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Digital Entrepreneurship: A review, research synthesis, and development of a framework

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ABSTRACT

The global rise of digital technologies has ushered in a new era of entrepreneurship, fundamentally reshaping traditional business models and driving economic growth and innovation. Digital entrepreneurship is highly relevant today, as advances in technology and infrastructure provide numerous opportunities for entrepreneurs in the modern digital economy. This study maps and synthesizes the field of digital entrepreneurship using two methods: a bibliometric analysis of research articles to identify key clusters, and an umbrella review of peer-reviewed review papers to integrate prior syntheses. Together, these methods surface 13 core themes covering enablers, challenges, mediators, and outcomes in digital entrepreneurship. Based on these consolidated themes, this study proposes the Digital Entrepreneurship Ecosystem Model (DEEM).

1. Introduction

The digital age has introduced a new era of entrepreneurship in which innovative ideas and technological solutions are redefining and revolutionizing traditional business models. Companies that started as digital startups more than a decade ago, such as Amazon, Google, and Facebook, have evolved into some of the most prominent and valuable corporations worldwide, showcasing the significance of digital firms in today's economy (Venâncio et al., 2023). Digitalization is one of the most significant and far-reaching transformations of our time, fundamentally altering our modes of living, working, and conducting business in the near and long-term future (Calderon-Monge & Ribeiro-Soriano, 2024; Kallmuenzer et al., 2024; Kraus et al., 2023a; Tiberius et al., 2024). Accordingly, the term "digital transformation" has gained significant traction in modern business discussions, being used to describe the profound and often disruptive impacts that digital technologies have on organizations across all sizes and industries (Nambisan, 2017; Nambisan et al., 2019). While the integration of these technologies presents considerable challenges for established companies, it simultaneously creates opportunities for entrepreneurs to engage in what Schumpeter termed "creative destruction" (Kraus et al., 2023b), where traditional industries and business models are disrupted and replaced by innovative, tech-driven alternatives (Amit & Zott, 2001). The World Economic Forum (WEF) estimates that approx. 70 % of the value created in the next decade will come from digitally enabled, platform-based business models (World Economic Forum, 2024). The COVID-19 pandemic catalyzed this shift, accelerating digital economic growth and pushing many organizations to adopt digital solutions for business continuity (Kraus et al., 2020). This rapid development during the pandemic opened numerous avenues for aspiring entrepreneurs to enter the market, thereby further increasing the focus on DE.

> DE can be defined as *"[…] a subcategory of entrepreneurship in which some or all of what would be physical in a traditional organization has been digitized"* (Hull et al., 2007, p. 293). As technological disruptions, particularly information and communication technologies (ICT), play a central role in the value creation process (Le Dinh et al., 2018), DE emerges at "*[…] the intersection of digital technology and entrepreneurship*" (Nambisan, 2017, p.1.) and represents *"[…] the new way of creating and doing business in the digital era"* (Le Dinh et al., 2018, p.1). In the context of the ongoing digital transformation and the uncertainties it creates for both the economy and society, the

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words of the evolutionary scientist Charles Darwin seem more relevant than ever: survival is not determined by intelligence or strength but by the ability to adapt and respond effectively to environmental changes (Megginson, 1963).

Against this background, gaining a deeper understanding of DE is becoming crucial for established companies, as well as for scholars and practitioners in the field of entrepreneurship. Several systematic literature reviews (SLRs) have already addressed DE. Some of them are now outdated, and some have a narrow focus on sub-aspects of DE. For example, Kraus et al. (2019) provided an early and now highly cited review detailing the opportunities, challenges, and success factors related to DE. Zaheer et al. (2019) conducted an interdisciplinary review examining how traditional perspectives on entrepreneurship are being disrupted in the digital era. Satalkina and Steiner (2020) investigated the transformative role of DE in innovation systems. Another notable review by Bejjani et al. (2023) examined the environmental context influencing DE activities. Despite these extant SLRs on DE, a broad and holistic overview is required of the field that has grown exponentially over recent years. Due to the large number of publications on DE, a bibliometric analysis of the diverse and fragmented field is needed (Donthu et al., 2021; Fernandes et al., 2024; Fernandes et al., 2024; Zaheer et al., 2019). Bibliometric analyses can help mitigate the fragmentation of a research field by identifying connections between different research streams and drawing on a larger body of scientific literature.

This paper aims to fulfil the need for a bibliometric review of DE literature. Although some bibliometric studies already exist, they primarily focus on performance analyses or somewhat simple content-based analyses or focus on a sub-topic. For instance, Dana et al. (2024) analyzed descriptive bibliometric indicators and word co-occurrence to identify key topics in the DE field. Similarly, Lungu et al. (2024) and Zhai et al. (2023) applied keyword co-occurrence analysis to identify and examine keyword clusters within the domain of DE. Sánchez-García et al. (2024) analyzed the most used keywords and their co-occurrence and combined this bibliometric approach with a literature review of abstracts. Other bibliometric analyses have a more specific topical focus, such as DE marketing (Amjad, 2022), DE platforms (Fernandes, Ferreira, et al., 2022), or the relationship between DE and sustainability (Fernandes, Pires, & Gaspar Alves, 2022). This study, however, distinguishes itself from these prior analyses by providing an extensive overview of DE's intellectual structure within business studies research, using the two main content-based science mappings and focusing on macro-level analyses. This study enhances existing bibliometric and literature reviews by utilizing two science mapping techniques: co-citation analysis to investigate foundational themes and bibliographic coupling to highlight recent research topics. A research framework is developed following the insights from these science mappings. It consolidates interrelations among various DE research areas and provides a structured approach to understanding how different elements of DE research are interconnected. This study further takes a step ahead by performing an umbrella review, synthesizing the results from past reviews on DE. This umbrella review consists of a thorough, comprehensive exploration of published review articles on the subject of DE. Through detailed coding and thematic categorization, the results were segmented into 13 main themes, reflecting key areas and future research directions within the context of DE. Against this background, the research questions are as follows R1.To identify the key findings from the bibliometric analysis of DE literature, and how do they highlight current research trends? R2 To synthesize and consolidate the main themes, theoretical perspectives, and ecosystem-level factors reported in existing review studies on digital entrepreneurship. R3: To integrate these synthesized insights with bibliometric mapping results to provide the conceptual foundation for the Model.

2. Methodology

2.1. Bibliometric analysis

A bibliometric analysis was conducted (e.g., Donthu et al., 2021; Öztürk et al., 2024) to achieve the research objective of obtaining a systematic and comprehensive overview of the DE research landscape, including identifying its historical foundations and emerging research streams. Bibliometric analysis is used to measure and evaluate large amounts of scientific literature in a specific field using bibliometric data. In contrast to literature reviews (e.g., Sauer & Seuring, 2023; Kraus et al., 2024) , the quantitative, statistical nature of bibliometric techniques offers greater objectivity in assessing publications (Donthu et al., 2021; Mukherjee et al., 2022). More specifically, this study employed two analyses: co-citation and bibliographic coupling. These two science mappings use citation data to analyze and visualize the intellectual structure and dynamics of a research field, based on measures of influence and similarity (Donthu et al., 2021; Lim & Kumar, 2023; Zupic & Čater, 2015).

Co-citation is defined as *"the frequency with which two items of earlier literature are cited together by the later literature"* (Small, 1973, p. 265), i.e. two documents are considered co-cited when they both appear in the reference list of another document. The more frequently two items are co-cited, the stronger their link and the higher the probability that they are thematically related (Donthu et al., 2021; Egghe & Rousseau, 2002; Small, 1973; Zupic & Čater, 2015). Depending on the focus of analysis, different types of co-citation exist, such as document co-citation, author co-citation and journal co-citation. In this study, a document co-citation analysis is used to identify seminal publications and foundational themes of the research field (Zupic & Čater, 2015).

Bibliographic coupling is a technique used to determine the relationships and similarities between scientific documents based on the number of references they have in common. When two documents cite the same source, they are considered bibliographically coupled. The more references they have in common, the more strongly they are linked and the greater the likelihood that they address similar research topics (Egghe & Rousseau, 2002). Bibliographic coupling is especially effective because, unlike co-citation analysis, which relies on highly cited and thus older publications, it provides visibility to recent and niche publications that have had less time to accumulate citations (Donthu et al., 2021; Zupic & Čater, 2015). Therefore, we also use this method in order to capture current trends and convey a more comprehensive understanding of the latest research developments in DE.

Bibliometric analysis does not replace traditional literature reviews. Rather, it acts as a complementary approach (e.g., at the macro level), helping to address gaps or limitations found in conventional methods. The interpretation of the derived thematic clusters relies on the researcher and their knowledge of the analyzed field, especially when the distinctions are not clear-cut (Donthu et al., 2021; Lim & Kumar, 2023; Zupic & Čater, 2015). In Fig. 1, a comparison of the chosen science mapping techniques is presented to summarize the key differences.

2.2. Data collection

This study used the Web of Science (WoS) Social Sciences Citation Index (SSCI) for bibliometric data because it is a long-standing citation indexing (Finch, 2012) and is widely used in entrepreneurship research and for bibliometric analyses (Norris & Oppenheim, 2007; Zupic & Čater, 2015). WoS also allows for the selection of high-quality journals, particularly those indexed in the Social Sciences Citation Index (SSCI), ensuring the inclusion of rigorously vetted publications. The literature sample was sourced on October 19th, 2025 (formerly on May 9, 2024). A topic search using the term "digital entrepreneur*" initially yielded 447 documents. The asterisk is applied for truncation, allowing the search to include multiple word variations, thus expanding the search scope and capturing further relevant results. A topic-based search covers not only

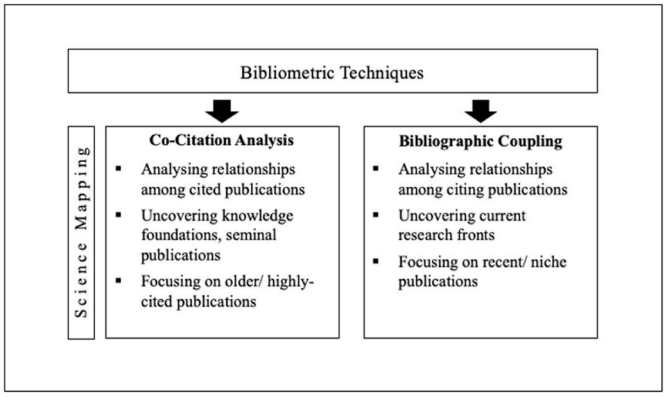

Fig. 1. Comparison of co-citation analysis and bibliographic coupling. Source: Own elaboration based on Donthu et al., 2021; Zupic & Čater, 2015.

the titles of articles but also abstracts and keywords of documents. This type of search method minimizes the risk of neglecting relevant publications when the search term does not appear explicitly in the title, thus achieving a more detailed coverage of the research field.

Several filters were applied to refine the dataset for quality, relevance, and replicability. First, the query was restricted to documents published between 2014 and 2024 (full year), as 2014 marked a turning point in academic interest with the growing influence of platform-driven innovation ecosystems and digitally enabled entrepreneurship models, leading to 379 results. Second, to maintain thematic focus, only documents categorized under "Business", "Management", and "Economics" were included, yielding 242 documents. This reflects the core disciplinary boundaries of digital entrepreneurship research. Third, the dataset was limited to peer-reviewed publications, retaining only the document types "Article" and "Early Access", leading to a sample of 216 articles. Following this, the dataset was manually reviewed for non-English papers, off-topic records, doublets, or necessary corrections in the original papers' meta data. The sample size did not change.

