Navigating Digital Horizons:
A Bibliometric Exploration of Digitalization in Family Businesses and Emerging Research Agendas

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ABSTRACT

Digitalization has become a strategic imperative for family businesses as they navigate the challenges of Industry 4.0, shifting market dynamics, and post-pandemic recovery. Despite the growing relevance of digital transformation, existing research on this topic remains fragmented and lacks a comprehensive understanding of its intellectual and thematic evolution. This study aims to map the development of scientific publications on digitalization in family businesses, identify dominant research themes, and outline emerging research directions related to technologies such as artificial intelligence (AI) and sustainability. Using the Scopus database, a bibliometric approach was applied to analyze publication trends, geographic distribution, co-authorship networks, and keyword co-occurrence patterns over the last decade. The results reveal significant growth in publication volume, with research concentrated in advanced economies and increasingly influenced by China's expanding collaboration network. Six major thematic clusters emerged, highlighting topics such as sustainability orientation, human capital, governance, Industry 4.0 technologies, and the catalytic effects of COVID-19 on digital adoption. These findings demonstrate that digital transformation in family firms is not merely technological, but deeply shaped by socio-emotional, governance, and cultural dimensions. Overall, this study provides a comprehensive research landscape and offers a forward-looking agenda to support more inclusive and sustainable digitalization in family businesses.

Keywords: family business; digitalization; bibliometric analysis; artificial intelligence; sustainability.

INTRODUCTION

Family businesses are the most dominant form of business organization in the world and are an important foundation for global economic stability. Hernández-Perlines et al. (2021) assert that family businesses are the most common corporate structure in various countries, while Chrisman et al. (2024) show that research on family businesses has increased significantly in the last two decades. In Indonesia itself, family businesses contribute greatly to GDP and employment, especially through family-based MSMEs (Ariswati et al., 2025; Kesuma et al., 2025). However, the dynamics of economic development and the advent of the Industrial Revolution 4.0 era require family businesses to transform through digitalization. Technologies such as artificial intelligence (AI), big data analytics, the Internet of Things (IoT), and cloud computing not only enable operational efficiency but also change innovation patterns, managerial processes, and the ability to adapt to market changes.

However, the digitization process in family businesses does not always run smoothly. Upadhyay et al. (2023) emphasize that the integration of disruptive technological innovations remains a major challenge for many family businesses due to limited resources, intergenerational resistance, and strong traditional values that influence strategic decisions. A Deloitte survey (2019) even shows that the adoption of digital technology is seen as the most important factor in maintaining competitiveness, but its implementation has been slow and uneven. This situation has become even more apparent since the COVID-19 pandemic (Irianto et al., 2025), which has drastically accelerated the need for digitalization. The crisis has revealed a digital divide between family businesses that have adapted to modern technology and those that still rely on conventional business models.

Amidst the urgency of this transformation, academic literature on digitization in the context of family businesses shows limitations. Many previous studies have focused on specific issues such as succession processes or competitive advantages, but there has been no comprehensive study that systematically maps the development of research over the past decade. Efforts to identify the evolution of themes, scientific collaboration networks, and trends in the development of digitization concepts remain a significant research gap. This gap is becoming increasingly relevant given that technological developments, particularly AI and sustainability issues, are beginning to shape new strategic directions in the world of family businesses. In Southeast Asia, including Indonesia, regional reports show that the level of digital adoption in family businesses is still low, at around 30%, making the need for global scientific mapping to understand this context even more urgent.

Based on these phenomena, this study adopts a bibliometric approach to analyze scientific publications on digitization in family businesses over the past ten years. Using Scopus-indexed data, this study visualizes publication growth, geographical distribution, author collaboration networks, and major theme clusters that reflect how the concept of digitalization is understood, researched, and developed in the realm of family management. In addition, the results of this analysis enable the formulation of a research agenda that is more relevant to current challenges, especially those related to the development of AI technology and sustainability demands.

By presenting a systematic scientific mapping, this study seeks to fill gaps in the literature and broaden understanding of how digitalization is developing in the context of family businesses.

Navigating Digital Horizons: A Bibliometric Exploration of Digitalization in Family Businesses and Emerging Research Agendas
(**Steven, et al.**)

The results are expected to contribute theoretically to academics, while offering strategic insights to practitioners and policymakers to promote inclusive, adaptive, and sustainable digital transformation in the face of accelerating global change.

METHODS OF RESEARCH

In scholarly endeavors aimed at charting the intellectual topography of nascent fields, bibliometric techniques offer a robust lens for distilling patterns from voluminous outputs, particularly in realms where innovation intersects with entrenched organizational forms. Such methods, by aggregating metrics like publication trajectories and relational densities, permit an inductive ascent from granular data to overarching narratives of conceptual maturation. In probing the nexus of digital adaptation and familial enterprises, the methodological edifice herein privileges a Scopus-centric corpus, a choice predicated on its proven utility in furnishing expansive, verifiable insights into management scholarship.

