Development Trends of Digital Transformation in Entrepreneurship and Innovation: A Bibliometric Analysis

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Abstract - The research provided a bibliometric analysis of 340 studies conducted between 2011 and 2022 related to digital transformation in entrepreneurship and innovation. The bibliographic data were extracted from the Scopus database and analyzed using bibliometric tools in R software. The research revealed research trends such as publication and citation per year, top sources, top authors, top documents, and top countries, as well as their impacts. The conceptual structure was analyzed using Multiple Correspondence Analysis (MCA) and hierarchical clustering analysis, which resulted in four cluster keywords related to leadership, entrepreneurial agility, technology impact, digital ecosystems, and digital services. The thematic map analysis identified twenty-seven clusters, which were mapped into four quadrants. Three of those clusters were identified as motor themes (micro foundation, digital global value chain, and digital servitization) which were analyzed in detail through content analysis. The theoretical contribution of the research is to enhance the understanding of how digital technology changes the broad assumptions on the sources, processes, and outcomes of entrepreneurial activities and innovation processes, while the practical contribution provides various contexts of technological impact.

Keywords: bibliometric, digital transformation, entrepreneurship, innovation, Scopus

I. INTRODUCTION

In today's world, the complexity and uncertainty in business and human lives are becoming increasingly apparent. For example, the pandemic, geopolitical dynamics, the rise of nationalistic movements, protracted recessions, increased polarization, the digitalization of economies, and rapid technological advancements have all contributed to the transformation of the global business environment (Allcott et al., 2020; Piroșcă et al., 2021; Sharma et al., 2020). It has been said that, "We live in a World of Worry" (UNDP, 2022) and, for many enterprises, the models and best practices of the past are no longer applicable with managers struggling to comprehend the new realities as businesses are under intense pressure to reinvent themselves. Likewise, business educators must reconsider what they teach and how they impart knowledge (Cavusgil et al., 2021).

Digital Transformation (DT) has become a strategic imperative in the leader agenda in both the private and public sectors across industry to deal with the complexity and uncertainty (Eggers et al., 2021; Wade, 2021; Smaje et al., 2022). In the small, medium and large enterprises, DT provides opportunity for a firm's internal capability optimization and business growth opportunities development by not only uplifting and optimizing internal IT and business process operation, but also allowing for better customer acquisition, and new business and products development (Furr et al., 2022). In the public sector (government), DT rationales span technology modernization, faster innovation enabler to meet citizen demand and expectation (Alvarenga et al., 2020; Eggers et al., 2021). The advent of new digital technologies, artificial intelligence (AI), big data, cloud computing, Internet of Things (IoT), social media, 3D printing, the commoditization of computer technology and mobile phones, proliferation of the internet, digital platforms (that facilitate social platform and peer-to-peer platform) and digital infrastructures have transformed innovation and entrepreneurship in a significant way (Alerasoul, Tiberius, & Bouncken, 2022; Nambisan, Wright, & Feldman, 2019; Sedera, Tan, & Xu, 2022). These technologies offer many opportunities and

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benefits to industrial firms such as better product quality, improved process, reliability and flexibility that can drive firm productivity (Chirumalla, 2021; Hamidu et al., 2023; Sony, Antony, & Mc Dermott, 2023).

To date, entrepreneurship study has focused on understanding the nature and source of uncertainty and how is the entrepreneurial action taken to unfold such uncertain condition (Bridge, 2021; Brown & Rocha, 2020; Rapp & Olbrich, 2020). The digitalization changes the nature of the uncertainty inherent in the entrepreneurial processes and outcomes, making the entrepreneurial outcomes and processes less bounded and less a predefinition of entrepreneurial agency (Nambisan, 2017). Rogers (2016) argued that digital transformation changes five domains of business, namely: 1) customers, 2) competition, 3) data, 4) innovation, and 5) value. The adoption of social media changes the customer role from merely aggregate actors to being marketed to and persuaded to influence. Customer demand also increases as they are expecting greater personalization and a closer relationship with the producer. The competition landscape also changes with the blurring boundaries of industries. The data are ubiquity generated and become the key assets for value creation with rapid experimentation making innovation decision-making determined based on testing and validation, and with value proposition changed and defined by customer needs.

There have been several previous literature review studies on the intersection between digital transformation, innovation, and entrepreneurship although mostly focused on narrative, critical or systematic reviews with a qualitative narrow research theme. It is considered narrow scope since it comprises of sub-themes of the discipline of digital transformation, entrepreneurship and innovation with a narrow and fragmented scope, context and focus on the theories and concept development. For example, the research by Nambisan et al. (2019) tried to identify the progress, challenge and key themes of digital transformation of innovation and entrepreneurship through a literature review of 11 articles in a special issue journal. The conceptual research that upended the entrepreneurship principle due to digital technology attributes was developed as well (Nambisan, 2017). There are also many bibliometric analyses with narrow scope, such as digital transformation in internal audit (Pizzi et al., 2021), pattern relationship between academic-industry collaboration research in digital transformation (Chen et al., 2022) or digital innovation specifically (Manotti

et al., 2020). Given the narrow research theme and potential bias caused by qualitative interpretation, the researcher aims to conduct broader scope bibliometric analysis covering the intersection between digital transformation, entrepreneurship, and innovation. The study is not only broaden and advanced the future research in these disciplines, but also to avoid the bias caused by researcher bias and lack of rigor examination and interpretation through quantitative approach (Zupic & Čater, 2015).

The findings have several academic and industry implications. The research provides a broader and comprehensive overview of the research domain with publication information trend, rank (publication outlet, authors, topics) and conceptual structure (thematic map) for scholars and practitioners in digital transformation, innovation, and entrepreneurship. The practitioners and industry can explore and use the results of various research on understanding the impact of digital transformation into innovation and entrepreneurship activities in various contexts.