The umbrella review analysis began with an initial search in the WoS using the terms title ("Digital Entrepreneurship" OR "Online Entrepreneurship" OR ″E-Entrepreneurship") AND ("Systematic Review" OR "Meta-Analysis" OR "Bibliometric Analysis"), yielding 614 results. After refining the search to include only review articles, 37 were selected. Further narrowing the list down to SSCI-indexed publications resulted in 20 articles, and focusing on management, business, and economics reduced the selection to 16. Ultimately, 13 articles were chosen for the final analysis, with some not entirely focused on DE but still contributing valuable insights for the generation of the comprehensive theme (Khatri et al., 2025; Koporcic et al., 2025). The review followed a structured search and selection process, retaining only peer-reviewed review article. The meta-level approach emphasizes thematic convergence and theoretical alignment, which are then integrated with bibliometric results rather than re-analyzing primary studies.

2.3. Data analysis

For data analysis, this study used VOSviewer version 1.6.20 (Van Eck & Waltman, 2010). The document co-citation analysis is based on the cited references from the final dataset, which contained 14,775 cited references. In contrast, bibliographic coupling focuses on the citing documents, analyzing the dataset of 213 publications. In both analyses, a citation threshold of seven was applied (Zupic & Čater, 2015) to obtain manageable sample sizes focusing on papers with a minimum level of relevance. As a result, the final samples for the co-citation analysis and bibliographic coupling were 170 and 162 respectively. This ensured approximately equal sample sizes for both analyses, allowing for consistent comparability between the two science mappings.

The generated maps (see below, section 3.1) provide a visual representation of both analyses. Each circle on the map represents a single publication. The size of a circle corresponds to the importance of that publication within the dataset: the larger the circle, the more significant the publication. The circles are color-coded to indicate the thematic clusters to which each publication belongs. The lines between the circles symbolize the citation links between the publications. The distance between the circles reflects the strength of their relationship – the closer the circles, the stronger the connection between the publications. The total link strength (TLS) represents the overall strength of the connections between the publications (Van Eck & Waltman, 2010). To determine the thematic clusters of each analysis, the titles and abstracts of publications were systematically reviewed and coded. If the titles and abstracts did not allow a full understanding of the themes of a cluster, the full articles were read (Lim & Kumar, 2023).

3. Results

3.1. Co-citation analysis

In the co-citation analysis, four distinct research clusters were identified, with 7888 links and a total link strength of 19,286. The co-citation map is depicted in Fig. 2. In the following, the derived clusters are introduced and briefly described. Manual screening was performed in Excel to identify and remove any remaining duplicate entries, such as early access and final versions of the same article. Entries with identical DOIs or substantially matching titles were treated as duplicates, and only the final, peer-reviewed version was retained. Additionally, we excluded non-research articles such as book reviews, editorials, and misclassified items by manually reviewing each document's title, abstract, and source. This ensured that only peer-reviewed, topic-relevant studies were included in the final dataset. These steps improved the reliability of the bibliometric dataset and the accuracy of the resulting science maps.

Cluster 1 (red): Impact of Digital Technologies on Entrepreneurship: The largest cluster, consisting of 45 publications, mainly addresses the transformative impact of digital technologies on entrepreneurship. According to Nambisan (2017, p. 1), DE lies "[…] *at the intersection of digital technologies and entrepreneurship."* Hull et al. (2007) conceptualize DE as a subcategory of traditional entrepreneurship, categorized by the degree of digital technology integration in value creation. This ranges from mild to extreme forms of DE. While terminology varies, there is a consensus that digital technologies act as external enablers of DE and lead to more opportunities for entrepreneurial activity (e.g., Hull et al., 2007; Nambisan, 2017; von Briel et al., 2018). Digital technologies, defined as *"[…] products or services that are either embodied in information and communication technologies or enabled by them"* (von Briel et al., 2018, p. 49), manifest in many different forms such as digital platforms, digital artifacts, and digital infrastructure (Elia et al., 2020; Nambisan, 2017). These technologies transform entrepreneurship by making traditional boundaries more fluid and distributing entrepreneurial agency more broadly throughout the venture creation process (Elia et al., 2020; Nambisan, 2017; Von Briel et al., 2018). Digital technologies facilitate communication and collaboration, support innovation and allow for cost-effective customer involvement across all phases of entrepreneurship, from exploring opportunities and testing concepts to financing and launching ventures (Nambisan, 2017). This iterative process enables the rapid formation, modification and implementation of product ideas and business models (Nambisan, 2017; Von Briel et al., 2018). Scholars widely recognize DE as a crucial driver for innovation, economic growth, and job creation (Elia et al., 2020; Ladeira et al., 2019; Nambisan, 2017; Satalkina & Steiner, 2020). Digital technologies not only reshape the entrepreneurial process and ecosystem but also influence the entrepreneur's role (Ladeira et al., 2019; Ngoasong, 2018; Satalkina & Steiner, 2020). Ngoasong (2018) introduced the term "entrepreneurial digital competencies" (EDCs), which refers to the skills required to adapt to and effectively utilize ICT. These competences

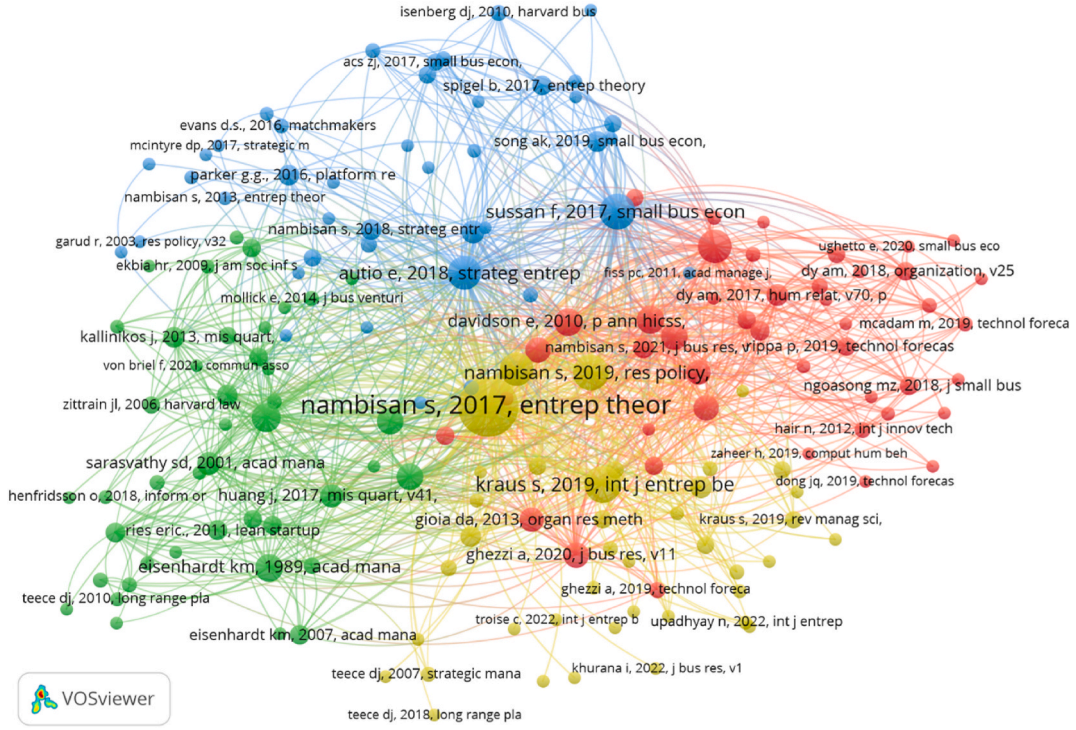

Fig. 2. Co-Citation Map (label view).
Source: Own elaboration based on VOSviewer.

extend beyond traditional entrepreneurial skills and ensure entrepreneurial success in the digital economy.

Cluster 2 (green): Value Creation and Business Models in (Digital) Entrepreneurship: With 43 publications, the second research cluster deals with theories of value creation and opportunity identification in entrepreneurship, the importance of business models and dynamic capabilities in the context of digital transformation. In addition to general, mostly older theoretical works on deriving theories from case study research (e.g., Eisenhardt, 1989; Eisenhardt & Graebner, 2007), there is a larger selection of publications focusing on the theoretical foundations of value and opportunity creation. These theories provide valuable insights into potential sources of value creation and entrepreneurial opportunities, including Schumpeterian innovation, the resource-based view (RBV), entrepreneurial bricolage, the distinction between opportunity discovery and creation, and effectuation theory (Alvarez & Barney, 2007; Amit & Zott, 2001; Baker & Nelson, 2005; Sarasvathy, 2001). Digitalization has transformed the discovery and exploitation of business opportunities, broadening the range of resources available to firms (Amit & Han, 2017; Zott et al., 2011). Scholars regard business models as essential units of analysis for understanding the architecture of value creation, particularly since the rise of the Internet in the mid-1990s (Teece, 2010; Zott et al., 2011). In times of rapid technological change, dynamic capabilities are seen as a key enabler of achieving sustainable competitive advantage. These organizational and strategic managerial competencies – the ongoing process of sensing, seizing, and transforming emerging opportunities – are essential for developing, implementing, and adapting business models to stay competitive in the evolving digital economy (Eisenhardt & Martin, 2000; Teece, 2010).

Cluster 3 (blue): Platform Economy and Open Innovation: The third research cluster, covering 42 publications, focuses on digital platforms, the innovations they generate, and their influence on the transformation of the economy. Platforms are recognized as technology-driven digital environments that enable businesses to connect with each other and with customers, providing an open and participatory infrastructure to foster value-creating interactions (Nambisan et al., 2018; Parker et al., 2016). Entrepreneurs can leverage platform strategies to drive innovation, especially from outside their boundaries. The data and insights gathered from these platforms can aid in various stages of product and service development. These digital spaces provide faster feedback loops from customers, enabling rapid adaption and creation of innovative solutions that closely align with customer needs (Nambisan et al., 2018; Parker et al., 2016). In addition, the openness of digital platforms also reduces the costs of research and commercialization (Nambisan et al., 2018). Platforms can be classified as either internal (i.e., company- or product-based) or external (i.e., industry-based) and can also be categorized into different types, such as innovative platforms (e.g., Apple iOS) and transaction platforms (e.g., Amazon). Platform businesses, which generate value using resources they neither own nor control, disrupt the conventional competitive landscape and are present across various industries and sectors. Examples include accommodation (e.g., Airbnb), social media (e.g., Facebook) and transportation (e.g., Uber) (Parker et al., 2016). The power of a platform primarily relies on cultivating a large, well-managed community that generates substantial value for each user, a phenomenon known as network effects (Parker et al., 2016; Srinivasan & Venkatraman, 2018). In this context, the phrase "chicken-and-egg problem" is frequently used to describe the difficulty of simultaneously attracting both producers and consumers to the platform (Parker et al., 2016; Rochet & Tirole, 2003).

