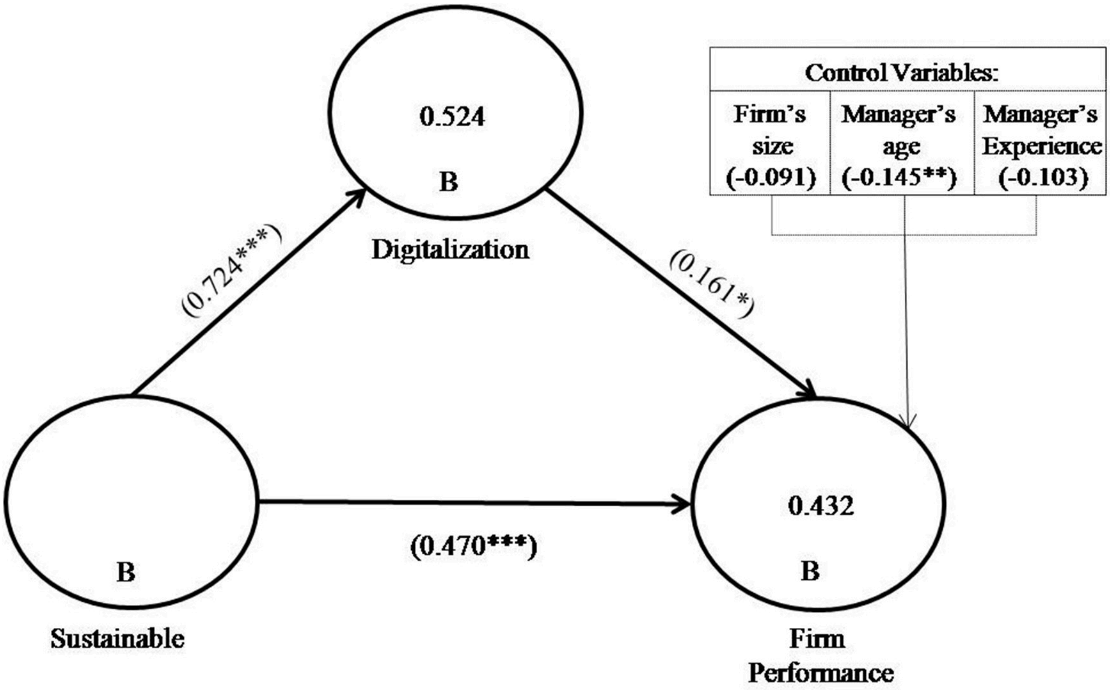


4.3 Robustness test

An alternative model was estimated to assess the robustness of the structural model. The robustness model, which specifies the composites as formative, is presented in Figure 3 (Cenfetelli & Bassellier, 2009). The results are consistent with those obtained from the original reflective model (see Figure 2), showing a significant explanatory effect (R^2 = 0.524 and R^2 = 0.432). However, in the alternative model, the mediating effect was not statistically significant.

The direct relationships remain stable. The relationship between sustainable strategies and digitalization is supported (β = 0.724), indicating that sustainable strategies positively influence digitalization. The relationship between sustainable strategies and firm performance is also supported (β = 0.470), demonstrating a substantial effect on firm performance. Finally, the relationship between digitalization and firm performance is confirmed (β = 0.161), indicating that digitalization positively influences firm performance.

Figure 3. Alternative model with formative composites



Consequently, the robustness model shows results that are consistent with the original analysis, with the exception of the mediating relationship between sustainable strategies, digitalization, and firm performance, which was not significant. Overall, the findings confirm that both digitalization and sustainable strategies are positively related to firm performance.

5. Discussion and conclusions

This research examined the integration of sustainable strategies and digitalization as sources of competitive advantage capable of improving the profitability and market share of manufacturing firms in the state of Coahuila, Mexico. The findings demonstrate the influence of sustainable strategies (Dalenogare et al., 2018; Heredia-Calzado & Duréndez, 2019; Suša Vugec et al., 2020) and the integration of infrastructure and smart technologies (CEPAL, 2020) on overall firm performance. Firms face the challenge of strengthening their innovation capabilities through a combined resource-based view (RBV) approach, assessing and developing intangible resources and capabilities related to sustainable strategies and digitalization in pursuit of business growth. These results are particularly relevant for an emerging economy such as Mexico, where digital technologies have been shown to support productivity strategies, promote social inclusion, and mitigate climate change (de Sousa Jabbour et al., 2018).

In Mexican manufacturing firms, sustainable strategies form part of a broader business strategy that combines resources and capabilities to improve performance and open new market opportunities (Barragán-Hernández & Aguilar-Fernández, 2024; Joensuu-Salo et al., 2018; Rashed & Shah, 2021). As Isaac Egurrola (2025) highlighted, the manufacturing industry in Mexico has continued to expand over the past 50 years, driven largely by increases in employment and productivity.