Scopus's preeminence in bibliometric inquiries stems from its holistic encapsulation of peer-reviewed contributions, surpassing fragmented alternatives in scope and fidelity for business-oriented domains (Behl et al., 2019; Tipu & Ryan, 2021). This database's singular indexing paradigm obviates the exigencies of inter-platform reconciliation, streamlining retrieval and obviating distortions from disparate schemas a procedural economy echoed in diverse applications (Kozakiewicz & Lis, 2021). Moreover, its embedded artifacts, encompassing author lineages and citation cascades, empower nuanced delineations of thematic interweavings, bolstering the auditability of resultant cartographies (Mustafa et al., 2021). For the present inquiry, this configuration proved singularly apposite, encapsulating evolutions in digital imperatives within family-centric ventures from 2015 onward, while circumventing the silos that plague multi-source amalgamations and thereby safeguarding chronological fidelity.

Anchoring the analysis is a bifurcated paradigm: a quantitative bibliometric armature, which quantifies associative structures to unveil latent progressions, interwoven with narrative elaboration to contextualize these within socio-organizational tapestries. This synthesis transcends rote enumeration, fostering argumentative depth by juxtaposing empirical aggregates against interpretive scaffolds, as evidenced in prior hybrids that trace thematic percolations (Parmentola et al., 2021). Inductively, such a fusion reveals not merely what proliferates say, surges in post-crisis outputs but why: the catalytic interplay of exogenous jolts and endogenous capacities in familial settings.

Operational inception hinged on a calibrated foraging protocol, emblematic of rigorous precedents that calibrate exhaustiveness against precision. Preliminary forays into antecedent corpora informed an iterative lexicon assembly, fusing digital motifs via Boolean scaffolds with familial delineators. Temporal bounds (2015–2025) and linguistic primacy, winnowed through PRISMA-inflected sieves: excising ephemera like commentaries and vetting abstracts for pertinence to adaptive corollaries (Sievers & Blank, 2023; Uddin, 2025). This distillation, guided by replicable rubrics peer scrutiny, empirical anchorage.

Augmenting this harvest, preprocessing rituals standardized variances: deduplication via identifier harmonization, anomaly excision through algorithmic scrutiny, and field normalization

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Navigating Digital Horizons: A Bibliometric Exploration of Digitalization in Family Businesses and Emerging Research Agendas
(**Steven, et al.**)

2928

employing Pandas-driven routines to fortify analytical sinew (Kozakiewicz & Lis, 2021). Propellant for interpretation resided in VOSviewer's algorithmic prowess, which, via similarity visualizations, orchestrated keyword confluences thresholded at quintuple incidences to crystallize clusters, illuminating nexuses like sustainability's entwinement with lineage stewardship (Vélez-Gutiérrez et al., 2025). Paralleling this, co-authorship lattices at national scales, apportioned fractionally to avert aggrandizement, traced collaborative topographies, with nodal magnitudes reflecting volumetric heft and ligatures denoting relational vigor (Behl et al., 2019; Fusco, 2021). These renderings, narratively unpacked, inductively forge contentions: digital ingress in kinships as a dialectic of heritage and exigency.

This scaffold, though efficacious, concedes Scopus's predispositions such as occidental skews in representational equity yet parries them through overt declarations, adjunctive filtrations, and corroborative cross-checks against peripheral repositories (Vera-Baceta et al., 2019).