Cluster 4 (yellow): Evolution of Entrepreneurial Ecosystems in the Digital Age: The fourth cluster, comprising 40 publications, focuses on entrepreneurial ecosystems (EEs) and their adaptation to the digital economy. Digital technologies reconfigure how entrepreneurship unfolds and where value is created – shifting analysis from single firms to multi-actor, platform-mediated ecosystems. Nambisan (2017, 2019) reframes digital entrepreneurship around new forms of uncertainty and generativity, calling for cross-level study of openness, platforms and ecosystem dynamics. Bharadwaj et al. (2013) articulate "digital business strategy" as a fusion of IT and business strategy, explaining why competition and collaboration now span ecosystem boundaries. Building on this foundation, ecosystem orchestration can be tied to dynamic capabilities (Teece, 2007, 2018) and their interdependence with business-model design, while Warner and Wäger (2019) show how

incumbents actually build such capabilities to renew positions within digital ecosystems. At the microfoundational level, value creation can be explained via digitally enabled resource configurations across partners (Amit and Zott, 2001). Properties of digital technologies act as external enablers at different venture-creation stages, clarifying the mechanisms by which ventures mobilize ecosystem resources (von Briel et al., 2018). Syntheses by Kraus et al. (2019) and Zahra et al. (2023) consolidate this agenda as they identify digital (entrepreneurial) ecosystems" as a central stream and as they show how digital ventures both leverage and actively shape their surrounding ecosystems over time. Several recent and already well-cited papers center around such ecosystems (Beliaeva et al., 2020; Khurana et al., 2022; Zahra et al., 2023).

3.2. Bibliographic coupling

The bibliographic coupling analysis revealed six research clusters, with the publications being connected by 9428 links and a total link strength of 24,650 (Fig. 3). In the following, the clusters are described.

Cluster 1 (red): Innovative Business Models through Digital Platforms and Lean Approaches: The first cluster, with 49 publications, concentrates on innovative business models shaped by digital platforms and lean approaches. Digital platforms offer entrepreneurs new opportunities to develop innovative business models within the digital economy, serving as *"[…] engines of innovation for other firms to build complementary products and services […]"* (Srinivasan & Venkatraman, 2018, p. 56). The sharing economy exemplifies an innovative business model mediated by digital platforms, revolutionizing traditional industries by enabling peer-to-peer transactions and efficient resource utilization. Successful businesses based on the idea of sharing include Uber and Airbnb, which leveraged digital technology to create new business models that are changing consumer behavior and disrupting established industries (i.e., transportation and accommodation) (Richter et al., 2017; Sanasi et al., 2020). Lean Startup Approaches (LSAs) are agile methods to enable BMI and have proven successful in DE. Agility is essential for adapting to changes, particularly in fast-paced, digital environments (Ghezzi & Cavallo, 2020). LSAs support the process of validating a startup's business idea, reducing uncertainty by rapidly testing ideas, gathering feedback, and developing customer-centric business models. However, established companies, whose business models are threatened by new digital technologies, can also benefit from these approaches (Ghezzi, 2019, 2020; Ghezzi & Cavallo, 2020).

Cluster 2 (green): Knowledge Dynamics in DEEs and the Impact of COVID-19: With 40 publications, the second largest cluster centers on DEEs, particularly emphasizing the role of knowledge, and examines how COVID-19 has accelerated various opportunities for DE. Elia et al. (2020) described DEEs as "collective intelligence systems" and emphasized the importance of collaboration and knowledge sharing through digital networks in the digital economy. DEEs facilitate digital information sharing across geographical borders and contribute to a more diverse knowledge base (Audretsch et al., 2023; Elia et al., 2020; Sahut et al., 2021). In today's digital landscape, knowledge is considered the most important strategic resource for organizations, essential for recognizing, implementing, and sustaining entrepreneurial opportunities, underpinned by the knowledge-based view (KBV) (Audretsch et al., 2023) and the knowledge spillover theory of entrepreneurship (Colombelli et al., 2024). Interactions within digital platforms become key channels for knowledge spillovers for entrepreneurs (Song, 2019). Access to complementary knowledge across organizational boundaries is a vital source of entrepreneurial potential, while the ability to identify, assimilate, transform, and apply this external knowledge – referred to as "(digital) absorptive capacity" – becomes a significant competitive advantage for driving innovation (Colombelli et al., 2024; Sahut et al.,

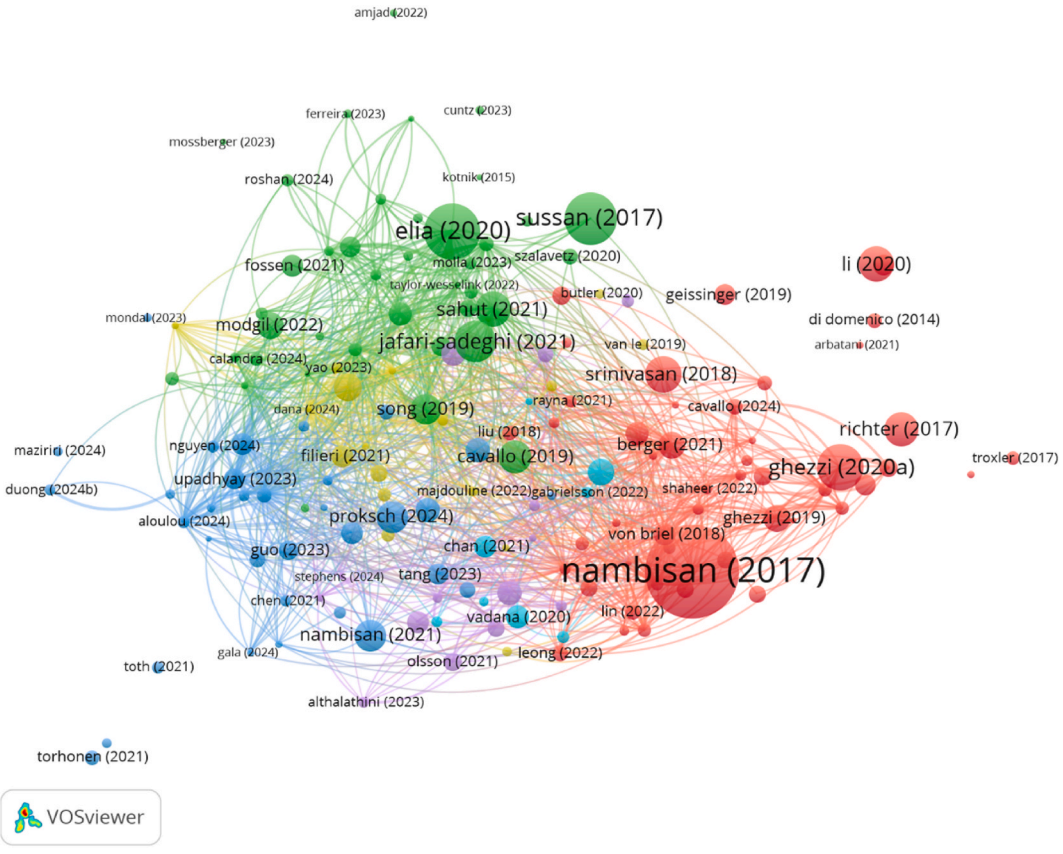

Fig. 3. Bibliographic Coupling Map (label view).
Source: Own elaboration based on VOSviewer.

2021; Song, 2019). According to Torres and Godinho (2022), this ability is particularly important for producing digitally enabled unicorns, pioneering digital innovation and transformation. COVID-19 accelerated digital transformation, reshaping business models and boosting investments in digital startups. Companies with pre-existing digital infrastructure adapted more successfully, as digital capabilities became essential for survival. The pandemic drove DE growth in sectors like e-commerce, entertainment, healthcare, and education, with entrepreneurs creating innovative responses to pandemic-related challenges (Modgil et al., 2022; Mossberger et al., 2023). This shift also enhanced organizational resilience, pushing companies to become more adaptable and digitally focused (Audretsch et al., 2023; Mossberger et al., 2023). COVID-19 also accelerated digital engagement, increasing acceptance of and demand for digital products and services: progress that might have otherwise taken several years to achieve (Modgil et al., 2022).

Cluster 3 (blue): Platforms, Capabilities, and Inclusion in Digital Entrepreneurship: This cluster with 33 items frames digital entrepreneurship as platform-mediated venturing in which value creation, discovery and scaling hinge on three intertwined elements: platform dynamics, capability stacks, and inclusion outcomes. Research on creators and streamers and digital markets shows how platform architectures, feedback loops and network effects produce heavy-tailed performance and new gatekeeping logics, with analyst/intermediary endorsement becoming pivotal for legitimacy and growth (Gala et al., 2024; Pollock et al., 2023; Törhönen et al., 2021). Capability-centric studies explain performance differentials: distributed innovation and digital opportunities convert into outcomes when firms marshal IT-enabled capabilities. Entrepreneurial orientation (EO) interacts with digitalization, sometimes constraining disruption, and capability configurations channel emerging technologies (such as AI) into adoption and innovation (Kraus et al., 2023a; Tang, Yao, Boadu, & Xie, 2023; Upadhyay, Upadhyay, Al-Debei, Baabdullah, & Dwivedi, 2023). A complementary stream re-centers inclusion, documenting subsistence and community-based entrepreneurship enabled by peer-to-peer platforms and highlighting empowerment pathways—especially for women—when complemented by education (Delacroix et al., 2019; Maziriri et al., 2024). At the same time, platform participation entails role conflicts and stressors that can depress venture performance, underscoring the need for responsible platform design and deliberate capability building (Nambisan, Siegel, & Kenney, 2024).

Cluster 4 (yellow): Micro-to-macro Foundations of DE: This cluster comprises 17 publications, which center around DE reflecting a recursive micro–meso–macro coupling of capabilities, ecosystems, and societal outcomes. Micro-foundations emphasize individual capabilities and mindsets. Technological knowledge and skills amplify the effect of innovation on DE (Redondo-Rodríguez et al., 2023). Configurations of DE psychological capital enable adaptive action under uncertainty (Yao et al., 2023). Micro-level trajectories also include user-to-entrepreneur transitions shaped by socio-material engagement with digital artifacts (Schiavone et al., 2020) and tactics such as effectuation and digitally enabled experimentation in corporate settings (Vassilakopoulou & Grisot, 2020). Sectoral work shows resource bricolage with digital tools converting constraints into opportunities (Bowen & Morris, 2024). Meso-foundations highlight ecosystems and roadmaps. A multilevel view shows how innovation ecosystems orchestrate resources and relationships across firm growth stages (Beliaeva et al., 2020). Social media discourse maps DE's themes and sentiment, evidencing community-level frames (Wilk et al., 2021). Macro-outcomes link internal capabilities with external conditions and shocks: a pre/post-COVID synthesis connects determinants to economic, technological and social impacts (Yáñez-Valdés et al., 2023), while research on digital social entrepreneurship after lockdowns identifies micro-foundations of digital-social value creation (Yáñez-Valdés et al., 2023). Cross-level, regional networks and funding shape where ventures thrive (Butler et al., 2020).