Digitalization supports environmentally sustainable manufacturing by enabling more efficient supply chain management and the adoption of flexible and eco-friendly production processes (Paritala et al., 2017). Sustainable strategies are often accompanied by investments in energy infrastructure, including initiatives that promote electric mobility and supply chains with a reduced environmental footprint (Martinez & Terrazas-Santamaria, 2024). According to Ponce et al. (2024), sustainable strategies and digitalization must converge in firms' daily operations—on the one hand, through strategic emphasis on energy efficiency and renewable energy project management, and on the other, through the use of artificial intelligence systems that optimize manufacturing processes while generating information for business intelligence applications.

Digital transformation will significantly influence the tensions and challenges associated with Industry 4.0 (Eller et al., 2020). Because of rapid technological change and the need for firms to remain competitive, digitalization can support the development of new capabilities. Digitalization promotes value chain integration by optimizing production processes, generating strategic information, reducing costs, and advancing sustainability (López-García et al., 2025). It is also a key element in the development of sustainable strategies that generate societal benefits, consistent with the RBV perspective. Digitalization should help address major environmental challenges such as emissions reduction, energy efficiency, and water conservation (Denuwara et al., 2019). There is an opportunity for private firms to implement new plans and procedures aligned with the Sustainable Development Goals, drawing on initiatives such as the circular economy and corporate social responsibility (Rashed & Shah, 2021).

This study contributes to the literature on sustainability and digital transformation in manufacturing firms. First, although several studies have examined sustainable strategies (Cuevas-Vargas & Fernández-Escobedo, 2025; Cuevas-Pichardo et al., 2025; Madrid-Guijarro et al., 2025; Martinez & Terrazas-Santamaria, 2024; Ponce et al., 2024) and digitalization (Beltramino et al., 2023; López-García et al., 2025; Lopez-Torres et al., 2025; Lozano et al., 2024; Pérez Escutia & Fischer de la Vega, 2023; Porras Sandoval et al., 2025), there remains an empirical gap concerning their joint impact on firm performance in Mexican manufacturing firms. Second, we propose that sustainable strategies support the creation, capture, and generation of value, with particular attention to social impacts. We also highlight the mediating roles of sustainable strategies and digitalization, underscoring their combined contributions to improved performance in manufacturing firms. These findings draw on the RBV framework and complement prior literature on sustainability and digital transformation.

In conclusion, manufacturing firms in Mexico must review and define the mechanisms through which sustainable strategies and digitalization are integrated into organizational processes. Strengthening these mechanisms will enable firms to maximize the positive effects of sustainability-oriented practices and digital technologies, while generating the information necessary for effective decision-making.

5.1 Practical implications

This research offers important implications for managers of manufacturing firms and for policymakers. For managers, the findings demonstrate the value of adopting innovative strategies that promote the digital transformation of business management. Management strategies should emphasize digital competitiveness by cultivating a strategic digital vision, aligning artificial intelligence and information generation with competitive advantage, and adopting a proactive digital orientation that supports differentiation and growth (Lozano et al., 2024; Pérez Escutia & Fischer de la Vega, 2023; Porras Sandoval et al., 2025). This approach is reinforced by integrating sustainable strategies as corporate pillars that promote a sustainable organizational culture, increase energy efficiency, and reduce waste (Cuevas-Vargas & Fernández-Escobedo, 2025; Cuevas-Pichardo et al., 2025; Ponce et al., 2024).

For policymakers, the findings underscore the need to promote measures and incentives that enable manufacturing firms to adopt and develop digital technologies in their management processes, while also facilitating investment in energy-saving infrastructure projects, climate policies, and tax incentives (Martinez & Terrazas-Santamaria, 2024). It is essential to implement regulatory frameworks that encourage investment in green technologies, advance sustainability through industrial development programs, and promote certifications based on sustainable technologies (Horbach, 2024; Jamil et al., 2025; Restrepo-Morales et al., 2024). By adopting sustainable strategies and digitalizing their operations, firms can strengthen their competitiveness and contribute to sustainable economic growth and long-term job creation.

5.2 Scope and new lines of research

This study has several limitations that offer opportunities for future research. The analysis examined the impact of digitalization and sustainable strategies on the financial performance of firms, and the results indicate that both variables are significant predictors of performance. However, conclusions may differ if samples are drawn from other states in Mexico. The study proposes a pathway for manufacturing firms to transition toward customer-centered business models by integrating technology, data analysis, and sustainable strategies to generate social and environmental value.

Future research should extend the analysis to additional Mexican states and, potentially, to other Central American countries with differing economic, cultural, and political contexts. Because this study focused solely on the manufacturing sector, future research should also examine other sectors that may have characteristics distinct from those analyzed here. Finally, the research is cross-sectional, relying on primary data collected at a single point in time. Longitudinal research would provide stronger evidence by determining whether the observed relationships remain consistent over time.