RESULT AND DISCUSSION

The following section presents the core findings of this study and explores their broader implications within the field. Structured into several interconnected subtopics, it offers a clear and coherent interpretation of the results, supported by analytical insights that deepen our understanding of the evolving landscape of digitalization in family businesses. Through this discussion, readers are invited to engage with the patterns, trends, and thematic relationships revealed by the bibliometric analysis, as well as the theoretical and practical conclusions that emerge from them. This section aims not only to explain what the data show, but also to illuminate why these findings matter and how they contribute to shaping future research directions.
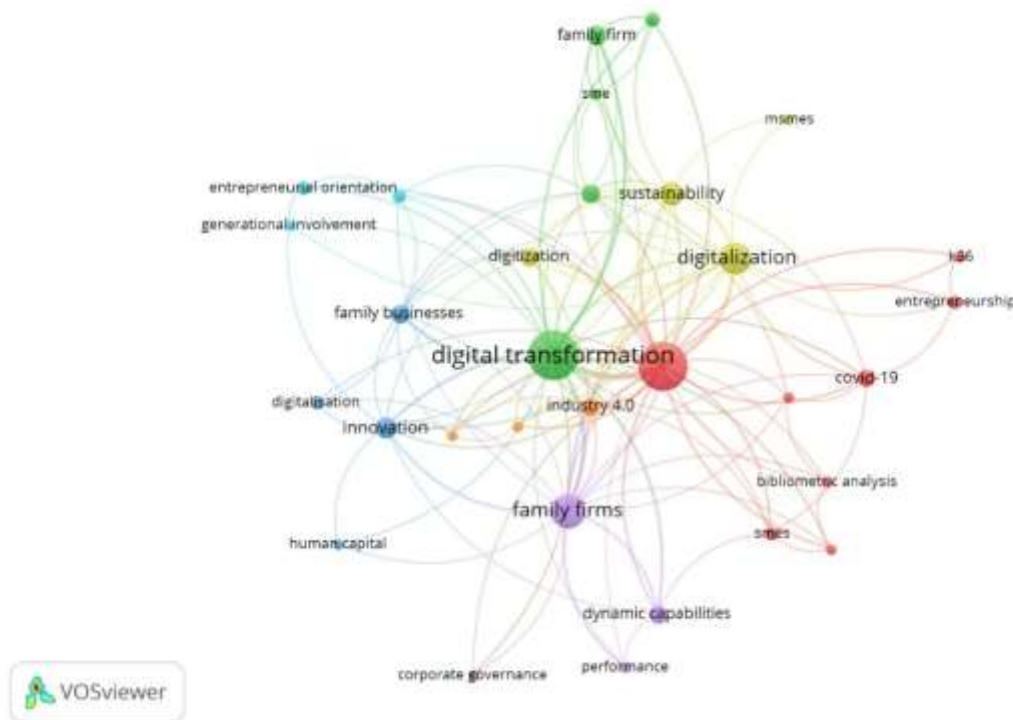

Navigating Digital Horizons: A Bibliometric Exploration of Digitalization in Family Businesses and Emerging Research Agendas
(**Steven, et al.**)

2929

Figure 1. Co-Occurrence
Source: Data Processed, 2025

Tabel 1. Co-Occurrence Analysis

Cluster Color	Size & Density	Top Keywords	Main Focus of Research	Key Characteristics
Green	Medium	Sustainability, SME, family firm, entrepreneurial orientation, generational involvement	Sustainability through entrepreneurial orientation & generational involvement in family businesses/SMEs in the digital era	Family values, long-term orientation, social-environmental contribution, digital technology adoption
Red	Large and conspicuous	covid-19, entrepreneurship, MSMEs, SMEs, JEL K36	The impact of the Covid-19 pandemic as a catalyst for digital transformation in SMEs and family businesses	Rapid adoption of e-commerce, remote work, digital platforms; the role of entrepreneurial resilience
Blue	Medium	innovation, human capital, entrepreneurial	The human aspect & innovation in digital transformation	Digital skills, employee training, innovation culture, the role of the younger generation,

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Navigating Digital Horizons: A Bibliometric Exploration of Digitalization in Family Businesses and Emerging Research Agendas

(**Steven, et al.**)

		orientation, digitalization family firms, corporate governance, performance, dynamic capabilities, family businesses		human resource capability development
Purple	The Densest	orientation, digitalization family firms, corporate governance, performance, dynamic capabilities, family businesses	Governance & its impact on performance in the era of digital transformation	Family ownership, board of commissioners, succession, dynamic capabilities as explanations for rapid adaptation
Orange	Small but strategic	industry 4.0, IoT, big data analytics, artificial intelligence, cloud computing, automation	Industry 4.0 technology in the digital transformation of SMEs & family businesses	The adoption of advanced technologies (IoT, AI, big data, etc.) by traditional businesses that are typically slow to adapt

Source: Data Processed, 2025

Analyzing Publication Growth and Geographic Distribution

The green cluster is dominated by the keywords sustainability, SME, family firm, entrepreneurial orientation, generational involvement, and entrepreneurial orientation. This group highlights how family businesses and SMEs integrate entrepreneurial orientation and cross-generational involvement as strategies to achieve sustainability in the era of digital transformation. Research in this cluster typically emphasizes that strong family values, long-term orientation, and the involvement of the next generation are the main drivers for family businesses to not only survive but also contribute to social and environmental sustainability goals when adopting digital technology.

The yellow cluster focuses on the technical and conceptual processes of digital transformation, with the main keywords being digitalization, digitization, and a close relationship to digital transformation. The difference between digitization (conversion from analog to digital) and digitalization (the use of digital technology to change business models) is often discussed here. This cluster is relatively small but very central because it acts as a "bridge" between pure technology and business applications. Research in this cluster tends to be conceptual or exploratory, discussing the stages, frameworks, and technical challenges in the digital transformation process in family businesses and SMEs.

