Digital transformation in start-ups: a bibliometric analysis

Aswathy Sreenivasan and M. Suresh
Amrita School of Business, Amrita Vishwa Vidyapeetham, Coimbatore, India

Received 14 December 2022
Revised 6 March 2023
1 May 2023
Accepted 4 May 2023

Abstract

Purpose – Research on the intersection of start-ups and digital transformation is still in its infancy, but it is gathering speed and has entered a period of ferment that may lead to discoveries and deeper understandings. From a purely descriptive standpoint, the topic has only recently entered an exponential development phase. This study aims to provide an overview of the digital transformation in start-ups.

Design/methodology/approach – The research only looked into account papers that mentioned the (("Digital transformation") AND ("Startups") OR ("Entrepreneurship") OR ("Entrepreneur")) for the title, abstract and keywords. The R programming language's Biblioshiny package was considered for thoroughly examining the papers.

Findings – This study evaluated the overview of digital transformation in start-ups between 2016–2022 using the articles from the Dimension database. The study of digital transformation is increasingly popular, but there needs to be more research focused specifically on the digital transformation of start-up companies. While the overall trend shows a rise in the interest and investigation of digital transformation, the number of studies explicitly addressing start-up digital transformation still needs to be higher. The highest publication and citation related to digital transformation is of Andreja Pucihar. The findings also show that the *Sustainability* journal has the highest network with other citations. Also, it has been found that the focus on digital transformation addresses the need for more research based on various theoretical perspectives. Based on the prominence percentile, the top three future research topics that can be explored are Product Innovation; Sustainability; Frugality, Digital Transformation; Strategic Alignment, and Cybersecurity; Strategies; Digital Transformation.

Research limitations/implications – The current study may serve as a general guideline for future investigation into this topic.

Practical implications – Regarding the practical ramifications, this study's findings can help entrepreneurs prepare to launch a business or are already doing so. This study's results provide a comprehensive framework of success variables that must be considered to improve the venture's performance.

Originality/value – This study's originality is from presenting a structured and in-depth literature review that describes the current state of the art for digital transformation in start-ups. A complete analysis of the data gathered on its digital transformation in start-ups is offered to establish that it is sustainable.

Keywords Digital transformation, Start-ups, Digitalization, Digital entrepreneurial ecosystem, Biblioshiny

Paper type Literature review

1. Introduction

We have had the opportunity to see one of the biggest economic shocks in history during the past several years: The Digital Revolution (Tischlinger & Van Wordragen, 2019). The environment in which we live is constantly changing at an accelerating rate. As the Internet becomes more pervasive in our daily lives, we are discussing a digital transformation, often known as a digital revolution. This digital transformation has caused things to change regularly, especially in the commercial realm. It has opened up several chances that every company must take advantage of, regardless of whether they are business oriented

Digital Transformation and Society
Vol. 2 No. 3, 2023
pp. 276-292
Emerald Publishing Limited
e-ISSN: 2755-077X
p-ISSN: 2755-0761
DOI 10.1108/DTS-12-2022-0072

(Tischlinger & Van Wordragen, 2019). As businesses differentiate their business models, products and services, new possibilities and dangers are created for most organizations. Additionally, these developments continuously alter how customers engage with businesses and one another. The advantages of going digital for a business are significant, but the process is complex since many obstacles exist (Karagiannaki, Vergados, & Fouskas, 2017).

VUCA is the most excellent way to describe the reality we experience today (El Hilali & El Manouar, 2019, March). Businesses struggle to survive in today's viciously competitive climate, where the danger of interruption from cutting-edge technologies undermines their performance. The idea of "digital transformation" serves as a strategic turning point to examine customer relationships, value propositions, operational procedures and business models. Digital transformation can be defined as using technologies to substantially boost the efficiency or reach of companies (Westerman *et al.*, 2014a, b). For the workers, clients, providers, partners and decision-makers of the organization to perform better, there must be a change in management, new ways of thinking, encouragement of innovation and new business strategies, digitization of assets and use of technologies (Karagiannaki *et al.*, 2017). Adopting digital technologies and evolving into a modern, adaptable firm should be prioritized. A proper balance of technological aptitude, business model reconfiguration, leadership competencies and organizational engagement is necessary to transition to a digital enterprise.

Start-ups must stay up with the newest trends and technology in today's quickly changing digital landscape to compete in their respective industries. Start-ups can use the potential of digital technologies to improve their operations, enhance consumer experiences and develop new business models using a "digital transformation" (Font-Cot, Lara-Navarra, & Serradell-Lopez, 2023). The phrase "digital transformation" describes incorporating digital technologies into all facets of an organization, including its operations, strategies, and goods and services. By automating manual processes and utilizing data analytics, digital transformation can assist start-ups in streamlining their operations, lowering costs and increasing efficiency. Adopting cutting-edge technologies like artificial intelligence (AI), blockchain and the Internet of Things (IoT) can also assist them in developing new revenue streams and business models. Start-ups can better react to shifting market conditions and customer needs and achieve a competitive edge in their industries by adopting digital transformation (Gupta & Bose, 2022). However, adopting new technology is only one aspect of digital transformation; a culture shift towards an inventive and flexible attitude is also necessary. Startups must be willing to try new things, iterate and accept failure as an essential step in learning. They must establish a culture of ongoing learning and development where staff members are encouraged to take calculated chances and think outside the box.