Cluster 5 (purple): Women's Empowerment through Digital Technology and Entrepreneurship: The fifth cluster, consisting of 15 publications, reframes digital entrepreneurship as a situated, gendered process of conditional emancipation rather than a technological leveler. Critical-social accounts show how empowerment narratives obscure how platform-based markets and uneven resources reproduce stratification (Martinez Dy, 2019). Context matters: in emerging, patriarchal and conflict-affected settings, women leverage digital affordances to navigate institutional voids, surveillance and mobility constraints—yet gains are precarious and partial (Althalathini & Tlaiss, 2023; Hassan, Mir, & Khan, 2021; McAdam et al., 2019). At the micro-level, studies of liminality trace how women scaffold transitions into digital venturing, negotiate legitimacy and care-work boundaries, and craft entrepreneurial identities in mutable online spaces (Kelly & McAdam, 2022, 2023). Platform governance shapes opportunity, as shown by evidence from the iOS App Store, which reveals gendered engagement gaps contingent on offline environments, while small-business work highlights the learning labor of keeping up with social media and digital skills (Kang, 2022; Olsson & Bernhard, 2021). Finally, digital communities – from online peer forums to social-media audiences – supply feedback, legitimacy and market access. Entrepreneurial storytelling becomes central to opportunity development in creator economies (Schou & Adarkwah, 2024; Stephens & Miller, 2024).

Cluster 6 (turquoise): International DE: This cluster with 8 items converges on digital-platform-enabled international entrepreneurship: digitalization and platform affordances let ventures discover, validate, and scale cross-border opportunities with fewer traditional foreign assets. At the micro level, inexperienced founders can internationalize rapidly by combining mindset-, means/effectuation-, and continuance-commitment logics, while AI-based prediction augments lean experimentation to speed evidence gathering under uncertainty (Gabrielsson et al., 2022; Raneri et al., 2023). At the platform (meso) level, crowdfunding platforms shape opportunity recognition, evaluation and exploitation through spatial, temporal and structural features (Ahsan & Musteen, 2021). Founder messaging matters, as money salience can depress backer support, while sustainability orientation offsets this penalty (Chan et al., 2021). At the macro level, global reach does not erase country differences, implying that demand-side strategies and user co-creation to overcome adoption frictions (Shaheer & Li, 2020). Complementing this, value-chain digitalization enables firms to convert limited foreign assets into foreign sales (Vadana et al., 2020), while corporate–startup co-creation relies on innovation-intelligence capabilities to manage uncertainty in digital ecosystems (Nobari & Dehkordi, 2023). Finally, digital capability and B2B models emerge as robust antecedents of SME internationalization and regional expansion choices (Chen, Guo, & Huang, 2023).

3.3. Umbrella review results

This umbrella review focuses only on prior review articles on DE, ensuring that this partial analysis is based on consolidated, peer-reviewed syntheses (Koporcic et al., 2025). The aim was to combine these meta-level reviews with our bibliometric mapping to consolidate the main themes, theoretical foundations, and ecosystem-level dynamics in the field. In the following,the main variables identified in the reviews are summarized.

4. Discussion

4.1. Science mappings and research framework

The co-citation analysis and the bibliographic coupling, complemented by a literature review of the publications within the derived clusters, offer valuable insights into the scientific research landscape on DE. Based on these findings, we propose a research framework that illustrates the current state, the primary research streams, and the main variables – independent, dependent and indirect – relevant to DE

research (Fig. 4).

4.1.1. Prerequisite or input factors

The prerequisites for DE can be distinguished as internal and external factors. Internal factors are directly related to the entrepreneur or organization and can be influenced to some degree, while external factors pertain to the surroundings in which the entrepreneur or organization operates and are beyond their control. These input variables are crucial in shaping the subsequent entrepreneurial process and the quality of outcomes.

Internal Factors: The importance of resources as a foundation for competitive advantages is well known (Barney, 1991). As digital entrepreneurs operate in a rapidly advancing technological environment, strong digital skills are essential for effective participation in the digital economy (Nambisan, 2017; Ngoasong, 2018). Entrepreneurs now rely on technology not just as a supporting asset but as a core component of their value proposition, especially as business models increasingly shift toward digital platforms (Srinivasan & Venkatraman, 2018). Furthermore, digital devices and technologies have unlocked the role of users as resource contributors in terms of customer data (Amit and Zott, 2001; Sussan & Acs, 2017). Access to customer information, and using it effectively, has become a key success factor. If they are to innovate and operate effectively in today's fast-paced, data-driven, and knowledge-intensive environments, digital entrepreneurs must be able to acquire, integrate, and exploit external knowledge (e.g., customer data) in unprecedented quantities, and at higher speeds and with a wider scope, than hitherto known. All this requires strong digital absorptive capacity (Audretsch et al., 2023; Sahut et al., 2021; Song, 2019). However, to fully leverage these advances and the expanded range of resources available, entrepreneurial digital competencies are crucial (Ngoasong, 2018). By utilizing digital technologies effectively, digital entrepreneurs can disrupt existing market structures and challenge established companies, much like Schumpeterian entrepreneurs (Sussan & Acs, 2017). Dynamic managerial capabilities are essential for entrepreneurs to navigate rapid technological changes and the uncertainties of the business environment. Recognizing the need for change, seizing opportunities, and continually adjusting business models to capitalize on them form the basis for sustainable competitive advantages (Berman, Schallmo, & Kraus, 2024; Teece, 2018). Since dynamic capabilities are closely linked to entrepreneurial managers' unique traits and experiences and shaped by organizational culture, they are difficult for competitors to replicate (Ghezzi & Cavallo, 2020; Teece, 2007, 2018; Warner & Wäger, 2019).

External Factors: The success of DE also depends on the environment in which it originates, grows, and receives support (Elia et al., 2020). A digital ecosystem is a crucial starting point and a vital influencing factor for successful DE, as it considers the specific requirements and dynamics of the digital economy. A major research stream focuses on the concept of "DEE", the intersection of digital and EEs (Sussan & Acs, 2017). Digital technologies have transformed "the locus of entrepreneurial agency": that is, there is no longer a single, predefined founder but a larger, more diverse group of actors engaging in the entrepreneurial initiative, with different motivations and skills (Elia et al., 2020; Nambisan, 2017). This changes the dynamics within the ecosystem and emphasizes the need for DEEs. A DEE integrates the digital infrastructures, technologies, and platforms essential for building and scaling digital businesses. Such ecosystems not only provide access to technological resources and markets but also promote the use of customer data, digital networks, and automated processes, all of which enhance the competitiveness and innovation potential of digital startups.

Another antecedent is that customers' high levels of digital acceptance and literacy create more opportunities for digital entrepreneurs (Modgil et al., 2022; Mossberger et al., 2023). The greater the levels of digital engagement and ICT proficiency, the more likely it is that users will contribute to value co-creation (Sussan & Acs, 2017).

"[W]hile digital technologies are global, the creation of digital companies remains local" (Sussan & Acs, 2017, p. 69). Future research should place

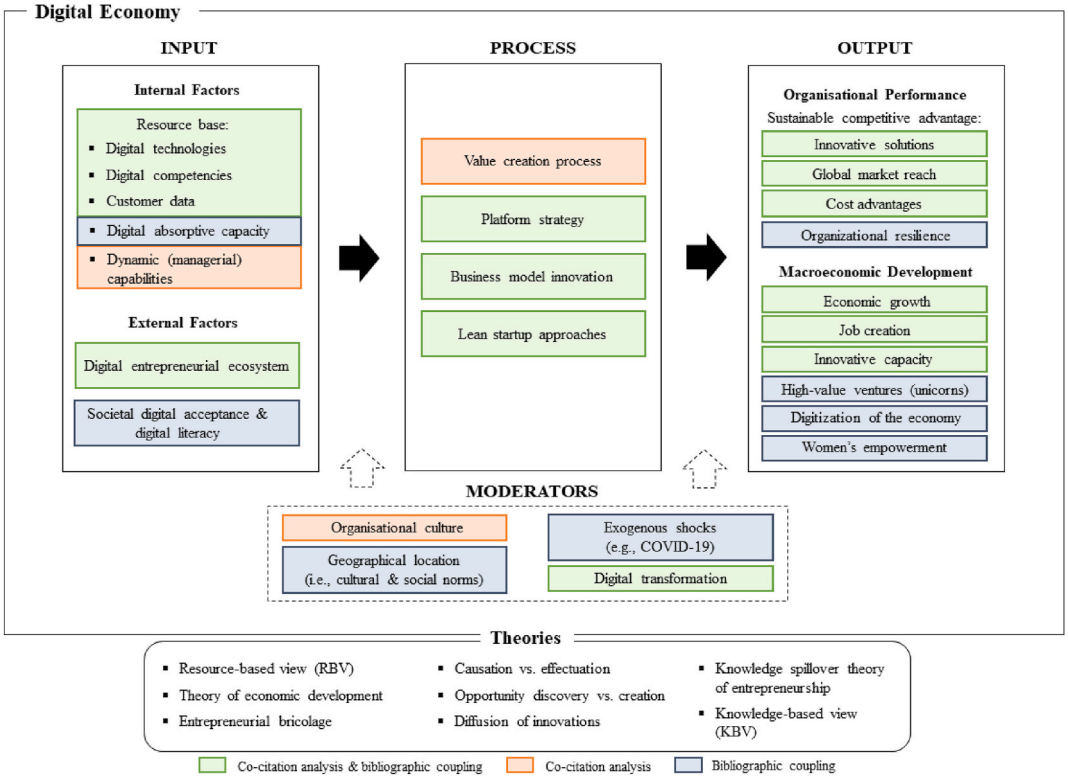

Fig. 4. Research framework on DE.
Source: Own elaboration.

greater emphasis on a broader range of DEEs, rather than focusing on Silicon Valley alone. Moreover, it is crucial to acknowledge the role of digital governance in fostering an entrepreneur-friendly environment (e.g., Ngoasong, 2018; Sussan & Acs, 2017). Song (2019) emphasized the need for governments to rethink and update regulations to suit the digital age, while also admitting that developing appropriate incentive structures is a major challenge. However, specific contributions on this topic have been limited so far.

4.1.2. Digital entrepreneurial process

Value creation is considered the driving force behind a company's success, as it enables it to create customer value, drive innovation, and maintain long-term competitiveness in the market. Value can be derived from various sources (Amit & Han, 2017; Amit & Zott, 2001). Digital technologies have introduced new avenues to generate value by enhancing access to information and creating network opportunities. The growing role of customers as "value co-creators" has attracted increasing attention, with value creation now closely tied to customer interaction on digital platforms. By leveraging customer data, firms can deliver personalized offers tailored to individual needs, which can pose threats to established firms (Amit & Han, 2017; Hsieh & Wu, 2019). Entrepreneurs can take advantage of platforms and open innovation by incorporating a platform strategy into their entrepreneurial process. Digital platforms inherently provide a degree of openness – sharing knowledge and resources – and thus offer new opportunities for entrepreneurs in the digital age (Hsieh and Wu, 2019; Nambisan et al., 2018; Sussan & Acs, 2017). Business models have come increasingly into focus as better explanations are sought for how value is created, delivered, and captured for target customers. They have gained prominence with the rise of the Internet because of the greater flexibility that digital technologies offer (Sahut et al., 2021; Teece, 2010; Zott et al., 2011). However, business models are highly context-dependent and often involve iterative processes in a dynamic digital environment. They must adapt over time as markets, customer needs and technologies evolve. Thus, BMI is seen as increasingly important for a company's long-term success (Teece, 2010). LSAs are agile methods that help entrepreneurs validate and innovate their business models through early customer feedback and market testing, initiating what is known as the "build--measure-learn" cycle to reach "product-market fit" (Ghezzi, 2019; Ghezzi & Cavallo, 2020). Taken together, digital entrepreneurs, unlike traditional entrepreneurs, no longer adhere to a rigid business plan. Instead, their actions and decisions evolve continuously throughout the entire entrepreneurial process.