II. METHODS

The research adopts bibliometric analysis from Scopus database focusing on descriptive analysis and the thematic trend analysis on digital transformation, entrepreneurship, and innovation. A bibliometric analysis is a quantitative approach to describe, evaluate and monitor past researches with the purpose for advancing a particular line of research (Zupic & Čater, 2015). The research follows the 5-steps bibliometric study as suggested by Zupic and Čater (2015), depicted in Figure 1. The analysis is conducted using bibliometric (Aria & Cuccurullo, 2017). In the research design, the research questions are determined, and the appropriate research method selected to answer the research questions. There are two research questions that the research answers: (1) What is the trend and impact on digital transformation for innovation and entrepreneurship? (2) What is the conceptual structure of digital transformation for innovation and entrepreneurship study?

The data are retrieved from Scopus database, the largest abstract and peer-review literature database delivering a comprehensive overview of the world's research in various disciplines (Elsevier, 2022). The search strategy focuses on the final articles with title, abstract, and keywords related to digital transformation, entrepreneurship, and innovation that
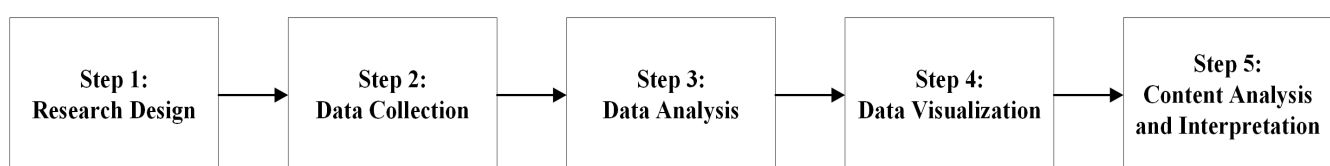
Figure 1 Bibliometrics Study Procedures
Source: Zupic and Čater (2015)

were sourced from the English language journals in subject area of business, management, and accounting. The search included articles published between 2011-2022. The Preferred Reporting Items for Systematic Reviews (PRISMA) method is used to present the search process and outcome on each stage (Figure 2). In the data analysis, the retrieved data are eliminated, merged, normalized, and cleaned as necessary resulting in 340 articles ready for analysis. There are five data categories with a total 31 metadata attributes retrieved from the Scopus Database: Citation Information (12 attributes), Bibliographic Information (8 attributes), Abstract & Keywords (3 attributes), Funding Details (4 attributes), and Other Information (4 attributes). The analysis used 11 of 31 metadata attributes with acceptable to excellent condition without missing data. Metadata attributes with status completely missing to poor were not included in bibliometric analysis (corresponding Author, Keyword Plus, Number of Cited References, and Science Category) as depicted in the missing data analysis in Table 1.

In analyzing the data, various methods are used in trending and impact analysis. The sum and mean of per year articles, author, source is used to identify their productivity. The Bradford's Law is to identify the core source impact within the research domain. The three-field plots are used to evaluate the relationship between the three fields bibliography attributes.

Table 1 Missing Data Analysis

| Meta-Data	Description	Missing Counts	%	Status
AB	Abstract	0	0.00	Excellent
C1	Affiliation	0	0.00	Excellent
AU	Author	0	0.00	Excellent
CR	Cited Reference	0	0.00	Excellent
SO	Journal	0	0.00	Excellent
PY	Publication Year	0	0.00	Excellent
TI	Title	0	0.00	Excellent
TC	Total Citation	0	0.00	Excellent
DT	Document Type	2	0.33	Good
LA	Language	2	0.3	Good
DE	Keywords	19	3.1	Good
DI	DOI	80	13.1	Acceptable
RP	Corresponding Author	188	30.8	Poor
ID	Keywords Plus	312	51.2	Critical
NR	Number of Cited References	609	100	Completely Missing
WC	Science Categories	609	100	Completely Missing
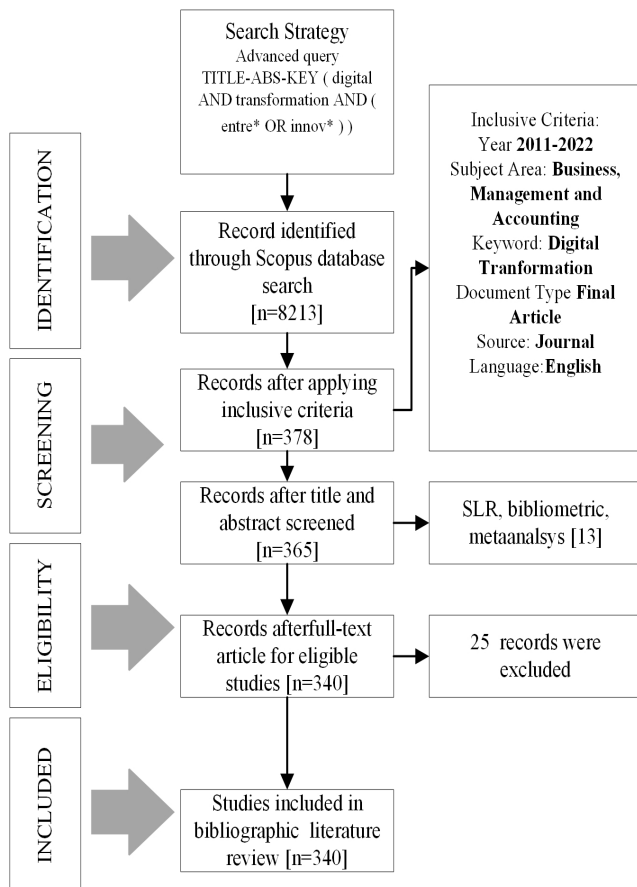
Figure 2 PRISMA Flow Chart