There has never been a better opportunity for start-ups and established companies to collaborate and create win–win collaborations (Lisa, Ibrahim, & Borges, 2020). Traditional businesses have now perceived these initiatives as threats to their market share or needing more ability to transform an entrepreneurial idea into a viable industry in a larger business strategy context. While this continues, entrepreneurs view established companies as challenging to disrupt and frequently doubt how committed established companies can help the start-ups expand their businesses. Such a chasm needs to be filled. To make this possible, numerous cooperative arrangements have been created to enable established companies to go digital. Therefore, digital transformation is the foundation for this study as the best defense against digital disruption risks.

Research on the intersection of start-ups and digital transformation is still in its infancy but is gathering speed. It has entered a period of ferment that may lead to discoveries and deeper understandings. From a purely descriptive standpoint, the topic has only recently entered an exponential development phase. An outline of digital transformation in start-ups is the goal of this study.

1.1 Digital transformation

Academics have long recognized technology as a significant influence on organizational form and structure (Thompson & Bates, 1957). Digital technologies are a considerable asset for organizational transformation due to their disruptive nature and systematic and cross-organizational repercussions (Besson & Rowe, 2012). One type of company transformation that is fueled by developing technologies is digital transformation (Tang, 2021). Effective digital transformation requires changes at many organizational levels, including the core businesses being adjusted, resources and capabilities being exchanged, processes and structures being reconfigured, leadership changes being made and adopting a vibrant digital culture. According to Westerman *et al.* (2014a, b) digital transformation uses technologies to modify companies' productivity or impact fundamentally. Digital transformation was defined by Li, Su, Zhang, & Mao (2018) from the perspective of how information technology affected the organization and how it aligned with businesses with small and medium enterprises (SMEs). These many definitions show that digital transformation is a process rather than a single action to upgrade an organization's function. It causes fundamental changes in organizations and results in the creation of new prospects for progress. Additionally, digital transformation is a phenomenon that affects business and society rather than being a process focused on an organization (Vial, 2021). Understanding the differences between digital transformation, digitization and digitalization is crucial. Digitization is converting analog information into digital form using automated processes and operations. Digital transformation is a more thorough adoption of new business models and digital platforms than digitalization, which includes digital elements in product or service offerings (Verhoef *et al.*, 2021).

The application of technology largely depends on the organization and sector. Businesses have the potential to fully digitize, alter and expand their companies due to these technological advancements. But firms with a robust digital presence typically combine these advanced technologies. Organizations may enhance customer offerings, boost client satisfaction and save sales costs as digital transformation grows (Mithas, Krishnan, & Fornell, 2005). Digital technology has a positive impact on business success, according to earlier studies. Businesses that use numerous digital business procedures will operate more efficiently (Ghi, Thu, Huan, & Trung, 2022). Companies are using digital technologies to increase productivity by synchronizing "data," "information" and "ideas."

1.2 Start-ups

In today's innovative scene, start-ups are viewed as essential players. A "transitory company designed to search for a reproducible and sustainable business model" is how a start-up is defined. Steve Blank is a Silicon Valley businessman who founded the lean start-up movement and the customer development methodology (Lisa *et al.*, 2020). A start-up is structured to find a working business model, but an enterprise is structured to execute and optimize one. A business model outlines how a company develops, distributes and retains value. Four requirements must be met for a new business to qualify as a start-up: it must be impermanent, seek a business model, be industrialized and repeatable, and be scalable (Paoloni & Modaffari, 2021). A start-up's capacity for growth is another distinguishing feature. The objective is to create a business model supporting massive customer growth and profit margins. The price increases with each successive customer. Start-ups may expand faster and farther quickly than a more traditional business because of their scalability and the model's reproducibility (Jadhav *et al.*, 2022). Since start-ups are pioneering businesses and are associated with the idea of exploration, we must also discuss an environment of great uncertainty while discussing them. Without understanding its clients, the position of the product, or other relevant information, the start-up is launching an activity in a new market.

Since start-ups are pioneering businesses and are associated with the idea of exploration, we must also discuss an environment of great uncertainty while discussing them (Lisa *et al.*, 2020). In the early stages of business, start-ups sometimes have limited ability and a lack of resources. Chen, Lin, Chen, Chao, and Pandia (2021) have demonstrated that organizations must have IT capabilities and contributes to business outcomes to undergo a digital transformation. Additionally, organizations will become more efficient when integrating digital technologies into their operational procedures (Brynjolfsson & Hitt, 2000). As a result, it is anticipated that digital transformation will serve as a bridge between human capital and company performance.

Therefore, digital transformation is no longer an option but a requirement for start-ups to be competitive and relevant in the digital age. Start-ups have expanded their reach beyond geographical limits, improved customer experience and optimized procedures, thanks to the adoption of digital technologies. This literature review paper focuses on the overview of the digital transformation of start-ups, its trends and future research scope. The main success determinants for start-ups in their journey toward digital transformation will be identified through a rigorous study of the available literature in this paper. This literature review article aims to offer insightful information about start-ups' journeys toward digital transformation. Entrepreneurs, investors and politicians who want to comprehend how digital change affects the start-up environment will find this study's conclusions helpful.

2. Methodology

A few years ago, bibliometric analysis and data collection were manually carried out (Garfield, 1972). Nevertheless, as information and communication technologies (ICT) have advanced, these procedures have become more accessible (Merigó, Gil-Lafuente, & Yager, 2015). These technologies have also contributed to developing methods for analyzing scientific databases (Pritchard, 1969; Yoon & Lee, 2012; Bonilla, Merigó, & Torres-Abad, 2015).