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Data Availability Statement

Data available on request due to privacy/ethical restrictions

References

Abou-Foul, M., Ruiz-Alba, J. L., & Soares, A. (2021). The impact of digitalization and servitization on the financial performance of a firm: An empirical analysis. *Production Planning & Control*, *32*(12), 975–989. https://doi.org/10.1080/09537287.2020.1780508

Al Hawamdeh, N., & Al-Edenat, M. (2025). Entrepreneurial leadership and organisational sustainability: the role of knowledge management. *Knowledge Management Research & Practice*, *23*(5), 545–558. https://doi.org/10.1080/14778238.2025.2470728

Arellano-Rodríguez, J. B. (2024). Supply chain integration and its relationship with the business performance of metal-mechanics small and medium-sized enterprises. *Small Business International Review*, *8*(2), e628. https://doi.org/10.26784/sbir.v8i2.628

Attewell, P. (1992). Technology diffusion and organizational learning: The case of business computing. *Organization Science*, *3*(1), 1–19. https://doi.org/10.1287/orsc.3.1.1

Baggia, A., Maletič, M., Žnidaršič, A., & Brezavšček, A. (2019). Drivers and outcomes of Green IS adoption in small and medium-sized enterprises. *Sustainability*, *11*(6), 1575. https://doi.org/10.3390/su11061575

Barney, J. (1991). Firm resources and sustained competitive advantage. *Journal of Management*, *17*(1), 99–120. https://doi.org/10.1177/014920639101700108

Barragán-Hernández, A. D., & Aguilar-Fernández, M. (2024). *Strategic dimensions of eco-innovation adoption in manufacturing SMEs in the context of Mexico City*. https://doi.org/10.20944/preprints202405.0019.v2

Bashir, M. F., Pan, Y., Shahbaz, M., & Ghosh, S. (2023). How energy transition and environmental innovation ensure environmental sustainability? Contextual evidence from Top-10 manufacturing countries. *Renewable Energy*, *204*, 697–709. https://doi.org/10.1016/j.renene.2023.01.049

Baumgartner, R. J., & Rauter, R. (2017). Strategic perspectives of corporate sustainability management to develop a sustainable organization. *Journal of Cleaner Production*, *140*, 81–92. https://doi.org/10.1016/j.jclepro.2016.04.146

Beltramino, N. S., Valdez-Juárez, L. E., Ingaramo, J. M., Gazzaniga, L. C., & Beltramino, N. A. (2023). The effects of organizational learning and entrepreneurial orientation on the corporate performance of Argentinean, Mexican, and Ecuadorian MSMEs. *Small Business International Review*, *7*(1), e503. https://doi.org/10.26784/sbir.v7i1.503

Brenner, B. (2018). Transformative sustainable business models in the light of the digital imperative — A global business economics perspective. *Sustainability*, *10*(12), 4428. https://doi.org/10.3390/su10124428

Buchalcevova, A., & Gala, L. (2013). Green ICT drivers and inhibitors perceived by the Czech SMEs. *Journal of System Integration*, *4*(2), 43–49.

Burton, A. M., & Dickinger, A. (2025). Innovation in crisis. The role of leadership and dynamic capabilities for a more innovative hospitality industry. *International Journal of Hospitality Management*, *124*, 103946. https://doi.org/10.1016/j.ijhm.2024.103946

Cagliano, R., & Behnam, S. (2019). Are innovation resources and capabilities enough to make businesses sustainable? An empirical study of leading sustainable innovative firms. *International Journal of Technology Management*, *79*(1), 1. https://doi.org/10.1504/IJTM.2019.10016975

Carmines, E., & Zeller, R. (1979). *Reliability and Validity Assessment*. SAGE Publications, Inc. https://doi.org/10.4135/9781412985642

Cassaro, E., Oro, I. M., Begnini, S., & Georges, M. R. R. (2024). The influence of digital transformation and implementation barriers on innovation in Brazilian micro, small, and medium enterprises. *Small Business International Review*, *8*(2), e660. https://doi.org/10.26784/sbir.v8i2.660

Cenamor, J., Parida, V., & Wincent, J. (2019). How entrepreneurial SMEs compete through digital platforms: The roles of digital platform capability, network capability and ambidexterity. *Journal of Business Research*, *100*, 196–206. https://doi.org/10.1016/j.jbusres.2019.03.035

Cenfetelli, R. T., & Bassellier, G. (2009). Interpretation of formative measurement in information systems research. *MIS Quarterly*, *33*(4), 689–708. https://doi.org/10.2307/20650323

CEPAL. (2020). *Perspectivas Económicas de América Latina 2020: transformación digital para una mejor reconstrucción*. https://hdl.handle.net/11362/46029