The red cluster is one of the most striking because it is triggered by the large keyword covid-19. Other strong keywords here are entrepreneurship, MSMEs, SMEs, and k36, which is the JEL classification code for Entrepreneurship. The Covid-19 pandemic has proven to be a major catalyst that has accelerated research on digital transformation among SMEs and family businesses. Many articles in this cluster analyze how the crisis has forced small and medium-sized businesses to quickly adopt digital technologies (e-commerce, remote working, digital platforms) for their survival, as well as how entrepreneurial resilience has been a determining factor in the success of this adoption.

The blue cluster emphasizes the human and innovation aspects of digital transformation, with the main keywords being innovation, human capital, entrepreneurial orientation, and digitalization. Research in this group highlights that the success of digital transformation in family

----
Navigating Digital Horizons: A Bibliometric Exploration of Digitalization in Family Businesses and Emerging Research Agendas
(**Steven, et al.**)

2931

businesses and SMEs does not only depend on technology, but is largely determined by the quality of human resources, a culture of innovation, and the organization's ability to develop employee capabilities in the digital era. Topics such as digital skills, employee training, and the role of the younger generation in driving innovation often arise here.

The purple cluster is one of the most dense and focuses on governance and performance aspects, with the main keywords being family firms, corporate governance, performance, dynamic capabilities, and family businesses. Research in this cluster analyzes how the governance structure of family businesses, such as family ownership, boards of commissioners, and succession, affects the company's ability to undergo digital transformation and ultimately impacts its finansial (Kesuma et al., 2025; Widaryo et al., 2025) and non-financial performance. The concept of dynamic capabilities is often used to explain how family businesses with good governance are able to adapt more quickly to changes in the digital environment.

The orange cluster is relatively small but strategic, dominated by Industry 4.0 keywords. This cluster connects digital transformation with fourth-generation advanced technologies such as the Internet of Things (IoT), big data analytics, artificial intelligence, cloud computing, and automation. Research here is typically more technical and discusses how SMEs and family businesses, traditionally considered slow to adapt, are beginning to adopt Industry 4.0 technologies as part of their digital transformation strategies.
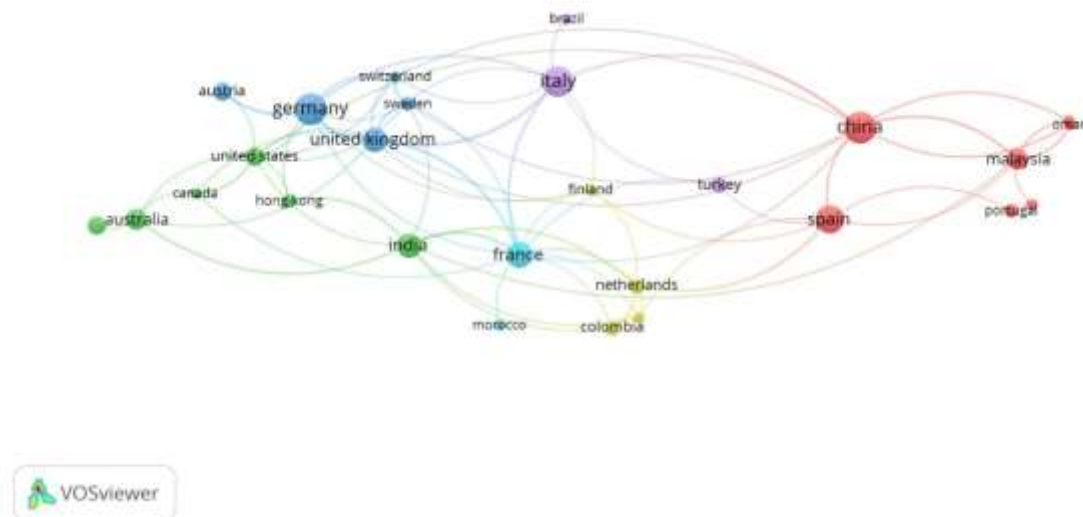

Figure 2. Co-Authorship
Source: Data Processed, 2025

Navigating Digital Horizons: A Bibliometric Exploration of Digitalization in Family Businesses and Emerging Research Agendas
(**Steven, et al.**)

Tabel 2. Co-Authorship Analysis

Group (Color)	Position on the Chart	Leading Country (Largest Node)	Other Major Countries in the Group	Key Characteristics of the Group
Green	Bottom left	Australia	India, Canada, Hong Kong, Morocco, and several other Anglosphere countries	Dominated by English-speaking countries (Anglosphere) + India as the hub of South Asia
Blue	Upper middle	Germany	United Kingdom, Switzerland, Sweden, Italy, France, Netherlands, Finland	Highly integrated Western and Northern Europe
Red	Right	China	Spain, Turkey, Malaysia, Portugal, Oman, as well as several countries in Southern Europe and Southeast Asia	A network centered on China with partners in Southern Europe and Asia
Yellow	Lower middle	Colombia	(Small group) only Colombia as the core, with few connections to the Netherlands and France	The smallest, relatively isolated group