Bibliometrics aid in exploring, arranging and analysis of massive amounts of data (Daim, Rueda, Martin, & Gerdsri, 2006). Albort-Morant, Henseler, Leal-Millán, and Cepeda-Carrión (2017) assert that the bibliometric studies will establish prospective research avenues through its signals while also enabling the knowledge of the past and understanding the advancement of the research. The characteristics above have encouraged the application of bibliometrics across various disciplines (Podsakoff, MacKenzie, Podsakoff, & Bachrach, 2008; Rey-Martí, Ribeiro-Soriano, & Palacios-Marqués, 2016; Baier-Fuentes *et al.*, 2019; Albort-Morant and Ribeiro-Soriano, 2016; Gaviria-Marin, Merigo, & Popa, 2018). Additionally, this technique has been used in other study fields, such as education and medicine (Diem & Wolter, 2013; Franks, Simoes, Singh, & Gray, 2006). Moreover, several journals have subsequently used this methodology to summarize their publications.

In this study, we used bibliometric analysis to get an overview of digital transformation in start-ups. Criteria for measuring both scientific productivity and a field's effect are included in the performance evaluation (Garfield, 1972). Additionally, a scientific mapping study of the digital transformation in start-up bibliographic information is presented in this paper. Numerous sorts of software are used to undertake this kind of study (Van Eck & Waltman, 2010, 2014; Cobo, Lopez-Herrera, Herrera-Viedma, & Herrera, 2012; Persson, Danell, & Schneider, 2009; Chen, 2006). In this study, Biblioshiny in R is used as an analysis tool. Massimo Aria developed the Java software Biblioshiny for bibliometrics from the University of Naples Federico. Biblioshiny uses the Shiny package environment in R programming to combine the bibliometrics package's functionality with the web app's usability (Srisusilawati, Rusydiana, Sanrego, & Tubastuvi, 2021). Use the Bibliometrix software to connect bibliographic data, perform "bibliometric analysis" and produce a data matrix

for "co-citation", "coupling", "scientific collaboration analysis" and "co-word analysis". Additionally, in disciplines like "network analysis", "factorial analysis" and "thematic mapping", new information frequently emerges at the intersections of structural and temporal evolution (Sreenivasan & Suresh, 2022).

Numerous databases, which can gather vast amounts of data and provide statistics using bibliometric indicators, can be used to obtain bibliographic data (Archambault, Campbell, Gingras, & Larivière, 2009). Due to its architecture for citation analysis and bibliographic queries, Dimension has recently emerged as a viable alternative to WoS. As a result, it can now carry out the same search operations as WoS (Vieira & Gomes, 2009; Meho & Yang, 2007; Gaviria-Marin *et al.*, 2018). Additionally, several researchers have marked that this database's strength stems from its broad inclusion of social science studies (Mongeon & Paul-Hus, 2016). Finding digital transformation in start-up records was carried out utilizing Dimension databases.

2.1 SPAR-4-SLR

This study also employs a comprehensive literature review to investigate the body of knowledge on digital transformation in start-ups and the crucial success variables. The "Scientific Procedures and Rationales for Systematic Literature Reviews" (SPAR-4-SLR) procedure was utilized to create a rigorous and open systematic review (Paul, Lim, O'Cass, Hao, & Bresciani, 2021). The SPAR-4-SLR process is shown in Figure 1. It consists of three stages and six sub-stages.

2.1.1 Assembling. Identifying and purchasing past literature is part of the first stage, assembling (Paul *et al.*, 2021). The domain, research questions, source type and source quality are identified in the identification sub-stage. Figure 1 gives a detailed presentation of the domain and the research topics that served as the direction for this review. Research publications that have undergone peer review made up the study's content. In the second sub-stage, acquisition, the research articles published between 2016 and 2022 were gathered using the search words (("Digital transformation") AND ("Startups") OR ("Entrepreneurship") OR ("Entrepreneur")) for the title, abstract and keywords.

2.1.2 Arranging. The arranging phase of the SPAR-4-SLR process entails the material's purification and the structuring of the literature using organizing codes.

2.1.3 Assessing. The evaluation of chosen items was the research protocol's third and last step. One way to assess the scientific contributions was through a bibliographic study to see if they were relevant to a particular research area. On the other hand, the review's findings were reported using an interpretive method.