Chabowski, B. R., Gabrielsson, P., Hult, G. T. M., & Morgeson, F. V. (2025). Sustainable international business model innovations for a globalizing circular economy: A review and synthesis, integrative framework, and opportunities for future research. *Journal of International Business Studies*, *56*(3), 383–402. https://doi.org/10.1057/s41267-023-00652-9

Chege, S. M., & Wang, D. (2020). Information technology innovation and its impact on job creation by SMEs in developing countries: An analysis of the literature review. *Technology Analysis & Strategic Management*, *32*(3), 256–271. https://doi.org/10.1080/09537325.2019.1651263

Chen, X., Despeisse, M., & Johansson, B. (2020). Environmental sustainability of digitalization in manufacturing: A review. *Sustainability*, *12*(24), 10298. https://doi.org/10.3390/su122410298

Chen, Y., & Lin, Z. (2021). Business intelligence capabilities and firm performance: A study in China. *International Journal of Information Management*, *57*, 102232. https://doi.org/10.1016/j.ijinfomgt.2020.102232

Chiarini, A., Belvedere, V., & Grando, A. (2020). Industry 4.0 strategies and technological developments. An exploratory research from Italian manufacturing companies. *Production Planning & Control*, *31*(16), 1385–1398. https://doi.org/10.1080/09537287.2019.1710304

ClusterIndustrial. (2022). *¿Cuál es la industria manufacturera con el mejor y el peor desempeño en México?*. https://clusterindustrial.com.mx/cual-es-la-industria-manufacturera-con-el-mejor-y-el-peor-desempeno-en-mexico/

Cuevas-Vargas, H., & Fernández-Escobedo, R. (2025). Improving the opportunities to implement Industry 4.0 through absorptive capacity: A multi mediator model evaluation in the manufacturing industry of Mexico. *International Journal of Information Technology & Decision Making*, *24*(03), 891–928. https://doi.org/10.1142/S0219622025410044

Cuevas-Pichardo, L. J., Maldonado-Guzmán, G., Gómez-Guillamón, A. D., & Garza-Reyes, J. A. (2025). The mediating role of circular economy in the relationship between Industry 4.0 and sustainable performance in the manufacturing industry. *Business Strategy and the Environment*, *34*(2), 1735–1750. https://doi.org/10.1002/bse.4075

Dalenogare, L. S., Benitez, G. B., Ayala, N. F., & Frank, A. G. (2018). The expected contribution of Industry 4.0 technologies for industrial performance. *International Journal of Production Economics*, *204*, 383–394. https://doi.org/10.1016/j.ijpe.2018.08.019

Dam, M. M., Kaya, F., & Bekun, F. V. (2024). How does technological innovation affect the ecological footprint? Evidence from E-7 countries in the background of the SDGs. *Journal of Cleaner Production*, *443*, 141020. https://doi.org/10.1016/j.jclepro.2024.141020

Darren, G., & Mallery, P. (1995). *SPSS for Windows Step by Step A Simple Guide and Reference*. Wadsworth Pub. Co.

de Sousa Jabbour, A. B. L., Jabbour, C. J. C., Foropon, C., & Godinho Filho, M. (2018). When titans meet – Can industry 4.0 revolutionise the environmentally-sustainable manufacturing wave? The role of critical success factors. *Technological Forecasting and Social Change*, *132*, 18–25. https://doi.org/10.1016/j.techfore.2018.01.017

Denue. (2019). *Directorio Estadístico Nacional de Unidades Económicas*. https://www.inegi.org.mx/app/mapa/denue/default.aspx

Denuwara, N., Maijala, J., & Hakovirta, M. (2019). Sustainability benefits of RFID technology in the Apparel Industry. *Sustainability*, *11*(22), 6477. https://doi.org/10.3390/su11226477

Di Vaio, A., Hassan, R., & Alavoine, C. (2022). Data intelligence and analytics: A bibliometric analysis of Human–Artificial Intelligence in public sector decision-making effectiveness. *Technological Forecasting and Social Change*, *174*, 121201. https://doi.org/10.1016/j.techfore.2021.121201

Di Vaio, A., Palladino, R., Hassan, R., & Escobar, O. (2020). Artificial intelligence and business models in the sustainable development goals perspective: A systematic literature review. *Journal of Business Research*, *121*, 283–314. https://doi.org/10.1016/j.jbusres.2020.08.019

Dijkstra, T. K., & Henseler, J. (2015). Consistent partial least squares path modeling. *MIS Quarterly*, *39*(2), 297–316. https://doi.org/10.25300/MISQ/2015/39.2.02

Ding, X., Sheng, Z., Appolloni, A., Shahzad, M., & Han, S. (2024). Digital transformation, ESG practice, and total factor productivity. *Business Strategy and the Environment*, *33*(5), 4547–4561. https://doi.org/10.1002/bse.3718

Eccles, R. G., Serafeim, G., Seth, D., & Ming, C. (2013). The performance frontier: Innovating for a sustainable strategy. *Harvard Business Review*, *91*(7), 1–10.