Source: Data Processed, 2025

In this graph, each circle (node) represents a country, while the size of the circle indicates how often the country appears or how significant its contribution is in the analyzed data (e.g., number of publications or citations). The lines connecting countries indicate significant relationships or collaborations between them; the thicker/darker the line, the stronger the relationship. In terms of color, there appears to be automatic clustering performed by VOSviewer.

There are four main groups that are clearly visible, namely the green group, the blue group, the red group, and the yellow group. The green group (bottom left) is dominated by Australia (the largest circle in dark green), followed by India, Canada, Hong Kong, and several other countries such as Morocco. This group tends to represent Anglosphere countries (English-speaking) plus India as a major center of collaboration in South Asia. The blue group (top center) is led by Germany (large blue circle), followed by the United Kingdom, Switzerland, Sweden, Italy, France, the Netherlands, and Finland. This is a highly integrated group of Western and Northern European countries in scientific collaboration. The red group (right) is dominated by China (the largest circle in this group), followed by Spain, Turkey, Malaysia, Portugal, and Oman. This group shows a strong collaborative network around China with several Southern European and Southeast Asian countries. The yellow group (bottom center) is relatively small, consisting only of Colombia and a few connections to the Netherlands and France.

The countries with the largest circles or the most influential in this network are, in order, Australia, Germany, China, India, the United Kingdom, France, and Italy. This shows that these countries are likely to be hubs for international research collaboration in the field being analyzed. The strongest relationships, indicated by the thickest lines, are seen between Germany–United

----
Navigating Digital Horizons: A Bibliometric Exploration of Digitalization in Family Businesses and Emerging Research Agendas
(Steven, et al.)

2933

Kingdom, Germany–Switzerland, Australia–India, as well as China–Malaysia and China–Spain. This illustrates the existence of very intense scientific collaboration corridors along these routes.

Overall, this graph illustrates a global scientific collaboration landscape that is still dominated by Western developed countries such as Western Europe, the US, Canada, Australia, and the UK, but shows China's rapid growth as a new center, especially in relation to Spain, Malaysia, and Turkey. India and Australia also appear very strong as bridges between the Western world and Asia. Meanwhile, Latin America (except for small Colombia) and Africa are almost invisible, indicating the low level of involvement of these regions in the global scientific collaboration network on the topics analyzed.

Identifying Major Theme Clusters Through Network Visualization

Based on keyword co-occurrence analysis using VOSviewer, six main clusters were identified that collectively form the research landscape on digital transformation in family firms and SMEs over the past decade. These clusters do not stand alone, but interact intensively around the central node of digital transformation, reinforcing the argument that digital transformation in this group of companies is multidimensional and influenced by complex internal and external factors.

The green cluster emphasizes that sustainability has become one of the main strategic motivations for family firms in implementing digital transformation. Family businesses often leverage their unique socio-emotional wealth to develop a strong entrepreneurial orientation, which positively influences their commitment to sustainability (López-Pérez et al., 2018). Unlike non-family companies that are more oriented towards short-term profits, family firms tend to view digital transformation as an instrument to achieve socioemotional wealth (SEW) and cross-generational sustainability. The keywords generational involvement and entrepreneurial orientation, which emerge strongly in this cluster, support the findings of Berrone et al. (2012) and Miller & Le Breton-Miller (2021) that the involvement of the next generation is often a key driver of the adoption of environmentally friendly technologies and sustainable business practices (Kesuma et al., 2025). Thus, digital transformation in family firms is not merely about pursuing efficiency, but also a means of preserving the family legacy through the achievement of ESG (environmental, social, governance) goals.

The relatively small but highly central yellow cluster highlights the conceptual difference between digitization (the conversion of analog processes to digital) and digitalization (business model change through digital technology). The existence of this cluster indicates that there is still confusion over terminology among researchers, while also indicating that most family firms and SMEs are still in the early stages (digitization) rather than the advanced stages (digitalization or digital transformation). This confusion often causes many family businesses and SMEs to get stuck in the early stages of digitization rather than advancing towards comprehensive digitalization, which is exacerbated by resource constraints and cultural resistance (Barile et al., 2022; Basly & Hammouda, 2020). These findings are in line with the study by Verhoef et al. (2021), which states that SMEs and family firms are often stuck in the digitization stage due to resource constraints and cultural resistance. In addition, research shows that companies are still heavily dependent on traditional operational models, which limit their ability to adopt strategies essential digital technologies that can improve performance during periods of economic

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Navigating Digital Horizons: A Bibliometric Exploration of Digitalization in Family Businesses and Emerging Research Agendas

(Steven, et al.)

disruption, such as during the COVID-19 pandemic (Henrika et al, 2025; Priyono et al., 2020; Alam et al., 2022; Kharaishvili & Lobzhanidze, 2023).