III. RESULTS AND DISCUSSIONS

There are 340 articles analyzed from 185 publication outlets (source) published between 2011-2022 with average growth rate 62.83%. The article's contents have a total of 17,879 references written by 911 authors (42 single authors and 869 collaborative authors) with 29.19% international co-authorship and 297 co-authors per document. The document's average age is 2.26 years where it is considered a young publication topic. Based on Figure 3, the earliest article publication was in 2011, with the topic gradually rising until 2016. Despite the very low number of publications prior to 2016, there were two periods where the average citation per article (Mean TC per Ar) and average citation per year (Mean TC per year) spiked up. The first period was in 2012 where the MeanTCperAr was 135, and MeanTCperyear was 11.25. The second period happened in 2015 with the MeanTCperAr and MeanTCperyear 332 and 36.89, respectively. There was only one article published between 2011-2015 with no publication in 2013. The earlier publications provided the strong foundation of the recent publications on digital transformation of innovation and entrepreneurship. The topic on national competitiveness by leveraging ICT, the organization capability to deal with disruption, competition shift of business and economic, digitalization and transformation of workforce emerged at that time. As per national competitiveness, there was a need for

solid foundation for ICT investment, digital readiness, information technology education, support for research & development through formal agency (Pavlicek et al., 2011). There was also a shift from individual firm competition to networks of firms (Katsamakas, 2014) enabled by transformation of people through a digital workspace (White, 2012). The need of dynamic capability to deal with disruption where building digital platform capabilities allows a firm to change, extend, and adapt existing resources process and value, which impacts firm performance (Karimi & Walter, 2015). The articles retrieved were published in 185 different sources where there are 17 sources in Zone 1, Bradford's law, and that are considered as nuclear sources. There is a total of 115 articles in these categories. Bradford's law of scattering use formulation and apply pareto distribution approach that identified core journals as most articles tends to be in small number of journals.

According to Table 2, Technological Forecasting and Social Change (TFSC) is the most relevant and most impactful source (22 articles, h-index=13,

g-index=2, and m-index=2.6, 1010 citations), ranked no 1 in Bradford's law. This journal specializes in methodology and practice of technological forecasting and future studies as planning tools as they interrelate social, environmental, and technological factors. The second most productive and impactful journal is Journal of Business Research (JBR) (13 articles, h-index=11, g-index=13 and m-index=2.20). The journal focuses on a wide variety of business decision contexts, processes, and activities in developing insights that are meaningful for theory, practice, and/or society at large. Its research is intended to generate meaningful debates in academia and practice that are thought provoking and have the potential to make a difference to conceptual thinking and/or practice. The Journal of Technology in Society (JST) focuses on global discourse at the intersection of technological change and the social, economic, business, and philosophical transformation of the world around us. The goal of the journal is to provide scholarships that enable decision-makers to thoughtfully and intentionally engage in the decisions that shape this dynamic (9 articles, h-index=7,
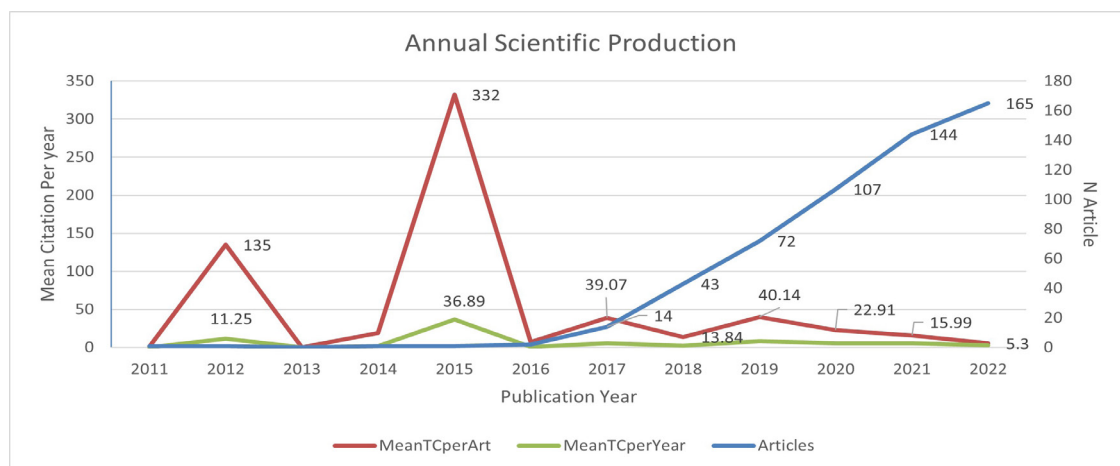

Figure 3 Annual Scientific Production 2011-2022

Table 2 Top 10 Most Impactful Journal Outlets (Source) and Bradford's Law

Journal Outlet	h	g	m	TC	NP	PY	Bradford's Law			
							Rank	Freq	Cum Freq	Zone
Technological Forecasting and Social Change	13	22	2.60	1010	22	2019	1	22	22	1
Journal of Business Research	11	13	2.20	1010	13	2019	2	13	35	1
Technology In Society	7	9	1.75	181	9	2020	4	9	53	1
Journal of Business Strategy	6	8	0.86	213	8	2017	5	8	61	1
Business Horizons	5	5	1.00	301	5	2019	7	5	73	1
Electronic Markets	4	5	1.00	94	5	2020	8	5	78	1
IEEE Engineering Management Review	4	9	0.50	181	9	2016	3	9	44	1
Industrial Marketing Management	4	4	1.00	170	4	2020	12	4	95	1
International Journal of Innovation Management	4	7	0.67	59	7	2018	6	7	68	1
Journal of Manufacturing Technology Management	4	4	1.00	88	4	2020	16	4	111	1

Note: h=h-index; g=g-index; m=m-index; TC=Total Citation; NP=Number of Publication; PY=Publication Year Start

g-index=9, m-index=1.75). Elsevier publishes three of the five top journals with the most productive and impactful regarding the digital transformation in entrepreneurship and innovation (TFSC, JBR, and JST). The Journal of IEEE Engineering Management Review and Journal of Business Strategy are the oldest journals where publication began in 2016 and 2017, respectively.