Elbashir, M. Z., Collier, P. A., & Davern, M. J. (2008). Measuring the effects of business intelligence systems: The relationship between business process and organizational performance. *International Journal of Accounting Information Systems*, *9*(3), 135–153. https://doi.org/10.1016/j.accinf.2008.03.001

Eller, R., Alford, P., Kallmünzer, A., & Peters, M. (2020). Antecedents, consequences, and challenges of small and medium-sized enterprise digitalization. *Journal of Business Research*, *112*, 119–127. https://doi.org/10.1016/j.jbusres.2020.03.004

Engert, S., Rauter, R., & Baumgartner, R. J. (2016). Exploring the integration of corporate sustainability into strategic management: a literature review. *Journal of Cleaner Production*, *112*, 2833–2850. https://doi.org/10.1016/j.jclepro.2015.08.031

Esmaeilian, B., Behdad, S., & Wang, B. (2016). The evolution and future of manufacturing: A review. *Journal of Manufacturing Systems*, *39*, 79–100. https://doi.org/10.1016/j.jmsy.2016.03.001

Falle, S., Rauter, R., Engert, S., & Baumgartner, R. (2016). Sustainability management with the sustainability balanced scorecard in SMEs: Findings from an Austrian case study. *Sustainability*, *8*(6), 545. https://doi.org/10.3390/su8060545

Fornell, C., & Larcker, D. F. (1981). Evaluating structural equation models with unobservable variables and measurement error. *Journal of Marketing Research*, *18*(1), 39. https://doi.org/10.2307/3151312

Gobbo, J. A., Busso, C. M., Gobbo, S. C. O., & Carreão, H. (2018). Making the links among environmental protection, process safety, and Industry 4.0. *Process Safety and Environmental Protection*, *117*, 372–382. https://doi.org/10.1016/j.psep.2018.05.017

Gorondutse, A. H., Arshad, D., & Alshuaibi, A. S. (2020). Driving sustainability in SMEs' performance: The effect of strategic flexibility. *Journal of Strategy and Management*, *14*(1), 64–81. https://doi.org/10.1108/JSMA-03-2020-0064

Grayson, D., Coulter, C., & Lee, M. (2018). *All in: The future of business leadership*. Routledge. https://doi.org/10.4324/9781351001205

Gunday, G., Ulusoy, G., Kilic, K., & Alpkan, L. (2011). Effects of innovation types on firm performance. *International Journal of Production Economics*, *133*(2), 662–676. https://doi.org/10.1016/j.ijpe.2011.05.014

Gómez Martínez, R., Medrano-Garcia, M. L., & Amo Navas, D. (2024). Evaluating ESG performance: The influence of firm size and gender diversity. *Small Business International Review*, *8*(2), e693. https://doi.org/10.26784/sbir.v8i2.693

Hair, J. F., Hult, G. T. M., Ringle, C. M., & Sarstedt, M. (2017). *A Primer on Partial Least Squares Structural Equation Modeling (PLS-SEM)*. Sage publications.

Hair, J. F., Ringle, C. M., & Sarstedt, M. (2013). Partial least squares structural equation modeling: Rigorous applications, better results and higher acceptance. *Long Range Planning*, *46*(1-2), 1–12. https://doi.org/10.1016/j.lrp.2013.01.001

Hair, J. F., Sarstedt, M., Hopkins, L., & G. Kuppelwieser, V. (2014). Partial least squares structural equation modeling (PLS-SEM). *European Business Review*, *26*(2), 106–121. https://doi.org/10.1108/EBR-10-2013-0128

Hallstedt, S., Isaksson, O., & Öhrwall Rönnbäck, A. (2020). The need for new product development capabilities from digitalization, sustainability, and servitization trends. *Sustainability*, *12*(23), 10222. https://doi.org/10.3390/su122310222

Hayes, A. F. (2009). Beyond Baron and Kenny: Statistical mediation analysis in the new millennium. *Communication Monographs*, *76*(4), 408–420. https://doi.org/10.1080/03637750903310360

Hennelly, P. A., Srai, J. S., Graham, G., & Fosso Wamba, S. (2020). Rethinking supply chains in the age of digitalization. *Production Planning & Control*, *31*(2-3), 93–95. https://doi.org/10.1080/09537287.2019.1631469

Henseler, J. (2017). Partial Least Squares Path Modeling. In P. S. H. Leeflang, J. E. Wieringa, T. H. Bijmolt, & K. H. Pauwels (Eds.), *Advanced Methods for Modeling Markets. International Series in Quantitative Marketing* (pp. 361–381). Springer International Publishing. https://doi.org/10.1007/978-3-319-53469-5_12