The emergence of red clusters dominated by COVID-19 with very large node sizes is empirical evidence that the pandemic has served as an external enabler (Davidsson, 2015), forcing the acceleration of digital transformation in SMEs and family firms. The COVID-19 pandemic has served as an external driver accelerating digital transformation in small and medium-sized enterprises (SMEs) and family businesses, transforming technology adoption from a strategic choice to a necessity for survival (Prayitno et al., 2024; Petropoulou et al., 2024). Research shows that this crisis triggered a significant surge in the adoption of e-commerce and digital platforms, which are vital for business resilience and innovation (Giotopoulos et al., 2022; Penco et al., 2022). This crisis has changed the nature of technology adoption from a strategic choice to a necessity for survival. The keywords entrepreneurship and MSMEs, which are closely related in this cluster, reinforce the argument that entrepreneurial resilience and bricolage are key mechanisms for small businesses to survive in the midst of exogenous shocks. These findings are consistent with research by Amankwah-Amoah et al. (2021) and Soluk et al. (2021), which found an exponential surge in the adoption of e-commerce, digital platforms, and remote working in family firms after 2020.

The blue cluster emphasizes that human capital and innovation culture are far more important determinants than technology itself in the context of family firms and SMEs. Digital progress is crucial in creating competitiveness and innovation, with the younger generation as the main driver within organizations. Research shows that a lack of digital skills and resistance from senior employees can be major obstacles in the digital transformation stage (Calabrò et al., 2020; Ande, 2019). The high frequency of the keywords "innovation" and "human capital" indicates a growing awareness that a lack of digital skills and resistance from senior employees are often major bottlenecks. This supports and expands the theory of dynamic managerial capabilities (Helfat & Martin, 2015) in the context of family businesses, where the younger generation, who are more digitally savvy, often act as digital champions who drive innovation from within. The theory of dynamic managerial capabilities developed by Helfat and Martin (2015) provides a framework for understanding the managerial role in managing and utilizing human capital to enhance innovation (Ande, 2019). Managers with dynamic capabilities, including relevant knowledge and skills, can integrate and transform organizational resources to drive innovation (Heubeck & Meckl, 2021). Further research supports the importance of human capital in optimizing a company's innovation capabilities, confirming that more adaptive managers can significantly improve an organization's innovation performance (Heubeck & Meckl, 2022; Garcés–Galdeano et al., 2016).

The purple cluster is the second most densely populated cluster after digital transformation itself, with the keywords corporate governance, family firms, dynamic capabilities, and performance. This cluster provides strong evidence that family governance (familiness in governance) can be both a source of competitive advantage and an obstacle to digital transformation. Family firms with a high level of governance professionalization (the existence of an independent board of directors, clear succession planning) tend to have better dynamic capabilities to integrate new technologies, resulting in superior performance. These findings enrich the governance-transformation nexus literature (Chrisman et al., 2015; Calabrò et

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Navigating Digital Horizons: A Bibliometric Exploration of Digitalization in Family Businesses and Emerging Research Agendas
(**Steven, et al.**)

2935

al., 2022).

Although it is the smallest in size, the orange cluster covering Industry 4.0 plays a strategic role in the context of digital transformation, connecting almost all other clusters. Technologies such as Artificial Intelligence (AI), Internet of Things (IoT), Big Data, and Cloud Computing are now beginning to touch on the discourse of digital transformation, especially in family businesses and Small and Medium Enterprises (SMEs) in Indonesia (Zhou et al., 2023; Hung et al., 2024). Although the adoption of these technologies is still in its early stages and generally limited to large companies with access to capital, the potential for creating smart family businesses in the future is enormous (Eugene & Arivazhagan, 2024). Research shows that this shift towards more complex digitalization can improve operational efficiency, product quality, and competitiveness in the global market (Sony & Naik, 2019; Raicu & Raicu, 2021). Thus, the existence of these clusters is an important indicator of the evolution of business towards an era where technology integration is an essential aspect of a company's success (Syed et al., 2024).

The six clusters collectively illustrate that digital transformation in family firms and SMEs cannot be reduced to a purely technological phenomenon, but rather is a socio-technical process influenced by family values and governance, human capabilities and innovation, the external shock of Covid-19, cross-generational sustainability orientation, and the availability of Industry 4.0 technology. The Covid-19 pandemic served as a critical point that activated and accelerated interactions between these dimensions. Thus, this study enriches the Resource-Based View (RBV) and Dynamic Capabilities frameworks by incorporating the dimensions of familiness and external shock as significant moderating variables in the context of digital transformation in family businesses and SMEs.