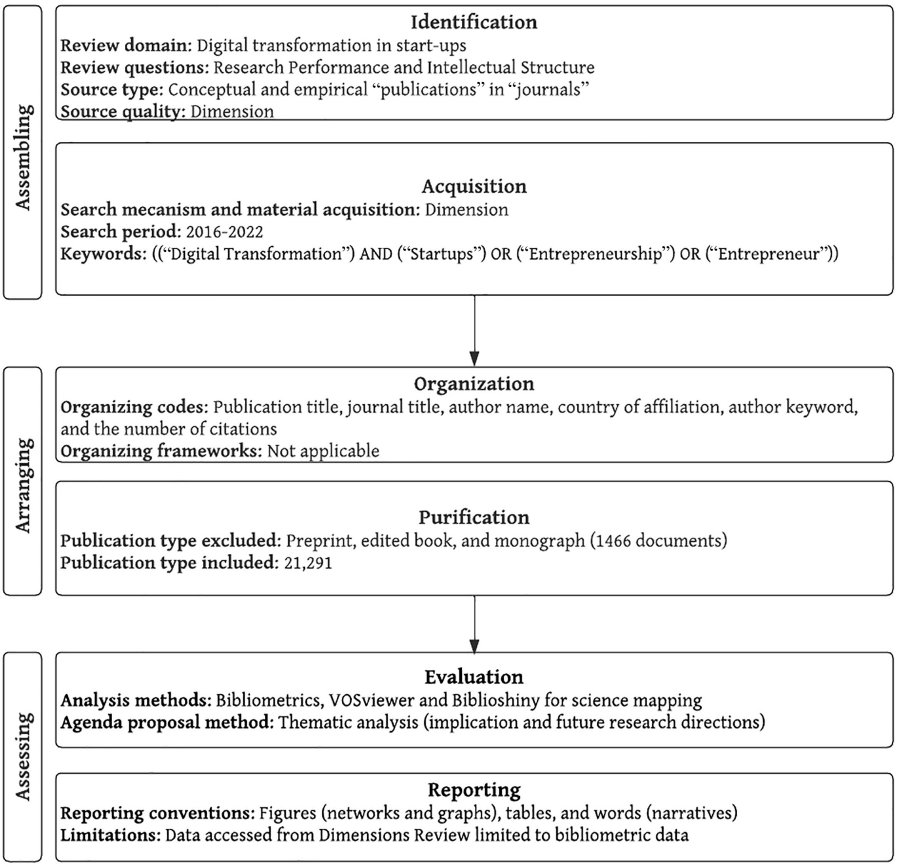
3. Results

3.1 Documents by year, authors and subject area

Over 2016–2022, studies on digital transformation in start-ups have increased steeply from 2017, along with the citations (Figure 2). The most publications are in 2022, with a TP of 7714. The number of publications has steeply increased from 60 in 2016 to 44622 in 2022. When we look at the network analysis of authors based on citations, the highest citation and Publication was of Andreja Pucihar, with TC of 1089 and TP of 159 (Figure 3); when we look at the subject area, business, management and accounting documents made up the most with 47 papers, followed by computer science with 41 documents (Figure 4).

3.2 Sources

Figure 5 shows the bibliographic coupling of the most relevant sources. *Sustainability* journal has the highest network with other citations. This journal has the highest TP and TC of 282



Source(s): Figure modified from Paul *et al*., 2021

Figure 1.
SPAR-4-SLR protocol

and 3630, respectively. This was followed by the journal *Advances in Intelligent Systems and Computing* with a TP of 167 and TC of 1052.

3.3 Conceptual structure

Figure 6 shows the co-occurrence network, which is divided into 4 clusters. The cluster detail is shown in Table 1. The first cluster, i.e. the red cluster, talks more about digital transformation, digital technologies, digital economy, design thinking, etc. The term "digital transformation" refers to the fundamental adjustments made to organizational operations, procedures and capacities due to the development of digital technologies. Sensing, grasping and repurposing the technological problems of the digital age into opportunities are necessary for digital transformation. Academic literature also recognizes design thinking crucial function as an innovation driver. Recent studies have also shown the importance of design in guiding digital transitions. Design thinking is a method based on dynamic capacities in this understanding. What needs to be added to the present version is how design thinking's dynamic capacities may promote digital transformation (Magistretti, Pham, & Dell'Era, 2021). The second cluster, i.e. the blue cluster, revolves more around innovation,