Table 3 Top 10 Global Cited Documents

Paper	TC	TC/Y	NTC
Nambisan et al. (2019)	590	118.00	9.10
Warner & Wäger (2019)	554	110.80	8.54
Frank et al. (2019)	410	82.00	6.32
Karimi & Walter (2015)	332	36.89	1.00
Matarazzo et al. (2021)	194	64.67	8.68
Li (2020)	191	47.75	5.22
Ferreira et al. (2019)	182	36.40	2.81
Krishnamurthy (2020)	179	44.75	4.89
Neumann et al. (2021)	170	56.67	7.60
White (2012)	135	11.25	1.00

TC= Total Citation; TC/Y= Total Citation per Year NTC= Normalized Total Citation

The top ten most cited local documents are depicted in Table 3. The first article by Nambisan et al. (2019) had a purpose to seek understanding of the implications of digital technologies in businesses especially in how the existing companies need to radically transform themselves in the emerging digital world.

The article had 590 total citations with an average of 18 citations per year published in the Research Policy Journal. There are three themes related to the wider implication of digital transformation in innovation and entrepreneurship: 1) openness, 2) affordance, and 3) generativity. Openness relates to how far digital technology can facilitate the nature and degree of openness of systems and their actors. Affordance is related to the potential and possibility offered by digital technology in innovation and entrepreneurship, and generativity relates to digital technology capacity to bring impact by entities or actors. In general, the topmost cited articles address various digital transformation aspects and their impact on innovation, entrepreneurship, and organization performance. Digital transformation is considered transforming and disrupting factors in various industry contexts that trigger discussion on dynamic capability that enable organizations to adapt, renew and innovate in response to these transforming and disrupting factors. These are publications in a specific industry (e.g., newspaper companies in Italy) and in the broader concept (e.g., servitization and Industry 4.0). The methodologies employed in the studies range from qualitative

research and multi-case studies to systematic literature reviews and content analysis. Different perspectives, such as customer value creation, business model innovation, the digital workplace, and education, are used to examine the implications and outcomes of digital transformation. The second article by Warner and Wäger (2019) explores how the incumbent firms in traditional industries built dynamic capability for digital transformation, and proposes a process model that consists of nine micro foundations. The article had 554 total citations with an average of 110.80 total citations per year. that identify contingency factors that develop dynamic capability for digital transformation. The qualitative study concludes that digital transformation is an ongoing process that recognizes agility in an organization business model, collaborative and organization culture. It raised the importance of organization culture in dynamic capability (Utomo & Budiastuti, 2019). The third most cited article written by Frank et al. (2019) that tried to develop business model innovation conceptual model of servitization and industry 4.0. The article had 410 total citations, with an average of 82 citations per year. It describes and integrates two different approaches in technology value adding activities: customer value adding (servitization) and process value adding (Industry 4.0), into nine possible configurations classified in manual, digital and Industry 4.0 related services.

Figure 4 shows the three-field plot analysis based on Sankey analysis which describes the relationship between the author's country of origin (AU_CO), author keywords (DE) and publication outlets (SO). The three-field plot presents the correlation between the publications with the most prominent concepts of digital transformation of innovation and entrepreneurship. The height of the rectangular nodes is proportional to the frequency of the presence of a particular country, keywords, and journal (publication outlets). The width of the lines between nodes is proportional to the number of connections. There are only 20 top author countries, keywords and publication outlets used for analysis. The results show the research related to digital transformation dominantly came from Italy (frequency = 161), Germany (frequency = 97) and the USA (frequency = 57) and were published in 20 publication outlets such as Journal of Technological Forecasting and Social Change, Journal of Business Research and Journal of Business Strategy. The publications related to innovation and entrepreneurship are ranked number 4 and number 13, respectively, opening a future research avenue though intersection research in business model innovation and technological innovation (big data, artificial intelligence).