Henseler, J., Hubona, G., & Ray, P. A. (2016). Using PLS path modeling in new technology research: Updated guidelines. *Industrial Management & Data Systems*, *116*(1), 2–20. https://doi.org/10.1108/IMDS-09-2015-0382

Henseler, J., Ringle, C. M., & Sarstedt, M. (2016). Testing measurement invariance of composites using partial least squares. *International Marketing Review*, *33*(3), 405–431. https://doi.org/10.1108/IMR-09-2014-0304

Heredia-Calzado, M., & Duréndez, A. (2019). The influence of knowledge management and professionalization on the use of ERP systems and its effect on the competitive advantages of SMEs. *Enterprise Information Systems*, *13*(9), 1245–1274. https://doi.org/10.1080/17517575.2019.1640393

Horbach, J. (2024). Digitalisation and sustainability measures at the firm level. *Digital Economy and Sustainable Development*, *2*(1), 19. https://doi.org/10.1007/s44265-024-00043-4

Hu, L.- tze, & Bentler, P. M. (1998). Fit indices in covariance structure modeling: Sensitivity to underparameterized model misspecification. *Psychological Methods*, *3*(4), 424–453. https://doi.org/10.1037/1082-989X.3.4.424

I-Scoop. (2021). *Digitization, digitalization, digital and transformation: the differences*. https://www.i-scoop.eu/digital-transformation/digitization-digitalization-digital-transformation-disruption/

IEA. (2021). *Global energy-related CO2 emissions by sector*. https://www.iea.org/data-and-statistics/charts/global-energy-related-co2-emissions-by-sector

Inegi. (2021). *Instituto Nacional de Estadística y Geografía*. https://www.inegi.org.mx/

Inegi. (2022). *Producto interno bruto por entidad federativa Coahuila de Zaragoza*. https://www.inegi.org.mx/contenidos/saladeprensa/boletines/2022/PIBEF/PIBEF_Coah.pdf

Ionescu-Feleagă, L., Ionescu, B.- Ștefan, & Stoica, O. C. (2023). The link between digitization and the sustainable development in European Union Countries. *Electronics*, *12*(4), 961. https://doi.org/10.3390/electronics12040961

Isaac Egurrola, J. (2025). Modalidades de reproducción y determinantes del crecimiento de la manufactura en México. *El Trimestre Económico*, *92*(365), 109–158. https://doi.org/10.20430/ete.v92i365.2700

Isensee, C., Teuteberg, F., Griese, K.-M., & Topi, C. (2020). The relationship between organizational culture, sustainability, and digitalization in SMEs: A systematic review. *Journal of Cleaner Production*, *275*, 122944. https://doi.org/10.1016/j.jclepro.2020.122944

Jamil, K., Zhang, W., Anwar, A., & Mustafa, S. (2025). Driving SME Sustainability via the Influence of Green Capital, HRM, and Leadership. *Sustainability*, *17*(13), 6076. https://doi.org/10.3390/su17136076

Jarvis, C. B., MacKenzie, S. B., & Podsakoff, P. M. (2003). A critical review of construct indicators and measurement model misspecification in marketing and consumer research. *Journal of Consumer Research*, *30*(2), 199–218. https://doi.org/10.1086/376806

Joensuu-Salo, S., Sorama, K., Viljamaa, A., & Varamäki, E. (2018). Firm performance among internationalized SMEs: The interplay of market orientation, marketing capability and digitalization. *Administrative Sciences*, *8*(3), 31. https://doi.org/10.3390/admsci8030031

Kohtamäki, M., Parida, V., Patel, P. C., & Gebauer, H. (2020). The relationship between digitalization and servitization: The role of servitization in capturing the financial potential of digitalization. *Technological Forecasting and Social Change*, *151*, 119804. https://doi.org/10.1016/j.techfore.2019.119804

Kunze, F., Boehm, S., & Bruch, H. (2013). Organizational performance consequences of age diversity: Inspecting the role of diversity-friendly HR policies and top managers' negative age stereotypes. *Journal of Management Studies*, *50*(3), 413–442. https://doi.org/10.1111/joms.12016

Landa Díaz, H. O., & Cerezo García, V. (2025). Dinámica de exportación, cadenas de valor y patrones de industrialización en México y Corea del Sur, 1995-2020. *Investigación Económica*, *84*(331), 92–116. https://doi.org/10.22201/fe.01851667p.2025.331.90250

Lopez-Torres, G. C., Schiuma, G., Muñoz-Arteaga, J., & Alvarez-Torres, F. J. (2025). Unveiling the relationships between visibility, information technologies and innovation management for sustainability performance: An empirical study. *European Journal of Innovation Management*, *28*(8), 3373–3394. https://doi.org/10.1108/EJIM-12-2023-1139

Lozano, E., Ibarra, O., Alvarado, C., & Ramírez, M. (2024). *Transformación digital en las MiPyMEs mexicanas y su permanencia en el mercado. Verano de la Ciencia XXIX, 28, 1–10*.