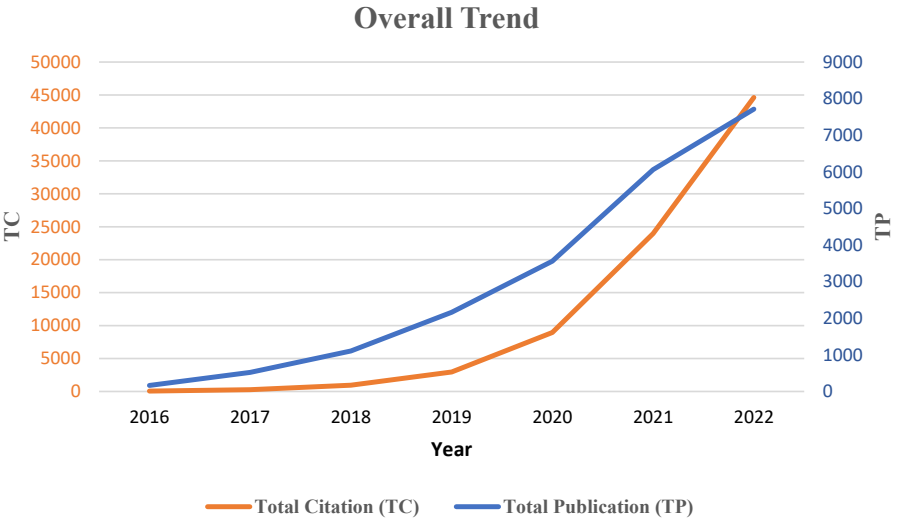


Figure 2.
Documents by year

Source(s): Figure by authors

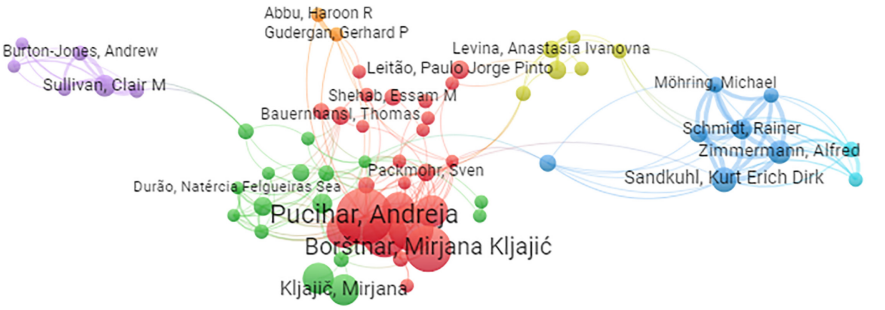
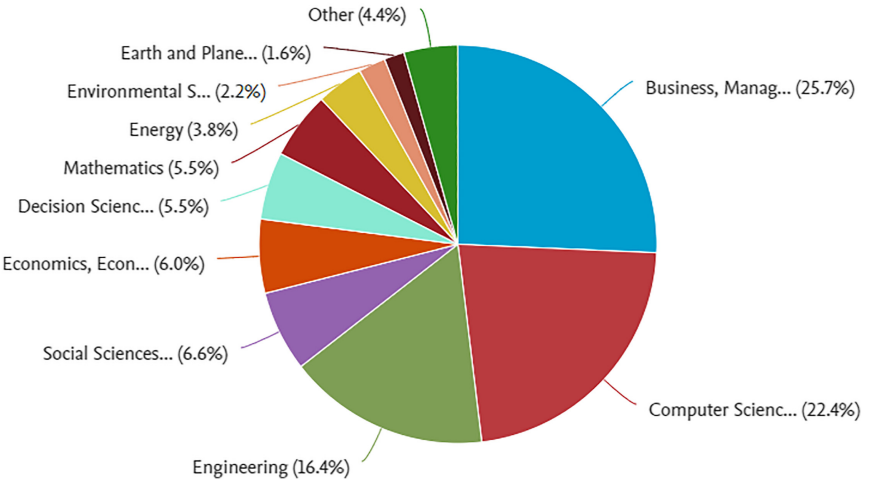


Figure 3.
A network analysis of the authors

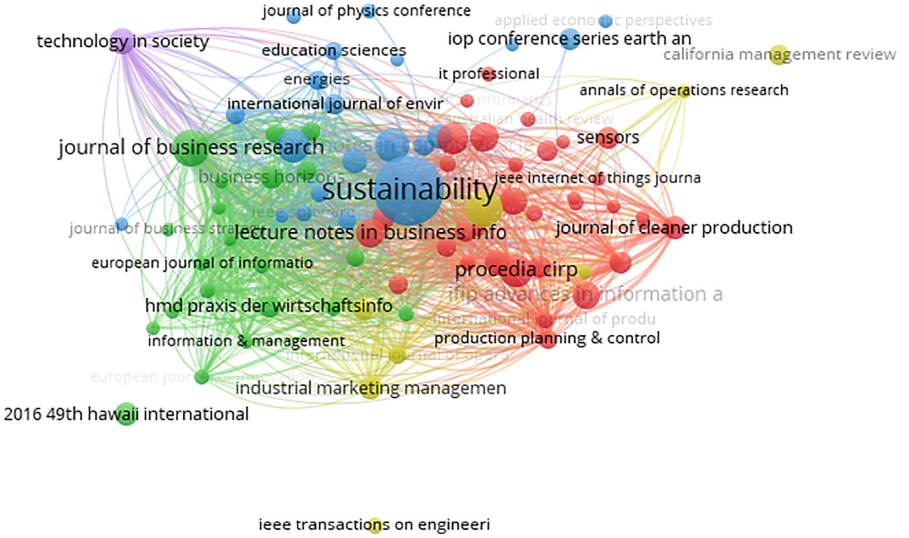
Source(s): Figure by authors

start-ups, Industry 4.0, AI, etc. A rapidly developing technical area with enormous transformational potential is AI. The activities can be rearranged, and the technology can be used for purposes other than those it originally intended for because of its digital nature. This makes it different from other technologies' physical constraints and allows for new coding and interpretations of the roles that digital technologies ought to play. It follows that new applications for the technology may arise even after being used to carry out a given task in a particular application setting (Brem, Giones, & Werle, 2021). The third cluster is the green cluster which revolves around digitalization and lean start-up. Digitalization has been a critical enabler of the "Lean Start-up" environment for entrepreneurial innovation, the activity's driving reason. Due to these expansions, business opportunity recognition and search are today very different processes than they were a decade ago. Furthermore, this problem is expected in the IT or Internet sectors (Prabhu, 2020). Figure 7 shows the thematic map. In this study, the density and centrality of thematic maps were separated into four



Source(s): Figure by authors

Figure 4.
Documents by subject area



Source(s): Figure by authors

Figure 5.
Most relevant sources

theme quadrants, as indicated in the figure. The level of interaction between a network and other networks is measured by centrality. Density, on the other hand, gauges the network's intrinsic strength. Given both measurements, a research area can represent a collection of research themes in a two-dimensional strategic diagram. Topics in the upper-right quadrant are significant for organizing and developing the research field. Themes in the upper-left quadrant have strong internal connections but weak outward connections, making them of