Factorial analysis is to create a conceptual structure map with multiple correspondence analysis (MCA). It is a descriptive method for evaluating simple two-dimensional and multiplexed tables containing corresponding metrics between rows and columns, closely grouping indicator levels with
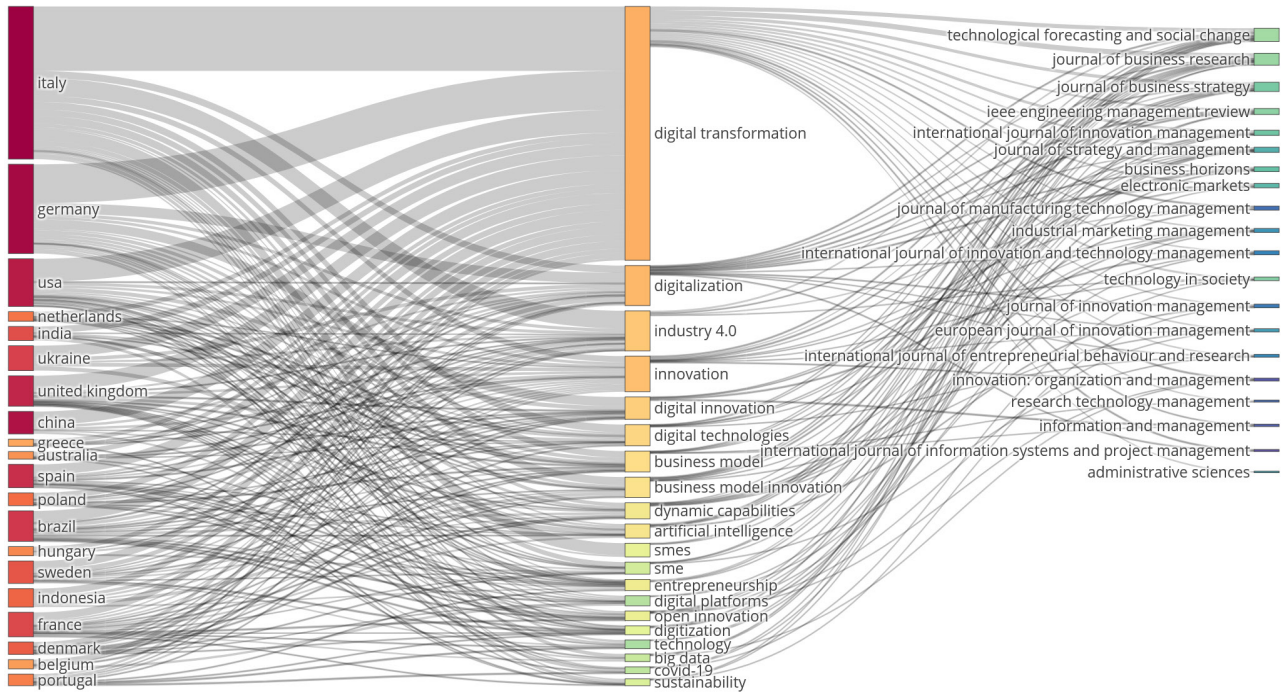
Figure 4 The Three-field Plot

similar characteristics; they were well-indicated in a 2-dimensional plot forming points clouds. The closer the keywords are to each other, the more related they are. Similarly, hierarchical clustering is used to cluster keywords with the highest similarity to generate a tree graph describing the correlation and de-correlation between keywords in detail. Keywords approaching the center point indicate that they have received high attention in recent years. The nearer to the edge, the narrower the study theme, or the transition to other themes. The MCA analysis result (Figure 5) shows there are five categories that are represented as Cluster 1 (red), Cluster 2 (blue), Cluster 3 (green), Cluster 4 (light brown), and Cluster 5 (pink). Cluster 1 relates to agility and entrepreneurial capacity, including knowledge management, design thinking and innovation performance. Cluster 2 relates to technological resources, capabilities, and adoption, which includes the digital value creation, competitive advantage, and specific technology adoption, e.g., cloud, artificial intelligence, big data, Internet of Things. Cluster 3 relates to leadership and change management. Cluster 4 relates to digital ecosystems. which include the digital business model, entrepreneurial ecosystems, innovation management, business ecosystem. Cluster 5 relates to digital services.

The hierarchical clustering analysis shows the relatedness between keywords, e.g., in Cluster 1 (red), the supply chain management is closer with organization ambidexterity instead of with social media or value creation even though they are in the same cluster. In Cluster 2 (blue), the design thinking has more relatedness on the strategy instead of

innovation and performance. The hierarchical cluster analysis in Figure 6 describes the connectedness between keywords.

There is a total of 27 clusters grouped based on the author-keywords and spread into four different quadrants' conceptual structure thematic map. A thematic map is created based on co-occurrence keyword network analysis and mapped into typological theme of domain (cluster) in a two-dimensional map (Cobo et al., 2011) based on the Centrality and Density using the Walktrap clustering algorithm as depicted in Figure 7. There is a total of three clusters which fall in the motor quadrant. The clusters falling in the motor quadrant are well-developed and important themes for the structure of this research as they have strong centrality and high density. These themes are micro foundation, digital global value chain, and digital servitization.