In addition, based on the co-authorship analysis of international scientific collaboration networks generated using VOSviewer software, the data analyzed reveals a highly dynamic and multipolar landscape in global knowledge production. The dominance of the People's Republic of China as the node with the highest size and degree marks a long-predicted tectonic shift in scientometric literature. China not only shows a very large volume of publications, but is also able to form very strong and diverse relationships with countries that are geographically, culturally, and developmentally very heterogeneous, ranging from Spain and Portugal in Southern Europe, Malaysia and Oman in Asia, to Brazil in South America. The striking thickness of the China–Spain link indicates that this cooperation has gone beyond mere researcher exchanges or joint projects, but rather reflects a long-term strategic alliance that is likely supported by substantial funding from both sides, joint laboratory programs, and alignment of national research priorities, for example in the fields of renewable energy, nanotechnology, and materials science.

The formation of a red cluster connecting China with Iberian-speaking countries and several developing countries such as Malaysia, Turkey, Brazil, and Oman shows a significant phenomenon in the context of global interaction. The growth of collaboration between BRIC member countries, especially China and Iberian countries, can be seen in academic publication patterns that reflect diversification in research (Guevara & Mendoza, 2016). Furthermore, research shows that digital technology and health interventions play an important role in improving social and health resilience in developing countries, including Turkey and Malaysia (Garg & Kumar, 2024; Vedanthan et al., 2017). In this context, these cross-border relationships provide opportunities for cultural exchange and innovation, contributing to broader economic

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Navigating Digital Horizons: A Bibliometric Exploration of Digitalization in Family Businesses and Emerging Research Agendas

(**Steven, et al.**)

growth and sustainable development in the countries involved (Yılancı et al., 2021).

With these developments, greater attention to the dynamics of this cluster will be important to understand how these countries can work together to address common global challenges, such as post-pandemic recovery and the climate crisis, which demand innovative collaborative solutions (Augustin et al., 2022; Alkan et al., 2023). This cluster demonstrates the emergence of a South–South plus Southern Europe model that no longer follows the traditional North–South collaboration pattern. Spain's presence as a bridge country in this cluster is particularly interesting: although historically Spain has been more often in the orbit of Western European and Latin American collaboration, it has now successfully positioned itself as China's main strategic partner in Europe. This can be explained by several factors, including China's large investments in Spain's infrastructure and energy sectors, Spain's relatively open policy towards cooperation with non-Western actors, and the similarity of research orientations in fields that are rapidly developing in both countries.

In contrast, the blue cluster led by Germany and the United Kingdom, together with Switzerland, Sweden, Italy, and Austria, still reflects the traditional strength of the European core in global science. This cluster is characterized by a very high density of interrelated connections, indicating a high level of institutional trust and mature joint funding mechanisms (such as Horizon Europe, ERC grants, and the Max Planck or Helmholtz networks). Italy's significant presence in this cluster also confirms that despite facing economic challenges, its research capacity remains competitive at the global level, particularly in physics, medicine, and earth sciences.

The green cluster dominated by Australia, India, the United States, Canada, and Hong Kong shows the continued influence of English as a lingua franca in international scientific collaboration. India, with its node size growing year on year, has now transitioned from being merely a peripheral player to an emerging hub connecting the South Asian research ecosystem with the Anglosphere network. Australia's role as an Asia-Pacific gateway has also become increasingly important, especially after the COVID-19 pandemic accelerated cooperation in virology, public health, and bioinformatics with neighboring countries.

The relatively separate French cluster (light blue) together with Morocco and Colombia shows that colonial traces and language are still strong determining factors in the formation of scientific networks. France has succeeded in maintaining its influence in former colonies or French-speaking regions through various instruments of scientific diplomacy such as Campus France, the Institut Français, and cotutelle thesis programs. This pattern shows that cultural and linguistic soft power remains relevant in an era of scientific globalization that is increasingly dominated by quantitative metrics.

Indonesia's absence from this entire network is a very significant and worrying finding. As the fourth most populous country in the world, a member of the G20, and the 16th largest economy in nominal terms, Indonesia's absence indicates a very wide disconnect between its demographic and economic potential and its international scientific performance. The causes are multifaceted, such as the low proportion of English-language publications in reputable journals, a national academic incentive system that is still oriented towards quantity rather than quality and international impact, limited funding for large-scale collaborative research, low mobility of Indonesian researchers abroad and vice versa, and Indonesia's scientific diplomacy in multilateral forums that is not yet optimal. This absence also indicates that the dataset used (possibly Scopus

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Navigating Digital Horizons: A Bibliometric Exploration of Digitalization in Family Businesses and Emerging Research Agendas

(**Steven, et al.**)

or Web of Science) has not been able to capture collaborations that may have occurred through non-publication channels, such as infrastructure development projects, training, or institutional cooperation that did not result in co-authorship.