López-García, R. D., Maldonado-Reyes, A., Reyes-Gallegos, M. M., Rodríguez-García, J. A., Calles-Arriaga, C. A., & Rocha-Rangel, E. (2025). Management and disposal of waste tires to develop a company for the manufacture of products based on recycled rubber in Tamaulipas, México. *Processes*, *13*(2), 394. https://doi.org/10.3390/pr13020394

Madrid-Guijarro, A., Maldonado-Guzmán, G., & Rodríguez-González, R. (2025). Unlocking resilience: The impact of Industry 4.0 technologies on manufacturing firms' response to the COVID-19 pandemic. *Management Decision*, *63*(1), 126–154. https://doi.org/10.1108/MD-02-2024-0262

Manresa, A., Bikfalvi, A., & Simon, A. (2021). Investigating the impact of new technologies and organizational practices on operational performance: Evidence from Spanish manufacturing companies. *Central European Journal of Operations Research*, *29*(4), 1317–1327. https://doi.org/10.1007/s10100-020-00692-8

Marcoulides, G. A. (Ed.). (1998). *Modern Methods for Business Research*. Psychology Press. https://doi.org/10.4324/9781410604385

Martinez, N., & Terrazas-Santamaria, D. (2024). Beyond nearshoring: The political economy of Mexico's emerging electric vehicle industry. *Energy Policy*, *195*, 114385. https://doi.org/10.1016/j.enpol.2024.114385

Martín-Peña, M.-L., Sánchez-López, J.-M., & Díaz-Garrido, E. (2019). Servitization and digitalization in manufacturing: The influence on firm performance. *Journal of Business & Industrial Marketing*, *35*(3), 564–574. https://doi.org/10.1108/JBIM-12-2018-0400

Meflinda, A., Mahyarni, M., Indrayani, H., & Wulandari, H. (2018). The effect of social capital and knowledge sharing to the small medium enterprise's performance and sustainability strategies. *International Journal of Law and Management*, *60*(4), 988–997. https://doi.org/10.1108/IJLMA-03-2017-0073

Monecke, A., & Leisch, F. (2012). SemPLS: Structural equation modeling using partial least squares. *Journal of Statistical Software*, *48*(3). https://doi.org/10.18637/jss.v048.i03

Nitzl, C., Roldan, J. L., & Cepeda, G. (2016). Mediation analysis in partial least squares path modeling. *Industrial Management & Data Systems*, *116*(9), 1849–1864. https://doi.org/10.1108/IMDS-07-2015-0302

Oláh, J., Aburumman, N., Popp, J., Khan, M. A., Haddad, H., & Kitukutha, N. (2020). Impact of Industry 4.0 on environmental sustainability. *Sustainability*, *12*(11), 4674. https://doi.org/10.3390/su12114674

Paritala, P. K., Manchikatla, S., & Yarlagadda, P. K. (2017). Digital manufacturing- applications past, current, and future trends. *Procedia Engineering*, *174*, 982–991. https://doi.org/10.1016/j.proeng.2017.01.250

Peters, M. D., Wieder, B., Sutton, S. G., & Wakefield, J. (2016). Business intelligence systems use in performance measurement capabilities: Implications for enhanced competitive advantage. *International Journal of Accounting Information Systems*, *21*, 1–17. https://doi.org/10.1016/j.accinf.2016.03.001

Ponce, P., Anthony, B., Bradley, R., Maldonado-Romo, J., Méndez, J. I., Montesinos, L., & Molina, A. (2024). Developing a virtual reality and AI-based framework for advanced digital manufacturing and nearshoring opportunities in Mexico. *Scientific Reports*, *14*(1), 11214. https://doi.org/10.1038/s41598-024-61514-4

Porras Sandoval, M. I., Solano Rosales, G. F., Rincón Montero, R. I., Rodríguez Zúñiga, M. A., & Pérez Esparza, E. (2025). Transformación digital en las PyMEs mexicanas: Un paradigma emergente de la inteligencia artificial para la competitividad empresarial. *Ciencia Latina Revista Científica Multidisciplinar*, *9*(2), 389–406. https://doi.org/10.37811/cl_rcm.v9i2.16847

Porter, M., & Heppelmann, J. (2015). *How smart, connected products are transforming companies. Harvard Business Review, October, 96–112*.