The micro foundation research focuses on individual actions and their interaction in the firm. It relates to the physiological and cognitive characteristics of individuals and their influence on firm resources, capabilities, routines, knowledge management (create, transfer, and share knowledge) and various product development capability, absorptive capacity, information processing capability, decision making, and problem solving capability, including how individuals relate to the dynamic capabilities with various contexts (Molina-Azorín, 2014). Chirumalla (2021) specifically tried to identify dynamic capability-sense-seize-reconfiguring capabilities (Teece, 2007) for internal process innovation with a micro foundation perspective. Individuals need to act as entrepreneurs to find the best methods and procedures for digital process
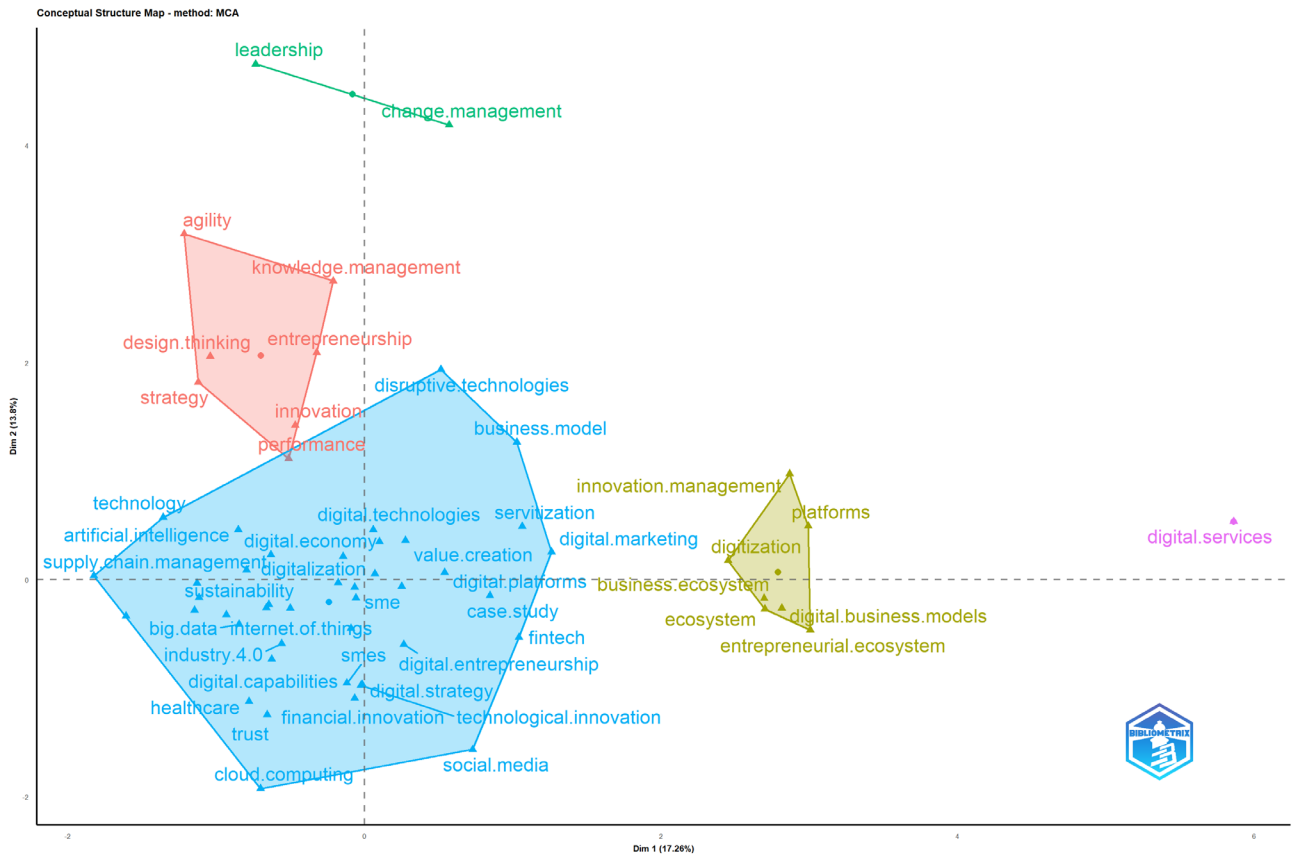
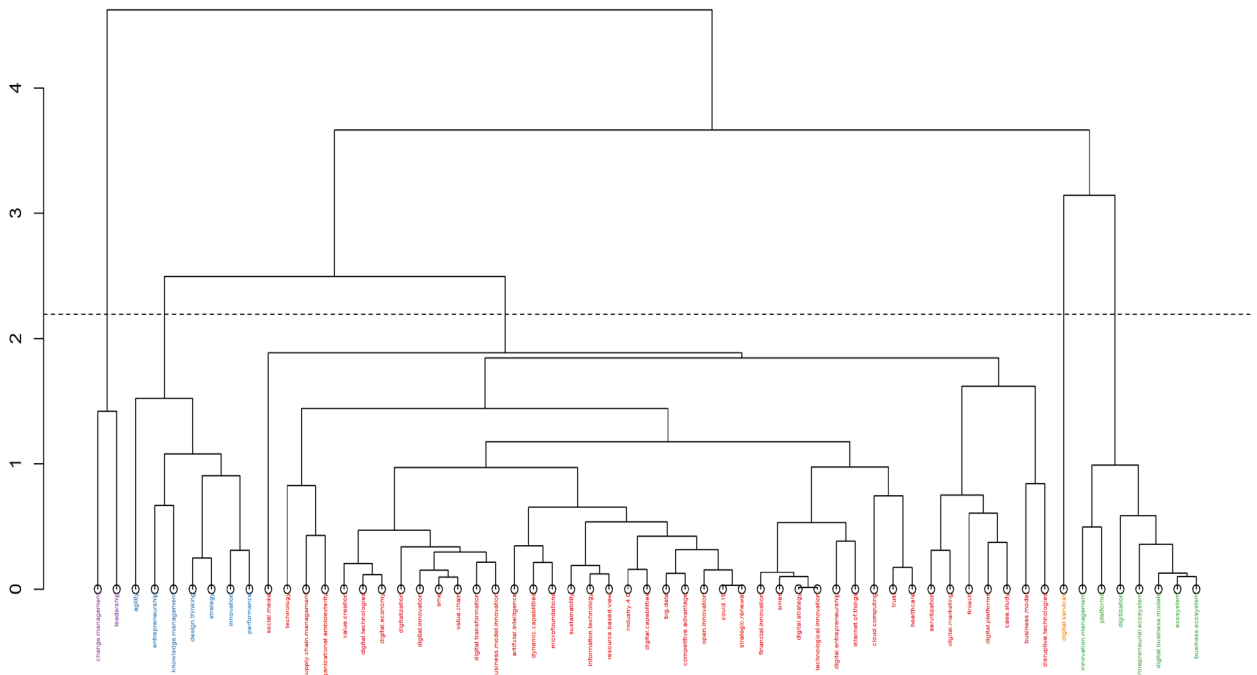Figure 5 Multiple Correspondence Analysis (MCA)

Figure 6 Hierarchical Clustering Analysis

innovation through data-driven knowledge, practical wisdom, and a creative mindset, in developing digitally enabled sensing capability. In digitally enabled seizing capability, individuals need to understand required resources and investment decisions and managing appropriate change management. And for the digitally enabled reconfiguration capability at the individual level, managers require top management leadership and integration skill, the workforce's digital maturity, redesign internal structure, internal technology transfer (which is most often influenced by cultural instead of technical aspects). Other research as related to the micro foundation focus on the individual digital skills (information, communication and software skill) and how it related to the innovation performance and SME (Small Medium Enterprise) (Scuotto et al., 2021).