Many research papers highlight the fact that digitalization has greatly amplified the role of customers, leading businesses to shift from product-focused to customer-centric business models to strengthen their competitive advantage (e.g., Amit & Han, 2017; Sussan & Acs, 2017; Teece, 2010). In light of this paradigm shift, a more in-depth analysis of the strategic effects of customer centricity on the entrepreneurial process would be highly relevant for the future. Research could also focus on how traditional organizations must adapt their processes, structures, and culture to implement the customer-first mentality. Such insights not only deepen understanding of customer centricity but also help organizations innovate their business models accordingly. Furthermore, given that data is regarded as the most valuable asset for DE (Sussan & Acs, 2017), cybersecurity and data compliance should be considered an integral part of digital business models. Song (2019) has already addressed the "privacy paradox", where there is a concern for user privacy and personal data protection, yet users often willingly share their information. Future research could investigate how proactive approaches to these issues might offer a significant competitive advantage and are crucial for the long-term success of digital businesses. Additionally, since customers are seen as "value co-creators", further studies could explore how data compliance requirements affect the ability of digital entrepreneurs to innovate.

4.1.3. Impact on organization and Macroeconomy (output)

The output represents the impact of DE on both (internal) organizational performance and, more broadly, on the overall economy. The output variables identified are key indicators of the success and benefits of DE.

Organizational Performance: DE results in highly customized, innovative solutions, as customers are no longer simply passive recipients but can actively collaborate in the entrepreneurial process, which is enabled by the dynamic, technology-facilitated interaction between entrepreneurs and customers (e.g., Ghezzi & Cavallo, 2020; Modgil et al., 2022; Nambisan, 2017; Nambisan et al., 2018). Moreover, DE offers access to both domestic and global markets due to more fluid boundaries, and the ability to scale quickly without proportionate cost increases (Hsieh & Wu, 2019; Nambisan, 2017). Further cost advantages arise from digital platforms that enable resource and knowledge sharing, reduce experimentation costs through iterative "feedback and change" loops, and promote open innovation to reduce research and commercialization expenses (Audretsch et al., 2023; Ghezzi & Cavallo, 2020; Nambisan et al., 2018; Sahut et al., 2021). During the pandemic, when companies were forced to rethink their business models, successful entrepreneurs leveraged digital technologies to maintain uninterrupted operations and build resilience throughout the crisis (Mossberger et al., 2023; Modgil et al., 2022). As a result, organizationally resilient companies can respond to uncertain events more quickly than their competitors (Audretsch et al., 2023). Overall, these factors contribute to a sustainable competitive advantage that sets DE apart from traditional entrepreneurship, especially in today's digital economy.

Macroeconomic Development: Concerning the impact of DE on the macro economy, several studies have addressed economic growth, job creation and increased innovative capacity (e.g., Modgil et al., 2022; Sahut et al., 2021; Sussan & Acs, 2017). The emergence of digitally enabled 'unicorns', which produce an extremely high proportion of DE activity, has a lasting impact on a country's economic and technological landscape, enhancing its global competitiveness (Torres & Godinho, 2022; Venâncio et al., 2023). Another way in which DE can be regarded as a driving force behind the digitization of the economy is by disrupting traditional industries and forcing established companies to adapt their business models to the digital reality in order to remain competitive (Modgil et al., 2022; Sahut et al., 2021). Moreover, DE provides emancipatory opportunities for women in economies with restrictive social and cultural norms. By using digital technologies, women can overcome traditional restrictions and discover new ways of self-realization and economic participation (Buss et al., 2024). This has the potential to gradually contribute to positive changes in terms of gender roles and gender equality in society (e.g., Kelly and McAdam, 2022; McAdam et al., 2019; Wiig et al., 2024).

While much of the research concentrates on the economic and, to some extent, social impacts of DE, the potential environmental impacts remain largely unexplored. Some publications have explored the sharing economy (Richter et al., 2017; Sanasi et al., 2020), which promotes responsible consumption and reduces the need for new resources. However, these discussions have primarily centred on the transformative power of digital platforms and new business models rather than emphasizing the sustainability dimension. Research specifically examining how digital technologies create new opportunities for sustainable business practices and contribute to achieving the Sustainable Development Goals (SDGs) is limited, indicating a potential gap in the literature.

Looking closely at the overall picture of the variables identified in relation to the output, we see that the publications in both analyses primarily emphasize the positive impacts of DE on organizational performance and overall economic development. But digital environments are often characterized by greater uncertainty, with digital technologies accelerating the pace of change (e.g., Ghezzi & Cavallo, 2020; Nambisan, 2017), indicating the rapid obsolescence of products and business models. The focus, however, is usually on the new opportunities this

presents for entrepreneurs rather than on the associated challenges. It would therefore be advisable for future research to further elaborate on the potential negative impacts of digital technologies on entrepreneurship to develop a more holistic view of the phenomenon (e.g., cybersecurity risks, low entry barriers leading to market saturation, exacerbation of the digital divide, the "grow fast or die" phenomenon and the need to reach a critical mass of users).

4.1.4. Indirect variables

In addition to the main variables outlined in the framework, previous research has also considered certain indirect variables that specify the boundary conditions under which the strength of the relationship between input, process and output is stronger or weaker.

The impact of digital technologies on business success in the digital era is more widely recognized in organizations where digital transformation is integrated into the enterprise's overall strategy. As a result, established firms are more willing to reinvent their business models (Modgil et al., 2022; Nambisan et al., 2019; Warner & Wäger, 2019). Also, an organization's culture can moderate the relationship between the acceptance of digital technologies and their effective implementation. A digital, innovation-oriented corporate culture fosters a digital mindset, which is essential for developing sensing capabilities that enable established firms to take advantage of the latest unexpected technological trends (Teece, 2018; Warner & Wäger, 2019). Additionally, exogenous shocks can serve as a catalyst for DE. For example, COVID-19 has accelerated the adoption of digital technologies and the adaptation of business models. The pandemic has increased the importance of digital skills, prompting companies to invest more in developing these competences. It has also accelerated society's acceptance and use of digital solutions. In many cases, the COVID-19 crisis has fostered a greater openness to digital innovations (Modgil et al., 2022). Lastly, although DE is characterized by a *"[…] less predefined locus of entrepreneurial agency […]"* (Sussan & Acs, 2017, p. 1), cultural and social norms specific to certain geographical regions significantly influence DE, particularly by determining who can initially establish a digital enterprise (McAdam et al., 2020). As a result, the sociocultural context in which DE takes place presents either an opportunity or a challenge for digital entrepreneurs (Ngoasong, 2018). In summary, research offering a more systematic exploration of indirect variables would be valuable in achieving a deeper and more nuanced understanding of the complex relationships involved.

4.1.5. Theoretical foundations

Theories relevant to the field of (digital) entrepreneurship are also discussed in the publications. The RBV and Schumpeter's theory of economic development are primarily highlighted in relation to potential sources of value creation and competitive advantage (Amit & Zott, 2001; Barney, 1991). Theories such as entrepreneurial bricolage (Baker & Nelson, 2005), causation and effectuation (Sarasvathy, 2001), and discovery and creation (Alvarez & Barney, 2007) deal with the question of how entrepreneurs recognize, develop and exploit opportunities. They offer different perspectives on the entrepreneurial process and decision-making (Fisher, 2012; Ghezzi, 2019). The diffusion of innovation theory (Modgil et al., 2022) and the knowledge spillover theory (Colombelli et al., 2024) are also referenced in bibliographic coupling, extending their application to digital contexts. Additionally, the KBV builds upon the RBV by highlighting knowledge as a critical strategic resource (Audretsch et al., 2023). In the rapidly changing digital landscape, these theories offer insights into the dynamics of innovation adoption and the utilization of new knowledge, which are crucial for survival and growth in the digital economy.

4.2. Umbrella review and Digital Entrepreneurship Ecosystem Model

The 13 themes from the umbrella review (Table 1), discussed below, were combined with our bibliometric results to form the main foundation of the Digital Entrepreneurship Ecosystem Model (DEEM). The components of the model are explained in the following.

4.2.1. Technology and digital infrastructure

Technology and digital infrastructure play a central role in DE by enabling businesses to operate efficiently, scale, and innovate. Key enablers include digital technology adoption and the use of Big Data analytics to offer more personalized services and customer engagement. Technology landscaping and the integration of digital technologies in traditional industries also act as enablers for innovation, allowing entrepreneurs to adapt to modern challenges. The relationship with, and embodiment of, technology and its coupling with business models further enhance the success of startups. Entrepreneurship and consumption on digital platforms, along with digital absorptive capacity and dynamic managerial capabilities, have also emerged as vital drivers for business scalability.

A significant mediator in this area is digital implementation, with AI-driven solutions, e.g. for InsurTechs, and the introduction of digital platforms in legacy industries providing enhanced operational capabilities. Big Data plays a pivotal role in decision-making processes, shaping future strategies and enabling data-driven growth. These technological advancements result in a highly resilient and adaptable digital infrastructure that supports entrepreneurial activities across various sectors (Arora & Singh, 2025; Berman, Stuckler, et al., 2024; Da Fonseca & Campos, 2021; Felicetti et al., 2024; González-Padilla et al., 2024; Kimjeon & Davidsson, 2022; Fernandes et al., 2024; Zaheer et al., 2019).

4.2.2. Business models and scalability in DE

For digital entrepreneurs, the ability to create and transform business models is essential for driving growth and scalability. Key enablers identified for this theme include *Decision-Making Factors,* such as business scalability decisions and adopting a technology/customer orientation when designing innovative business models. Enablers like *Business Process Transformation*, *Business Resource Transformation*, and *Business Model Transformation* (including digital adoption) also play a crucial role in fostering business evolution. Advanced technologies, such as *3D Printing* and *Maker Spaces*, serve as tools for creating unique products and services, thus enhancing market positioning. *Social Capital* strengthens business models by leveraging networks, relationships, and community resources. The *Venture Lifecycle* acts with the *Lean Start-up Approach* as a mediator in this theme, encompassing the stages from initial development to scaling, open innovation and knowledge sharing. Challenges related to market expansion and resource management arise as ventures progress through these stages, requiring businesses to adapt continuously. The outcome of this theme is the achievement of *Successful DE*, which results in scalable ventures, higher market valuation, and improved business sustainability and profitability. Critical outcomes also include *Human Capital Development* through digital skills training and a consumer-driven entrepreneurial approach. However, barriers, such as financial constraints and the complexity of navigating market expansion, can hinder business model success. This theme emphasizes the dynamic and continuous transformation of business models in DE, where strategic decisions, technological integration, and effective scaling practices converge to yield successful outcomes (Arora & Singh, 2025; Berman, Stuckler, et al., 2024; Da Fonseca & Campos, 2021; Jiang et al., 2024; Felicetti et al., 2024; Secundo et al., 2020; Sitaridis & Kitsios, 2024; Zaheer et al., 2019).