Potter, C., Bastounis, A., Hartmann-Boyce, J., Stewart, C., Frie, K., Tudor, K., Bianchi, F., Cartwright, E., Cook, B., Rayner, M., & Jebb, S. A. (2021). The effects of environmental sustainability labels on selection, purchase, and consumption of food and drink products: A systematic review. *Environment and Behavior*, *53*(8), 891–925. https://doi.org/10.1177/0013916521995473

Powell, T. C. (1995). Total quality management as competitive advantage: A review and empirical study. *Strategic Management Journal*, *16*(1), 15–37. https://doi.org/10.1002/smj.4250160105

Pérez Escutia, N., & Fischer de la Vega, L. (2023). La transformación digital como ventaja competitiva de las pymes mexicanas. *FACE: Revista De La Facultad De Ciencias Económicas Y Empresariales*, *23*(2), 30–42. https://doi.org/10.24054/face.v23i2.2457

Rashed, A. H., & Shah, A. (2021). The role of private sector in the implementation of sustainable development goals. *Environment, Development and Sustainability*, *23*(3), 2931–2948. https://doi.org/10.1007/s10668-020-00718-w

Restrepo-Morales, J. A., Valencia-Cárdenas, M., & García-Pérez-de-Lema, D. (2024). The role of technological innovation in the mitigation of the crisis generated by COVID-19: An empirical study of small and medium-sized businesses (SMEs) in Latin America. *International Studies of Management & Organization*, *54*(2), 120–136. https://doi.org/10.1080/00208825.2023.2301213

Ruivo, P., Johansson, B., Sarker, S., & Oliveira, T. (2020). The relationship between ERP capabilities, use, and value. *Computers in Industry*, *117*, 103209. https://doi.org/10.1016/j.compind.2020.103209

Santis, P., Albuquerque, A., & Lizarelli, F. (2016). Do sustainable companies have a better financial performance? A study on Brazilian public companies. *Journal of Cleaner Production*, *133*, 735–745. https://doi.org/10.1016/j.jclepro.2016.05.180

SmartPLS. (2020). *Software SmartPLS*. https://www.smartpls.com

Stewart, H., & Gapp, R. (2014). Achieving effective sustainable management: A small-medium enterprise case study. *Corporate Social Responsibility and Environmental Management*, *21*(1), 52–64. https://doi.org/10.1002/csr.1305

Suša Vugec, D., Bosilj Vukšić, V., Pejić Bach, M., Jaklič, J., & Indihar Štemberger, M. (2020). Business intelligence and organizational performance. *Business Process Management Journal*, *26*(6), 1709–1730. https://doi.org/10.1108/BPMJ-08-2019-0342

Teerasoponpong, S., & Sopadang, A. (2022). Decision support system for adaptive sourcing and inventory management in small- and medium-sized enterprises. *Robotics and Computer-Integrated Manufacturing*, *73*, 102226. https://doi.org/10.1016/j.rcim.2021.102226

Trașcă, D. L., Ștefan, G. M., Sahlian, D. N., Hoinaru, R., & Șerban-Oprescu, G.-L. (2019). Digitalization and business activity. The struggle to catch up in CEE countries. *Sustainability*, *11*(8), 2204. https://doi.org/10.3390/su11082204

Ukko, J., Nasiri, M., Saunila, M., & Rantala, T. (2019). Sustainability strategy as a moderator in the relationship between digital business strategy and financial performance. *Journal of Cleaner Production*, *236*, 117626. https://doi.org/10.1016/j.jclepro.2019.117626

United Nations. (2020). *Global indicator framework for the Sustainable Development Goals. 17 Goals to Transform Our World*. https://www.un.org/sustainabledevelopment

Weill, P., & Woerner, S. (2015). Thriving in an increasingly digital ecosystem. *MIT Sloan Management Review*, *56*(4), 27–34.

Wicaksari, P., Saputra, A. R. P., & Rahmah, A. N. (2024). The influence of green quality of work life, green employee engagement, and green rewards on green employee retention in SME employees. *Small Business International Review*, *8*(1), e627. https://doi.org/10.26784/sbir.v8i1.627

Willems, J. C. (2000). Modelling dynamical systems using manifest and latent variables. *Mathematics and Computers in Simulation*, *53*(4-6), 227–237. https://doi.org/10.1016/S0378-4754(00)00209-3

Williams, L. J., Vandenberg, R. J., & Edwards, J. R. (2009). 12 structural equation modeling in management research: A guide for improved analysis. *The Academy of Management Annals*, *3*(1), 543–604. https://doi.org/10.1080/19416520903065683

Yiu, L. M. D., Yeung, A. C. L., & Cheng, T. C. E. (2021). The impact of business intelligence systems on profitability and risks of firms. *International Journal of Production Research*, *59*(13), 3951–3974. https://doi.org/10.1080/00207543.2020.1756506

Yunis, M., Tarhini, A., & Kassar, A. (2018). The role of ICT and innovation in enhancing organizational performance: The catalysing effect of corporate entrepreneurship. *Journal of Business Research*, *88*, 344–356. https://doi.org/10.1016/j.jbusres.2017.12.030