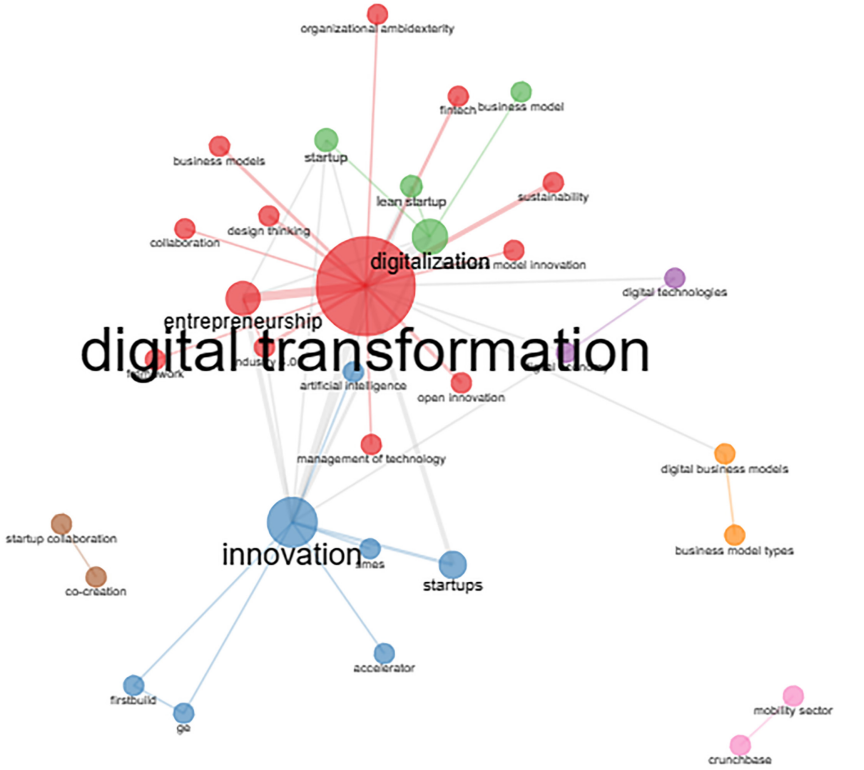


Figure 6.
Co-occurrence network

Source(s): Figure by authors

only minor significance for the field. The lower-left quadrant's themes are minimal and poorly developed. The themes in this quadrant primarily represent either emerging or dissipating concepts and have low density and centrality. Although poorly designed, the themes in the lower-right quadrant are crucial for a research field. Themes that are universal and fundamental are found in this quadrant. With the addition of pertinent keywords other than the author's keywords, a semi-automatic system that reviewed the titles of all references to the study object produced these findings so that the outcomes could capture that more profound variance. As a driving topic with high density and centrality in the upper right quadrant, it has to be developed and is crucial to be researched further. A distinct and uncommon theme is present in the upper left quadrant, which also has a high degree of development, as seen by its high density but low centrality. Additionally, themes that have been employed for a long time but have seen a decreasing trend and pronounced low centrality might be seen in the lower left quadrant. Finally, the lower right quadrant has a fundamental theme with high centrality but low density. Figure 8 shows the conceptual structure map. The red and blue sections contain related terms, the two halves of the area divided into this data. The red area in the figure has more and different words, meaning that more research publications have made connections between the terms mentioned, the most popular topics and their relationships to other topics.

Nodes	Clusters
Digital transformation	1
Digital economy	
Digital technologies	
Open innovation	
Fintech	
Sustainability	
Business models	
Collaboration	
Design thinking	
Business model innovation	
Framework	
Management of technology	
Organizational ambidexterity	
Innovation	2
Entrepreneurship	
Startups	
Industry 4.0	
Artificial Intelligence	
Accelerator	
First build	
SMEs	
Digitalization	3
Lean start-up	
Business model	
Digital business model	4
Business model types	
Co-creation	5
Startup collaboration	
Crunchbase	6
Mobility sector	

Source(s): *Table by authors

Table 1. Co-occurrence network tabular form

4. Discussion and future research topics

This study evaluated the overview of digital transformation in start-ups between 2016 and 2022 using the articles from the Dimension database. It is evident from the statistics above that there is a rising trend in the study of digital transformation, and only a few studies are being explored in start-ups' digital transformation. The use of digital technology in the agro-industrial complex has recently taken the world by storm. Digital transformation in agriculture encompasses "cutting-edge information technology," "robots," and "artificial intelligence" (Kulik, Androsova, Solovjeva, & Zuppelo, 2021, July). The various digital transformation agents are "social networks," "cloud computing," "artificial intelligence," "big data," and so on. Digital tools are being used by businesses to streamline operations, improve customer service, and develop fresh, cutting-edge business models. They are "agile methodology," "application programming interface," "DevOps," "information management," etc. (Lima, Rainatto, & de Almeida Andrade, 2019). The conventional entrepreneurial ecosystem is severely disturbed by digital transformation as conventional interdependencies shift in both scope and character (Subramaniam, Iyer, & Venkatraman, 2019). The entrepreneurial ecosystem became the "digital entrepreneurial ecosystem" due to the digital upheaval.

The focus on digital transformation addresses the need for more research based on various theoretical perspectives. The prominence percentile can be used to guide future study