4.2.3. Entrepreneurial ecosystem and policy support in DE

The broader entrepreneurial ecosystem plays a pivotal role in enabling the success of digital ventures by providing critical infrastructure, tools, and resources. Key enablers include *Innovation Platform Ecosystems*, such as Google Android and GitHub, which foster collaboration, creativity, and business development by offering a foundation for startups to thrive in the digital space. Similarly, *Chat Room Ecosystems*, like Slack channels, provide collaborative environments where digital

Table 1
Integrated synthesis of DE literature.

Theme	Enabler Identified (Aggregate Dimension)	Challenging/Barriers Factors Identified (Aggregate Dimension)	Mediation (Aggregate Dimension)	Outcomes (Aggregate Dimension)	References
Technology and Digital Infrastructure	Digital Technology Adoption; Big Data Usage for Analyzing Personalities; Technology Landscaping; Digital Technology Integration (Specificity, relationality, embodiment, and coupling of technology); Entrepreneurship and Consumption on Digital Platforms; Digital Platforms; Dynamic Managerial Capabilities, Digital absorptive capacity.		Digital Implementation (Mediator): AI-based InsurTech solutions, integration of digital platforms in legacy industries, use of big data for decision-making; Technology and Digital Infrastructure		Arora and Singh (2025); Berman, Stuckler, et al. (2024); Da Fonseca and Campos (2021); Felicetti et al. (2024); González-Padilla et al. (2024); Kimjeon and Davidsson (2022); Fernandes et al., 2024; Zaheer et al. (2019).
Business Models and Scalability	Decision-Making Factors (Enabler): Business scalability decisions, technology/customer orientation in business model design. Business Process Transformation (Enabler), Business Resource Transformation (Enabler), Business Model Transformation (Enabler), Business Model Transformation (Digital Adoption), Business Models, 3D Printing, and Maker Spaces; Social Capital; Business Model Innovation		Venture Lifecycle (Stages of DE from development to scaling). Lean start-up approach	Successful DE (Outcome): Growth and scalability of digital ventures, increased market valuation, business sustainability, and profitability; Human Capital Development and Digital Skills Training; Organizational Scalability, Innovation, Resilience, Consumer-driven entrepreneurship, High-value ventures (Unicorns)	Arora and Singh (2025); Berman, Stuckler, et al. (2024); Da Fonseca and Campos (2021); Felicetti et al. (2024); Jiang et al. (2024); Sitaridis and Kitsios (2024); Secundo et al. (2020); Zaheer et al. (2019).
Entrepreneurial Ecosystem and Policy Support	Innovation Platform Ecosystem (acts as an enabler by providing infrastructure, tools, and resources for innovation, fostering collaboration, and supporting developers and businesses, e.g., Google's Android platform). Chat Room Ecosystem (Supports knowledge sharing and problem-solving for digital entrepreneurs, fostering a collaborative digital environment). Entrepreneurial Ecosystems (Enabler): Digital ecosystems, business incubators, accelerators, online marketplaces facilitating entrepreneurship. Innovation Ecosystem (Collaboration for Growth)	Institutional and regulatory factors affecting female digital entrepreneurs; administrative constraints and lack of entrepreneurial competency in DE; intranational differences,	Marketplace Ecosystem (acts as a middleman connecting buyers and sellers, reducing transaction costs, facilitating exchanges, and organizing interactions without creating innovation (e.g., Airbnb). Chat Room Ecosystem (facilitates communication and collaboration among innovators, enabling co-creation, learning, and networking (e.g., Slack channels for startup collaboration). Transition to Digital Ecosystem (Mediator). Experiential Learning and Digital Learning Environments (MOOCs, Game Simulations, Incubators). Cultural processes linked to entrepreneurship, Knowledge Sharing, Open Innovation	Open-Source Ecosystem (forms when independent contributors collaborate to build solutions (e.g., Linux, GitHub projects where open-source communities drive innovation), Organizational resilience	Alhajri and Aloud (2024); Arora and Singh (2025); Bejjani et al. (2023); Berman, Stuckler, et al. (2024); Da Fonseca and Campos (2021); Jiang et al. (2024); Fernandes et al., 2024; Sitaridis and Kitsios (2024)
Funding and Investment	Technological Entrepreneurship (investment in tech ventures); Digital Start-Up Funding (venture capital, crowdfunding, self-funding)				Arora and Singh (2025); Berman, Stuckler, et al. (2024); Jiang et al. (2024); Zaheer et al. (2019).
Market Access and Globalization			Digital Transformation (expansion through digital means)	Scaling and Growth Strategies (data-driven operations, rapid iteration, and market expansion), Cost advantages, Global market reach	Arora and Singh (2025); Zaheer et al. (2019).
Consumer Behavior and	Decision-Making Factors (Enabler): focus on customers' needs, listening		Entrepreneurs' Online Behavior Impact (Broad Communicators, Core	DE (Leveraging Digital Markets)	Arora and Singh (2025); Berman, Stuckler, et al. (2024); Da Fonseca and

(*continued on next page*)

Table 1 (*continued*)

Theme	Enabler Identified (Aggregate Dimension)	Challenging/Barriers Factors Identified (Aggregate Dimension)	Mediation (Aggregate Dimension)	Outcomes (Aggregate Dimension)	References
Digital Engagement	to customers, user experience optimization; Consumer passions fueling entrepreneurial desire, Customer data		Participants, Exclusively Buyers, Passive Users, Proactive Guardians)		Campos (2021); González-Padilla et al. (2024).
Talent and Skills	Intrinsic Drivers (Enabler): education level, passion, persistence, strong and educated founding team, digital leadership. Extrinsic Drivers (Enabler): training and education, access to networks, support from friends and community. Digital Knowledge Base Creation (Enabler). Personality Traits of Digital Entrepreneurs: Entrepreneurial Personality Classification (Altruistic, Professional, Boomerang, Selective, Connector, Rebel, Troll). Digital Mindset and Computational Thinking. Digital Technologies for Entrepreneurship Education, Digital Competencies		Entrepreneurial Self-Efficacy; The Digital Entrepreneur's Profile	Job creation	Berman, Stuckler, et al. (2024); González-Padilla et al. (2024); Jiang et al. (2024); Fernandes et al., 2024; Secundo et al. (2020); Sitaridis and Kitsios (2024)
Regulatory and Legal Challenges	Regulatory and Policy Support	Gender-specific laws, financial barriers, and lack of institutional support impacting female entrepreneurs	Policy and Regulatory Challenges (impact of regulations on DE)		Alhajri and Aloud (2024); Kimjeon and Davidsson (2022); Sitaridis and Kitsios (2024); Zaheer et al. (2019).
Competition and Platform Dependency	Open-Source Collaboration (Enabler): GitHub, open-source software communities, developer collaborations. Digital Platform Readiness (Enabler)			Digital Entrepreneurial Performance (success factors, impact of digital ventures on industries)	Berman, Stuckler, et al. (2024); Zaheer et al. (2019); Fernandes et al., 2024.
Cybersecurity and Data Privacy		Cybersecurity and Privacy Risks in Digital Space (malware threats, cybersecurity attacks, data privacy concerns, AI-driven decision risks)			González-Padilla et al. (2024).
Digital Innovation and Transformation	Digital Leadership (Enabler): Leaders integrating technology into business models, digital transformation leadership. AI-Driven Personality Prediction: use of AI and NLP for Personality Assessment. Business Model Innovation (lean startup, Agile methodologies). Digital-Innovation Ecosystems			Successful Digital Transformation (Outcome). Innovative capacity	Berman, Stuckler, et al. (2024); González-Padilla et al. (2024); Fernandes et al., 2024; Zaheer et al. (2019).
Sustainability and Social Impact			Digital Resilience (Mediator): sustaining business growth despite external shocks.	DE creates empowerment opportunities for women and addresses gender disparity. Digitization of the economy, Job creation, Economic growth.	Alhajri and Aloud (2024); Berman, Stuckler, et al. (2024).
Entrepreneurial Collaboration and Networks	Start-up collaboration		Social Capital		Felicetti et al. (2024); Jiang et al. (2024).

entrepreneurs can share knowledge and solve problems. Digital ecosystems that consist of *business incubators*, *accelerators*, and *online marketplaces* facilitate entrepreneurship by supporting business growth and innovation. *Mediators* include the *Marketplace Ecosystem*, which connects buyers and sellers, reducing transaction costs and promoting business interactions, and the *Transition to Digital Ecosystems*, which enables digital ventures to scale and engage in experiential learning through *Digital Learning Environments* like MOOCs and game simulations. The *Open-Source Ecosystem* (e.g. Linux, Github projects), *Open Innovation* and *Knowledge sharing* facilitate independent collaboration and co-creation, enabling entrepreneurs to build solutions collectively while fostering continuous learning and adaptation.

These mediators help establish strong networks that enable co-creation and knowledge sharing. However, barriers to entrepreneurship persist. This is especially true for female digital entrepreneurs, whose access to resources and opportunities is limited by institutional and regulatory factors, including gender-specific policies and financial constraints. Region-specific *administrative constraints* and *lack of entrepreneurial competency* further complicate the entrepreneurial landscape. Despite these challenges, the outcomes of a thriving entrepreneurial ecosystem include successful collaborations, enhanced knowledge transfer, and greater market penetration, all of which contribute to the long-term sustainability of digital ventures.

4.2.4. Funding and investment in DE

Technological Entrepreneurship and *Digital Startup* Funding are the primary enablers for funding and investment in DE. Investment in *Tech Ventures* is a critical enabler, helping digital ventures access the capital they need to develop innovative technologies and products. Additionally, *Digital Startup* Funding through various channels, such as *venture capital*, *crowdfunding*, and *self*-funding, plays a crucial role in providing the financial support entrepreneurs require during the initial stages of business formation and growth (Arora & Singh, 2025; Berman, Stuckler, et al., 2024; Jiang et al., 2024; Zaheer et al., 2019).

4.2.5. Market access and globalization in DE

Market access and globalization are crucial for digital ventures to expand beyond their local boundaries and reach a global customer base. The *mediator* in this process is *Digital Transformation*, which provides digital ventures with the technological capabilities to scale and tap into new markets. The *outcome* of this transformation is the successful implementation of *Scaling and Growth Strategies*, which are data-driven and focus on rapid iteration and market expansion. These strategies drive business success by enabling businesses to grow faster, adapt to market changes, and reach broader audiences. *Cost Advantages* and *Global Market Reach* also emerge as critical outcomes, as businesses leveraging digital transformation can optimize operations, reduce overhead costs, and gain access to international markets with greater efficiency (Arora & Singh, 2025; Zaheer et al., 2019).

4.2.6. Consumer behavior and digital engagement in DE

Consumer behavior and digital engagement play a crucial role in the success of DE. The *enablers* in this theme include *decision-making factors*, such as focusing on customers' needs and optimizing the user experience. These factors fuel entrepreneurial drive, as consumer passions often stimulate the desire to innovate and create. *Customer Data* also serves as a key antecedent, providing insights into user preferences, purchasing patterns, and behavioral trends that enable businesses to tailor their offerings and enhance engagement. The *mediator* in this process is the *Entrepreneurs' Online Behavior Impact*, which includes different types of online interactions, such as those of the *broad communicators*, *core participants*, *buyers*, *passive users*, and *proactive guardians*. These behaviors shape how entrepreneurs engage with their audiences and adapt to market trends. The *outcome* of these efforts is successful DE, where ventures can leverage digital markets to expand and thrive (Arora & Singh, 2025; Berman, Stuckler, et al., 2024; Da Fonseca & Campos, 2021; González-Padilla et al., 2024).