This digital transformation is an ongoing process related to the business model innovation through a collaborative approach and culture (Warner & Wäger, 2019). These three articles open up vast scopes for future trends opportunities: (1) there is room for research on how the individual interacts externally with internal and external works within its ecosystem perspective; (2) various process levels, industry context, firm size, organization and workforce maturity level process industrial firms to represent various industrial contexts and characteristics; (3) the detailed focus on digital technology, e.g., IoT, AI, cloud computing or a combination between those technology

as related to individual capability; (4) future studies should extend the empirical work by including diverse approaches, such as survey-based, action-based, and mixed-method based studies; (5) the research did not consider the cost-benefit analysis or financial analysis of the transition toward digitally enabled process innovation. Future studies should consider different methods of capital budgeting and investment proposals for these initiatives, including aspects such as estimating and evaluating implementation risks and management priorities.

Digital global value chain relates to the impact of digital technologies on the firm while international strategies relate to born-digital firms and going-digital firms (Strange, Chen, & Fleury, 2022). The born-digital firms are those founded in the internet era with a global value chain and proposition while going-digital firms are traditional firms transitioned to digital by a new value proposition through innovation in product, services, business model, and improved internal business processes. There are several concepts introduced using various methodologies for born-digital or going digital firms: liability of ecosystem integration (Rong, Kang, & Williamson, 2022), cross-side network interaction (Liu, Wu, & Song, 2022), strategic vs operational digital transformation (Yu, Fletcher, & Buck, 2022), and recombinant firm-specific advantages (Gooderham et al., 2022), and various SME internationalization capabilities
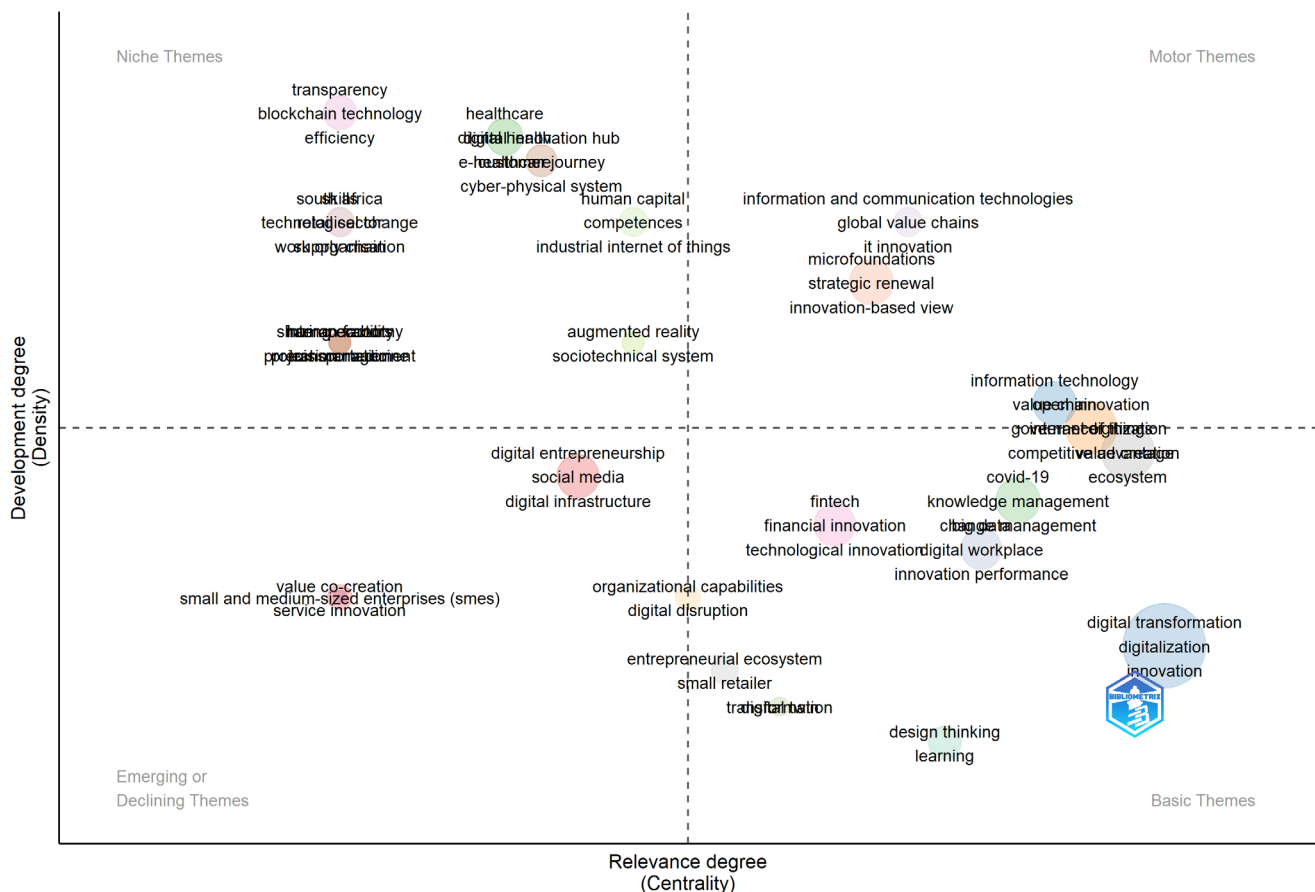

Figure 7 Thematic Map Analysis

through digital platforms, the internet and social media (Brieger et al., 2022; Ipsmiller et al., 2021; Lee et al., 2022). The impact and implication of digital technology in international strategy has widened as there are still unknown opportunities for research on the competition and interaction between firms in the blurring boundaries, demand side innovation and firm capabilities to develop and maintain a global value chain, digital platform technology variation, context (small and large firms), measurement (single item vs multiple items), time (cross-sectional and longitudinal), alternatives of moderating effects, and interaction between various stakeholders, and also the role of digital ecosystems in firm internationalization.