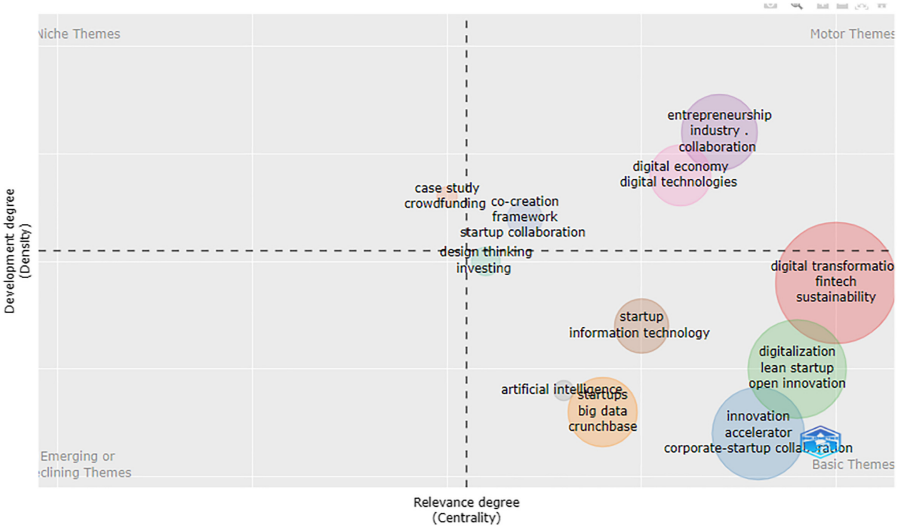


Figure 7.
Thematic map

Source(s): Figure by authors

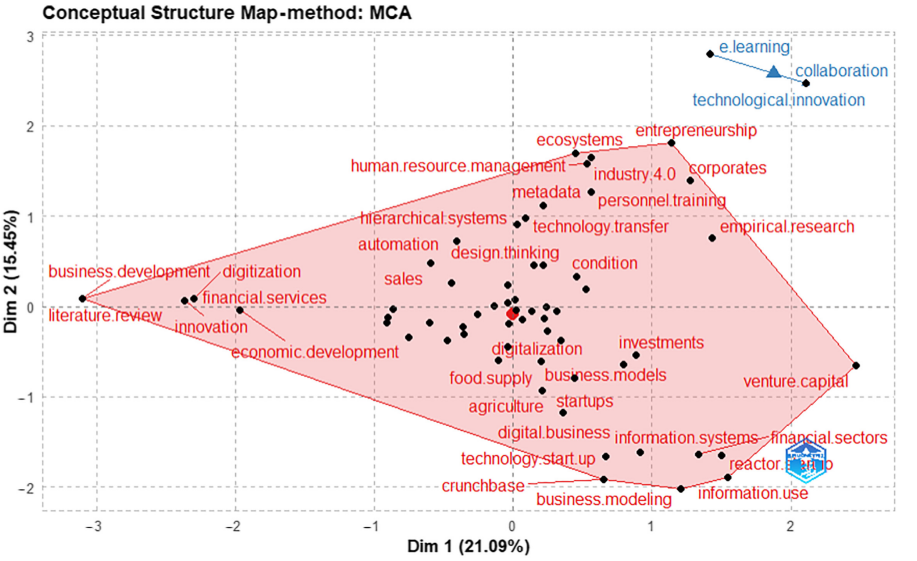


Figure 8.
Conceptual
structure map

Source(s): Figure by authors

subjects. The top three topic prominence percentiles from Scival are displayed in Table 2. As prominence reflects a topic's current exposure and momentum, it is primarily based on the citations and views of its most recent publications. "New Topics" refers to research areas that have noticeably accelerated growth in recently published journals and are probably the

recipients of current funding. These new Topics are taken from parent Topics currently existing and are created based on direct citation linkages developed over the past year.

4.1 Product innovation; sustainability; frugality

Frugal innovation (FI) is an example of a new type of entrepreneurial environment in which tiny businesses with little resources create inventions for underserved consumers in developing nations using various technologies. FIs promote sustainability and open up new markets (Hossain, 2020). The majority of Indian businesses operate at the cutting edge of technology and prioritize cost reduction, sometimes through jugaad or FI, to accommodate Indian consumers' limited means of affordability. Most innovations occur in processes and organizations than in products or supply chain management. The primary contributors to Indian patents, foreign multinational corporations, do not seem deterred by the weak enforcement of the current IP protection law. The growth of start-ups, which show potential as a source of novel products and business models, is a recent notable development (Krishnan & Prashantham, 2019).

4.2 Digital transformation; strategic alignment

Existing literature has improved our comprehension of some facets of the digital revolution, but we still need a complete picture of its nature and ramifications (Vial, 2021). Organizations increasingly use information technology (IT) to assist them in responding to unexpected environmental hazards and opportunities. Owing to the rapidly growing popularity of business analytics (BA), it is now a crucial research area to examine the factors that precede or influence the adoption of BA and the subsequent effects on firm performance (Aydiner, Tatoglu, Bayraktar, Zaim, & Delen, 2019). Recent changes in new digital technologies have significantly impacted people, organizations and society. The enormous amount of digital data available to businesses can be a new way to create value. How companies might use digital technologies to improve performance, meanwhile, are only partially evident (Martínez-Caro, Cegarra-Navarro, & Alfonso-Ruiz, 2020). Corporate digitization can accelerate the growth of value-adding activities, but businesses will only fully realize this potential once they adopt a digital organizational culture. Companies should expect to perform better by identifying the corporate culture that best supports their digital strategy (Martínez-Caro *et al.*, 2020).