4.2.7. Talent and skills in DE

Talent and skills are essential for the success of DE. The *intrinsic drivers* (enablers) that influence talent and skill include education level, passion, persistence, a strong and educated founding team, and digital leadership. These qualities are critical for navigating challenges and identifying opportunities in the digital landscape. The *extrinsic drivers* (enablers) include entrepreneurship education and training (Kuratko, 2005; Tiberius & Weyland, 2024), access to networks, and support from friends and the community. Other critical enablers are the creation of a *digital knowledge base, entrepreneurial personality traits,* the *digital mindset,* and *computational thinking*. The *mediators* in this theme are *entrepreneurial self-efficacy* and *the digital entrepreneur's profile*, as these influence the confidence and capabilities of entrepreneurs. Together, these enablers and mediators lead to the development of successful digital entrepreneurs, whose capabilities and profiles reflect their potential to innovate and succeed in digital markets (Berman, Stuckler, et al., 2024; González-Padilla et al., 2024; Jiang et al., 2024; Secundo et al., 2020; Sitaridis & Kitsios, 2024).

4.2.8. Regulatory and legal challenges in DE

Regulatory and legal challenges play a crucial role in shaping the DE landscape. The enabler in this context is *regulatory and policy* support, which provides the necessary framework for digital entrepreneurs to operate and grow. However, challenges, such as gender-specific laws, financial barriers, and a lack of institutional support, disproportionately affect female entrepreneurs, creating significant obstacles to their entry and success in digital ventures. The mediators in this context are the policy and regulatory challenges that influence DE by either facilitating or constraining growth. This highlights the need for more inclusive and supportive policies that ensure fair opportunities for all digital entrepreneurs and level the playing field for women (Arora & Singh, 2025; Berman, Stuckler, et al., 2024).

4.2.9. Competition and platform dependency

Open-source collaboration and *digital platform readiness* help digital entrepreneurs thrive in highly competitive markets. However, platform dependency can also create challenges, as businesses become overly reliant on a single platform for their operations and customer engagement. Digital entrepreneurial performance is influenced by competition and the successful leveraging of platforms for innovation and market growth.

4.2.10. Cybersecurity and data privacy

As digital businesses handle vast amounts of data, *cybersecurity risks and privacy* concerns are significant barriers. Ensuring the security of digital systems and safeguarding consumer data are vital for maintaining trust and business continuity. Enablers, such as AI-driven security solutions, help mitigate these risks, while successful data management practices act as mediators for ensuring secure operations. Improved consumer trust and business resilience are among the outcomes of addressing these cybersecurity issues (González-Padilla et al., 2024).

4.2.11. Digital innovation and transformation

Digital leadership is a key enabler of DE, with leaders actively integrating advanced technologies into business models and driving digital transformation within their organizations. This includes the application of AI-driven tools for personality prediction and the use of AI and Natural Language Processing (NLP) to enhance decision-making processes. Entrepreneurs deploying business model innovations, such as lean startup and agile methodologies, empower their businesses to adapt to the ever-evolving digital landscape. Additionally, digital innovation ecosystems provide a collaborative environment that fosters growth, innovation, and business development. The outcome of these efforts is successful digital transformation, leading to the creation of resilient,

agile, and market-relevant business models that contribute to the overall success of digital ventures (Berman, Stuckler, et al., 2024; González-Padilla et al., 2024; Zaheer et al., 2019).

4.2.12. Entrepreneurial collaboration and networks

Start-up collaboration is a significant enabler for digital entrepreneurs, providing opportunities for networking, resource sharing, and knowledge exchange, all of which are crucial for growth and scalability. This is mediated by *social capital*, which facilitates collaboration within networks, enhancing the flow of information and building trust among entrepreneurs. This allows digital ventures to access resources, form strategic partnerships, and expand their market reach, enabling startups to thrive and succeed in competitive digital ecosystems (Felicetti et al., 2024; Jiang et al., 2024).

4.2.13. Sustainability and social impact

Digital resilience enables businesses to sustain growth and remain adaptable when facing external shocks, such as economic downturns or market disruptions. This resilience allows businesses to navigate challenges and continue innovating. The outcome is that DE addresses gender disparity by providing women with new avenues for participation, greater economic independence, and leadership opportunities within the digital economy. The broader impact of DE also extends to the *Digitalization of the Economy, Job Creation, and Economic Growth*, as digital ventures drive employment opportunities, contribute to economic expansion, and accelerate the integration of digital technologies into traditional industries. (Berman, Stuckler, et al., 2024; Alhajri & Aloud, 2024).

This study takes a step further by building on the insights from our earlier Input Process Output model, the themes identified in our bibliometric analysis, and the findings from our umbrella review. Based on these combined results, we propose a final integrated and practical framework called the Digital Entrepreneurship Ecosystem Model (DEEM) (see Fig. 5 and Table 2), which brings together evidence from multiple review methods into one clear, multi-level framework. The Digital Entrepreneurship Ecosystem Model (DEEM) views digital-entrepreneurship ecosystems as adaptive socio-technical systems (building on e.g., Elia et al., 2020; Zaheer et al., 2019). DEEM understands the evolution of digital ecosystems as a product of the interaction of three mechanisms: digital affordances (Zaheer et al., 2019), entrepreneurial agency (Bejjani et al., 2023; Kimjeon & Davidsson, 2022), and cognitive-human-capital infrastructure (Hietaniemi et al., 2024; Maran et al., 2022; Solberg et al., 2020).

Each of these mechanisms have been examined in isolation, but no framework has explained their causal interdependence. DEEM integrates them under a single architecture, explaining how technological affordances enable and are shaped by entrepreneurial agency, and how these dynamics are reinforced through ecosystem-level human-capital cognition. This interplay occurs under certain conditions, such as institutional maturity, the regulatory and policy environment (Berman, Stuckler, et al., 2024; Elia et al., 2020), and ecosystem maturity (Bejjani et al., 2023). Collectively, these factors create the evolutionary logic driving digital ecosystem adaptation.To explain this logic, the DEEM model is structured around four interdependent layers.

4.2.14. Foundation and enablement layer

At the foundational level, technological infrastructure, data governance, financing mechanisms, and regulatory frameworks function as digital-affordance engines. Together, they expand the scope of entrepreneurial action by enabling digital technology that is connected, capable of recombination, and programmable (Arora & Singh, 2025; Bejjani et al., 2023; Elia et al., 2020; Zaheer et al., 2019). This makes up the first generative mechanism in digital entrepreneurship: enabling new types of ventures while imposing technical and regulatory constraints (Berman, Stuckler, et al., 2024; Kimjeon & Davidsson, 2022). DEEM expands on prior reviews, particularly Elia et al. (2020), by not only mapping themes but providing a causal explanation of how digital infrastructures and institutional mechanisms co-evolve. It posits that the technological–institutional environment is not static but an adaptive mechanism that is responsive to entrepreneurial experimentations, policy environments, and data-governance feedback. The strength of this mechanism is moderated by boundary conditions, such as institutional maturity and policy coherence (Berman, Stuckler, et al., 2024; Elia et al., 2020), ecosystem maturity and funding cycles (Bejjani et al., 2023), and external enablers like regulatory or technological shocks (Kimjeon & Davidsson, 2022).

Proposition 1. *If digital-affordance creation is supported by mature*

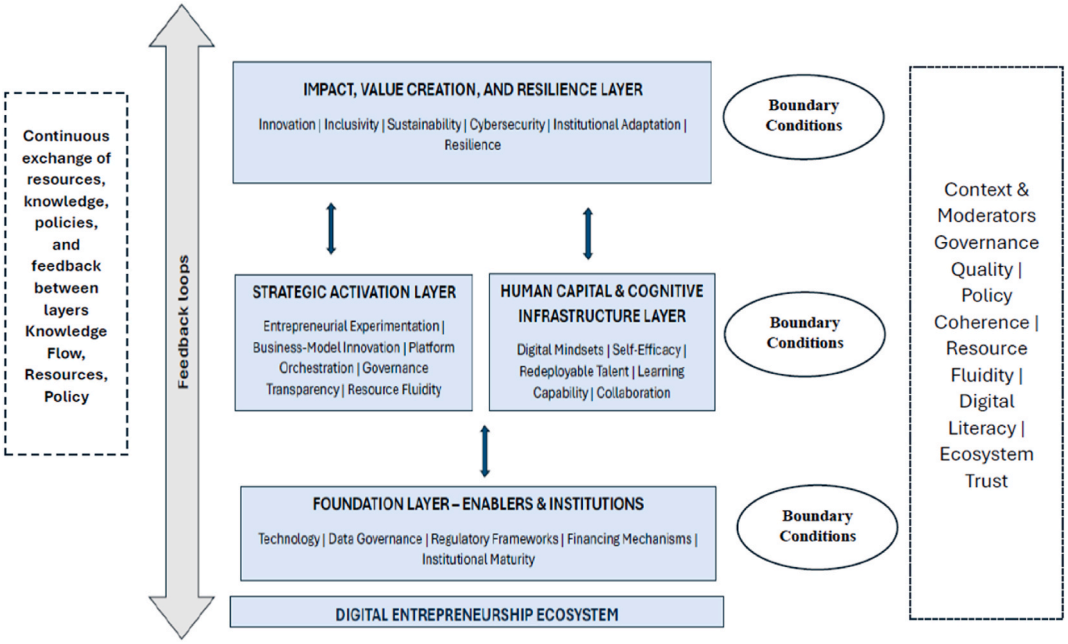

Fig. 5. Digital entrepreneurship ecosystem model.
Source: Created by Authors.

Table 2
Theme-to-layer categorization for the digital entrepreneurship ecosystem model.

Theme	DEEM Layer	DEEM Mechanism
Technology and Digital Infrastructure	Foundational	Provides digital affordances; forms the base enabling connectivity and recombination.
Business Models and Scalability	Strategic	Represents entrepreneurial agency that translates affordances into growth and market impact.
Entrepreneurial Ecosystem and Policy Support	Foundational	Institutional and policy frameworks act as digital-affordance engines and governance supports.
Funding and Investment	Foundational/ Strategic	Dual role: as foundational capital infrastructure and as strategic enabler of agency and scaling.
Market Access and Globalization	Strategic	Reflects entrepreneurial orchestration and scaling across digital markets.
Consumer Behavior and Digital Engagement	Human-Capital and Cognitive-Infrastructure	Captures cognitive and behavioral dynamics shaping digital interactions and innovation.
Talent and Skills	Human-Capital and Cognitive-Infrastructure	Represents human-capital cognition and adaptive learning capacity of the ecosystem.
Regulatory and Legal Challenges	Foundational	Defines institutional maturity and boundary conditions enabling or constraining affordances.
Competition and Platform Dependency	Strategic	Reflects platform governance and agency dynamics affecting entrepreneurial strategy.
Cybersecurity and Data Privacy	Foundational	Ensures trust and data integrity; part of institutional-infrastructural affordances.
Digital Innovation and Transformation	Strategic	Represents outcomes of entrepreneurial agency and reconfiguration processes.
Sustainability and Social Impact	Impact	Reflects value creation, ecosystem renewal, and feedback mechanisms.
Entrepreneurial Collaboration and Networks	Human-Capital and Cognitive-Infrastructure	Represents social capital and knowledge recombination across digital actors.

institutions and adaptive coherent policy, then digital entrepreneurship ecosystems demonstrate greater opportunity diversity and sustained evolutionary adaptation. Conversely, under weaker boundary conditions, affordance generation becomes fragmented, limiting entrepreneurial experimentation and renewal.