Digitalization allows companies to transition from product provider to a solution provider through services offering. The digitalization acts as an enabler and driver of the business model value creation and value capture (Kohtamäki et al., 2019).

Several sub themes of research are raised in the digital servitization cluster. The first one is provider and customer relationship in digital servitization. Kamalaldin et al. (2020) found four relational components that enable profitable provider-customer relationships, namely: 1) complementary digitalization capabilities, 2) relation-specific digital assets, 3) digitally enabled knowledge-sharing, and 4) partnership governance. The complementary digitalization capabilities become a critical aspect to establish provider-customer relationships as the provider needs to source complementary services that customers lack on, either from internal or external capabilities. As complementary digitalization capability existed, the relationship between the provider and customer evolved in the area of investment in digital technology alignment (solution co-development) and digital competence development (human assets and digital competences). The relationship will move deeper to transparent knowledge-sharing processes and routines.

The second sub-theme is ecosystem integration for higher value creation. Culot, Orzes, and Sartor (2019) mentioned that five value creation dimensions in the emerging business model are: 1) technologies, 2) data, 3) product, 4) services, and 5) channels crafting the trajectory of value creation in the manufacturing as Industry 4.0 emerges. The integration of these five dimensions will bring the highest value, which goes beyond only supply chain and service integrations but needs to have ecosystems integration as adopted by many technology companies, e.g., Uber, Google, Amazon, and Tesla. It opens a research venue on value chain configuration that will drive competitiveness, especially the use of data in these new configuration scenarios.

The last sub-theme is the business process innovation with various contexts. SME has four levels of engagement in the adoption of digital technologies: 1) digital awareness, 2) digital acquirement, 3) digital collaboration, and 4) digital transformation and each of the levels has several relevant variables to assess the digital technology utilization readiness and how the digitalization process happens (Garzoni et al., 2020). The use of artificial intelligence becomes prominent in developing digital capability and business modelling in the manufacturing through agile customer co-creation, data driven delivery operation and scalable ecosystem integration (Sjödin et al., 2021). The digital process and services innovation suggests that digital capability should be driven by technology, solutions and digital business concepts.

The future research related to generalization of AI capabilities across sectors and contexts needs to be examined, namely: 1) the understanding of the AI capability in B2B and B2C contexts; 2) the use of AI at other industry levels as to what extent and how AI capability will be used for different scenarios; 3) the ecosystem orchestration, governance, partnering and new types of sharing revenue for AI, including the role of AI implementation as well as in assisted, augmented and autonomous solutions.

As for SME digital servitization, it is considered interesting to explore further the servitization in various phases of digital transformation phases that embrace different analytical and methodological approaches. Indicators and metrics are required to assess the achievement of the SME toward the digital transformation.

IV. CONCLUSIONS

The bibliometric research aims to provide a preliminary scientific map on current study of the innovation and entrepreneurial action transformed by digital technologies. It summarizes the latest trends, impacts, and the conceptual structure of the current scientific publications in the Scopus database related to digital transformation, entrepreneurship, and innovation.

The trending analysis from the annual scientific publication shows an increasing number of publications since 2016. There are several important articles written prior to 2016 related to technology's role in national competitiveness, disruption and behavioral shifting of firms and humans in their concept, boundaries, and capabilities. There are 17 nuclear sources from analysis using Bradford's law that ranked in the 10 most impactful journal outlets. The top ten most cited documents are related to dynamic capabilities, servitization, value creation, innovation, and firm performance. The three-field plot analysis shows that the digital transformation research came from Italy, Germany, and the USA. The conceptual structure analysis using multiple correspondence analysis and hierarchical clustering analysis reveals keywords relatedness between research in the digital transformation domain as related to the entrepreneurship and innovation, (e.g., leadership, change management, various digital practices and management, digital services, and innovation management). The keywords further map into clusters into the thematic map with topics like

micro foundation, global value chain, and servitization as the motor themes in the recent study on digital transformation on entrepreneurship and innovation.

The research provides important sources and articles that can be used as theoretical reference for future study as digital technology changes the broad assumption on source, processes and outcomes of entrepreneurial activities and innovation processes. As a practical contribution, the research provides references to the technological (AI, Cloud, IoT, 3D printing) impact on entrepreneurial activities and innovation in various organizations (e.g., small, medium and large enterprises, citizens, employees, B2B, B2C), and industry (e.g., manufacturing, healthcare, education, government).

The research limitation lies on the dataset from a single source, Scopus, which is analyzed using conceptual analysis approaches namely MCA, hierarchical analysis, and thematic map analysis based on keywords. The determination of the final sample based on digital transformation author keywords might limit the bibliographic approach, which might affect the conclusion.

Future research is suggested to incorporate a larger set of data that combines and normalizes data from Web of Science (WoS) and Scopus with further analysis to understand the knowledge, concepts, intellectual and social structures using various bibliometric approaches and tools.

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