Overall, this visualization depicts a scientific world that is increasingly polarized and fragmented into several geo-epistemic regions that do not fully overlap with traditional geopolitical divisions. China has succeeded in creating a sphere of scientific influence that extends beyond Asia to reach Southern Europe and Latin America, while Western powers maintain their internal cohesion through language, institutions, and joint funding. In this context, developing countries that do not immediately increase strategic investment in open science, international publications, and scientific diplomacy risk permanent marginalization on the global knowledge map. For Indonesia, these findings should serve as a wake-up call to undertake major reforms of the national research system, strengthen the internationalization of higher education, and develop more aggressive and targeted science diplomacy in order to enter at least one of the existing clusters within the next decade.

Formulating a Future Research Agenda Oriented Toward Emerging Contexts Such as AI and Sustainability

The results of this study open up a number of opportunities for the development of digitalization studies in family businesses in the future. Because this study uses a Scopus-based bibliometric approach, the findings only describe the general landscape of research and the direction of global publications, but do not touch on the depth of meaning, social dynamics, and consequences of digitalization on family businesses themselves. Therefore, further research can be directed to complement this big picture through more in-depth approaches and perspectives.

First, future research can expand the data sources to more diverse databases, such as Web of Science, Google Scholar, Dimensions, or even regional databases such as the ASEAN Citation Index. The integration of several databases can offer a richer representation and reduce indexing bias. With a broader range of sources, the research map of digitization in family businesses will be more accurate and inclusive.

In addition to expanding the scope of publications, further research is also needed to examine the quality and substance of the research findings. Bibliometrics only show how often and how certain topics are discussed, without assessing the depth of the theory or the strength of the empirical evidence. Combining bibliometrics with a systematic literature review (SLR) will provide a more comprehensive understanding of the theoretical and methodological foundations in this field.

The next important direction of research is to understand the social and cultural context that shapes the success or failure of digital transformation in family businesses. Digitalization is not just about technology; it also relates to family values, intergenerational relationships, and attitudes toward change. Qualitative studies such as in-depth interviews, multigenerational case studies, or organizational ethnography can offer emotional and human insights that are difficult to capture through quantitative analysis.

In addition, there are opportunities to move towards predictive and causal research, such as examining how digitization affects business performance, succession success, innovation, or sustainability in various industrial sectors. Quantitative approaches such as SEM-PLS, fsQCA, or

----
Navigating Digital Horizons: A Bibliometric Exploration of Digitalization in Family Businesses and Emerging Research Agendas

(**Steven, et al.**)

2938

longitudinal studies can be used to understand the relationships between variables in greater depth.

With the emergence of new technologies, future research also has the opportunity to explore more cutting-edge themes, such as the role of artificial intelligence (AI), big data, and cyber security in family businesses; digital leadership in generational succession processes; or the potential of digitization in driving green innovation and sustainability. The context of Indonesia and other developing countries provides ample room for exploration, given that the majority of family businesses are still in the early stages of digitalization.

Overall, future research in this field will move from simply mapping trends to understanding human experiences, family dynamics, and the business and social impacts of digitalization. This approach is expected to produce scientific contributions that are not only academically relevant, but also have a real impact on family businesses and policymakers in accelerating inclusive and sustainable digital transformation.

CONCLUSION

This study provides a structured overview of the digitalization landscape in family businesses by mapping publication trends, thematic clusters, and global collaboration patterns. The findings show that digital transformation is shaped by a combination of technological progress, governance structures, human capital, and external shocks such as COVID-19, indicating that technology alone does not drive change. Instead, digital readiness emerges from the interaction between family dynamics, innovation capabilities, and strategic adaptation.

The thematic clusters highlight growing attention toward sustainability, Industry 4.0 technologies, and the human side of digital transformation, while the co-authorship analysis reveals a research environment dominated by Europe, China-centered networks, and Anglosphere countries, with notable underrepresentation from Southeast Asia. These insights collectively demonstrate that the field is expanding but remains uneven across regions and research approaches.

Overall, this study clarifies the current intellectual landscape and points to future research opportunities, particularly the need for deeper qualitative insights, broader global participation, and investigation into how emerging technologies like AI will shape the long-term resilience and competitiveness of family businesses.

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2939

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2941

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Navigating Digital Horizons: A Bibliometric Exploration of Digitalization in Family Businesses and Emerging Research Agendas

(**Steven, et al.**)

2942