4.2.15. Strategic Activation layer

The strategic-activation layer explains how entrepreneurial agency converts digital affordances into tangible outcomes through experimentation, business-model innovation, and the orchestration of complementarities across digital networks (Bejjani et al., 2023; Felicetti et al., 2024). Entrepreneurs, start-ups, and platform actors engage in transformative agency that both employs and reconfigures digital infrastructures, market norms, and platform governance (Davidsson et al., 2021; Parker et al., 2016). This layer reflects the intentional, coordinated actions through which actors translate foundational affordances into entrepreneurial outcomes and, as a result, strategically reshape the ecosystem itself. At this layer, the generative mechanism is recursive structuration: the entrepreneurial actions that reconfigure digital and institutional structures, which in turn modify the affordances and resources available to future actors. DEEM formalizes this process, showing how entrepreneurial agency and environmental structures co-evolve through feedback loops conditioned by governance and resource fluidity. The integration of these mechanisms reconciles the technology-, actor-, and governance-focused clusters observed in the bibliometric results. Boundary conditions include platform-governance design, funding cycles, capital liquidity, and ecosystem trust (Bejjani et al., 2023; Berman, Stuckler, et al., 2024; Kimjeon & Davidsson, 2022). With transparent governance and fluid resources, the interplay between agency and structure accelerates innovation and scalability. Conversely, more restrictive or fragmented conditions constrain agency and impede transformation. Drawing on Dynamic Capabilities Theory (Teece, 2018) and Platform Strategy (Parker et al., 2016), this layer conceptualizes digital entrepreneurship as a configurational process in which sensing, seizing, and reconfiguring capabilities operate across multi-actor ecosystems.

Proposition 2. *If governance is transparent and resources are fluid, then entrepreneurial agency recursively reconfigures institutional and technological architectures, which, in turn, expand subsequent affordances. In contrast, if these boundary conditions are weak, then the effects of agency remain transitory and fragmented.*

4.2.16. Human-capital and cognitive-infrastructure layer

The human-capital and cognitive-infrastructure layer represents the adaptive intelligence that enables the renewal and evolution of digital-entrepreneurship ecosystems. Prior reviews (e.g., Bejjani et al., 2023) and bibliometric analyses identify human capital, learning capability, and digital competencies as central (yet fragmented) elements of digital-entrepreneurship research. DEEM synthesizes these insights into a single generative mechanism, explaining how the interplay of skills, cognition, and redeployable talent enables ecosystem-level adaptation and innovation. Based on the literature on digital competencies and learning (Hietaniemi et al., 2024; Maran et al., 2022; Oberländer et al., 2020; Solberg et al., 2020), this layer consists of three interdependent dimensions: digital mindsets—shared cognitive orientations toward technology, experimentation, and adaptability (Solberg et al., 2020); digital self-efficacy and agility—the confidence and flexibility required to integrate and repurpose emerging technologies (Maran et al., 2022); and redeployable human capital—the capacity to reallocate skilled labor across ventures to maintain continuity and renewal under uncertainty (Hietaniemi et al., 2024). Together, these dimensions form a capability system through which ecosystems accumulate, recombine, and transfer knowledge. Through this flow of knowledge, human capital moves from being a firm-level resource to an ecosystem-level adaptive mechanism. More than a descriptive account of individual skill and training, this integration explains how human-capital cognition acts as a generative process, linking micro-level learning and behavioral confidence with macro-level renewal.

Boundary conditions at this layer include labor-market flexibility, educational responsiveness, and the diffusion of digital mindsets across institutions. This understanding of how knowledge circulating through digital networks enables collective learning and resilience.

Proposition 3. *If ecosystems exhibit shared digital mindsets, strong self-efficacy, and redeployable talent, then collective learning, innovation, and resilience increase.*

4.2.17. Impact, value creation, and resilience layer

This layer explains how outcomes of digital entrepreneurship drive renewal and adaptation within the ecosystem. For instance, Elia et al. (2020) emphasized interaction flows among digital actors, and Bejjani et al. (2023) highlighted governance interdependencies. Yet these studies treated impact primarily as a product of entrepreneurial processes rather than a continuing driver of change.

In contrast, DEEM understands entrepreneurial impact as a generative feedback mechanism through which outcomes like innovation, inclusivity, and resilience influence earlier layers, thereby reshaping infrastructures, governance, and human-capital capabilities (see bibliometric results). Drawing on resilience thinking and risk-governance

perspectives (Berman, Stuckler, et al., 2024; Felicetti et al., 2024), the model sees digital ecosystems as adaptive systems that evolve through iterative cycles of learning and renewal. Positive outcomes bolster institutional trust and investment, while setbacks trigger corrective learning and policy adaptation.

The theory frames such impact as a self-reinforcing process that connects micro-level entrepreneurial outcomes with meso-level coordination and macro-level institutional evolution. This closes the causal cycle by explaining how value creation generates the conditions for its own adaptation. Boundary conditions here include governance maturity, absorptive capacity, and societal digital trust (Elia et al., 2020; Modgil et al., 2022).

Proposition 4. *If ecosystems demonstrate mature governance, strong absorptive capacity, and responsive institutions, then entrepreneurial outcomes transform into feedback that enhances adaptability and resilience. Where these boundary conditions are weak, evolution remains fragmented or path-dependent.*

4.2.18. Cross-cutting context and moderators

The bibliometric analysis revealed that contextual factors such as governance quality, institutional maturity, and exogenous shocks moderate the strength and direction of relationships between entrepreneurial inputs, processes, and outcomes. In our synthesis, these factors appeared as *indirect variables*, forming the boundary layer that had been absent in earlier frameworks (e.g., Elia et al., 2020).

DEEM incorporates these insights as a cross-cutting contextual layer that influences all of the system's mechanisms. These moderators influence the interaction of digital affordances, entrepreneurial agency, human capital, and impact. As such, ecosystems tend to better adapt and innovate in mature institutional environments, marked by transparent governance and widespread digital literacy (Bejjani et al., 2023; Berman, Stuckler, et al., 2024; Mossberger et al., 2023). Under conditions of weak governance or cultural rigidity, the interplay between layers slows and evolution becomes path-dependent.

This contextual dimension brings together structural and dynamic perspectives on digital entrepreneurship. It clarifies that variability in performance across ecosystems often arises not from deficits in technology or entrepreneurial capabilities, but from the boundaries imposed by these moderating conditions.

4.3. Theoretical and practical implications

This study offers an integrated framework, positioning digital-entrepreneurship ecosystems as evolving socio-technical systems that adapt through recursive interactions among foundational, strategic, cognitive, and outcome layers. Unlike previous linear models, this framework is not merely descriptive, but also explains *how* the feedback between digital affordances, entrepreneurial agency, and human-capital cognition produces self-reinforcing adaptation and resilience, so long as the boundary conditions are favorable. As such, it is capable of explaining why ecosystems with similar technological and institutional characteristics can diverge in performance. The model connects micro-level learning and agency with macro-level institutional evolution, addressing fragmentation in prior research (Bejjani et al., 2023; Elia et al., 2020). By including contextual moderators such as governance maturity, resource fluidity, and digital-mindset diffusion, it also accounts for variations across regions and sectors. Theoretically, the model contributes a mid-range mechanism-based framework that links entrepreneurial behavior, policy structures, and ecosystem renewal under a single adaptive architecture.

On the practical side, the model provides policymakers, educators, and entrepreneurs with a clear, iterative roadmap for designing, managing, and identifying obstacles to digital-entrepreneurship ecosystems (also, see Table 3). Specifically, one that consists of four interdependent steps: (1) **Build** by strengthening digital infrastructure, ensuring regulatory clarity, and encouraging funding accessibility; (2) **enable** by fostering platform development, business-model innovation, and policies that support experimentation; (3) **empower** human capital through entrepreneurial training, digital-mindset diffusion, and the creation of collaborative learning networks; and (4) **evaluate** by monitoring outcomes such as inclusivity, sustainability, and resilience to ensure long-term impact. These stages highlight the dynamic nature of ecosystem development where learning, feedback, and adaptation are continuous processes rather than sequential ones.

Table 3
Practical roles of Stakeholders across the DEEM strategic layers.

Layer	Key Stakeholders	Functions
Foundation	Governments, policy makers, regulators, investors, digital-infrastructure providers, platforms	**Build** the enabling environment by strengthening digital and data infrastructure, ensuring regulatory clarity, and expanding access to funding and connectivity.
Strategic Activation	Entrepreneurs, start-ups, platform owners, venture capitalists, accelerators	**Enable** entrepreneurial agency through business-model innovation, platform orchestration, and scalable digital ventures that translate affordances into market outcomes
Human-Capital and Cognitive-Infrastructure	Educators, universities, training bodies, mentors, digital communities, professional networks	**Empower** human capital by developing digital mindsets, self-efficacy, and redeployable skills; promote collaboration and collective learning across the ecosystem
Impact	NGOs, social enterprises, research organizations, policy evaluators, civil-society actors	**Evaluate** and sustain ecosystem performance by ensuring inclusive, ethical, and resilient outcomes; feed lessons back into earlier layers for continuous adaptation

5. Conclusion

This study advances a unified understanding of digital entrepreneurship, using insights from a bibliometric mapping and an umbrella review. The bibliometric analysis produced an Input–Process–Outcome (IPO) model that revealed key drivers, processes, and outcomes, while the umbrella review synthesized thematic insights across existing frameworks. Together, these informed the DEEM framework and its four interconnected layers—Foundation, Strategic Activation, Human Capital and Cognitive Infrastructure, and Impact and Resilience. In DEEM, the Impact and Resilience layer operates as a feedback mechanism, looping outcomes such as innovation, inclusion, and adaptability back into earlier layers, thereby sustaining the ecosystem. This framework advances digital entrepreneurship theory by linking structural, strategic, and human dimensions within one adaptive system. As a conceptual model, DEEM offers a strong foundation for future empirical validation and refinement.

Finally, this study has several limitations. First, the bibliometric mapping relies on citation data, which may be influenced by the Matthew Effect (Merton, 1988), where already well-cited publications attract more citations regardless of their current relevance. Second, the umbrella review was restricted to published review articles, which may limit coverage of emerging topics. Finally, although combining bibliometric and umbrella review methods offers a broad and structured view, it may still underrepresent niche or fast-evolving areas in digital entrepreneurship.

CRediT authorship contribution statement

Carolin Camps: Writing – original draft, Validation, Software, Methodology, Investigation, Formal analysis, Data curation. **Sascha Kraus:** Writing – review & editing, Writing – original draft, Validation, Supervision. **Asha Thomas:** Writing – review & editing, Writing – original draft, Visualization, Methodology, Investigation, Data curation. **Victor Tiberius:** Writing – original draft, Supervision, Project administration, Conceptualization. **Paul Jones:** Writing – original draft.

Declaration of competing interest

The authors report there are no competing interests to declare.

Data availability

The authors are unable or have chosen not to specify which data has been used.

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