4.3 Cybersecurity; strategies; digital transformation

Organizations now regularly face more extensive and severe cybersecurity attacks, estimated to cost between $375 and $575 billion annually due to the speed at which new technologies are developed, the sophistication of cybercriminals and the pace at which the digital transformation of society is taking place. The IT "attack surface" is expected to keep growing as more infrastructure, systems and devices are interconnected and depend on one another, and more customer, supplier and partner interfaces are used. The methods used by different organizations to try to prevent cybersecurity breaches differ (Carcary, Doherty, & Conway, 2019). Some are highly restrictive, making even routine business tasks onerous, while others need to be more permissive with poor oversight and insufficient policies and procedures,

Topics	Prominence percentile
Product innovation; Sustainability; Frugality	97.5
Digital Transformation; Strategic Alignment	96.4
Cybersecurity; Strategies; Digital Transformation	96.2

Source(s): *Table by authors

Table 2.
Prominence topics

leading to unnecessary exposure. Digital leaders frequently have a more robust tolerance and appetite for risk-taking and experimentation to find critical prospects for the future, but implementing adequate cybersecurity measures is now an especially requirement. Organizations must reconsider their cybersecurity management strategies and acknowledge that traditional perimeter defenses and access control are insufficient. Instead, comprehensive and proactive strategies that constantly adapt and change to counter new dangers and lessen the possible harmful effects of exposure are needed. To ensure that controls stay current with and appropriate for the evolving IT threat landscape, it is essential to understand how effective the organization's cybersecurity initiatives are (Carcary *et al.*, 2019).

5. Theoretical and practical implication

This study significantly advances the topic of digital transformation in start-ups in terms of both theory and application.

The report uses bibliometric analysis to evaluate the digital transformation research in start-ups thoroughly. With this method, it is possible to pinpoint essential themes, patterns and gaps in the literature, which can shed light on the field's current state and suggest areas for future study. The study fills the hole in the literature by offering a thorough and recent analysis of digital transformation in start-ups.

The article also emphasizes the significance of digital transformation for start-ups because digital technologies are becoming an even more crucial component of contemporary companies. These insights are helpful for start-ups considering digital transformation initiatives since they offer advice on approaching and managing the process correctly.

In conclusion, the research makes a significant theoretical and practical contribution to understanding digital transformation in start-ups. The study fills a vacuum in the knowledge and directs future research by offering a thorough literature overview and highlighting important themes and trends.

5.1 Limitations and future research directions

We encountered some constraints when conducting our research, which is crucial to consider while assessing our study. Firstly, the time frame was limited. One of the most significant areas for improvement in the existing literature is that many published studies need to state the study's limitations or make recommendations for future research areas. Future research into addressing the limitation will thus enable us to learn more about digital transformation in start-ups. Studies on the importance of the digital transition, particularly in start-ups, are generally few.

6. Conclusion

Our study mainly aimed to look into start-ups' past digital transformation literature. We discovered that there needs to be more research on digitization's impacts on firms and the essential elements for success throughout the digital transformation era. We were able to develop a profound knowledge of the digital transition in start-ups by thoroughly and methodically examining the literature. The key driver of a successful and functional digital transformation is not technology. The technology works because of "people", "procedures", "culture" and "mentality"; the digital transformation is a people thing, not a process. It implies that people must be managed, guided and supported during this development. Although having the "necessary equipment", "software" or "website" is the first step, it is insufficient. A digital transition cannot be successful without trained individuals who are permitted to handle those electronic devices and investigate them in ways that increase the value they may provide.

The article demonstrates how significant a digital transformation change is for people and organizations. It seems one of the toughest challenges businesses have ever faced.

And any company must consider these, even internally, if it wants to remain competitive now and in the future. This makes innovation and the use of cutting-edge technology essential components of companies. In addition, customer expectations are at the core of any company, as they search for a business model and a way to provide a good or service that this is the first time anyone else has done. Adopting horizontal management encourages and supports organizational creativity by facilitating easy contact between individuals. Existing businesses can also undergo a digital transformation. It may be more challenging, though, and will take much time. It is essential to have a leader's backing when fostering a culture of change and innovation. Moving toward a more digital approach can occasionally be challenging if leaders and managers must be aware of the current difficulties.

Reference

Albort-Morant, G., & Ribeiro-Soriano, D. (2016). A bibliometric analysis of global impact of business incubators. *Journal of Business Research*, *69*(5), 1775–1779.

Albort-Morant, G., Henseler, J., Leal-Millán, A., & Cepeda-Carrión, G. (2017). Mapping the field: A bibliometric analysis of green innovation. *Sustainability*, *9*(6), 1011.

Archambault, É., Campbell, D., Gingras, Y., & Larivière, V. (2009). Comparing bibliometric statistics obtained from the web of science and scopus. *Journal of the American Society for Information Science and Technology*, *60*(7), 1320–1326.

Aydiner, A. S., Tatoglu, E., Bayraktar, E., Zaim, S., & Delen, D. (2019). Business analytics and firm performance: The mediating role of business process performance. *Journal of Business Research*, *96*, 228–237.

Baier-Fuentes, H., Merigó, J. M., Amorós, J. E., & Gaviria-Marín, M. (2019). International entrepreneurship: A bibliometric overview. *International Entrepreneurship and Management Journal*, *15*(2), 385–429.

Besson, P., & Rowe, F. (2012). Strategizing information systems-enabled organizational transformation: A transdisciplinary review and new directions. *The Journal of Strategic Information Systems*, *21*(2), 103–124.

Bonilla, C. A., Merigó, J. M., & Torres-Abad, C. (2015). Economics in Latin America: A bibliometric analysis. *Scientometrics*, *105*(2), 1239–1252.

Brem, A., Giones, F., & Werle, M. (2021). The ai digital revolution in innovation: A conceptual framework of artificial intelligence technologies for the management of innovation. Ieee. *Transactions on Engineering Management*, *70*(2), 770–776.

Brynjolfsson, E., & Hitt, L. M. (2000). Beyond computation: Information technology, organizational transformation and business performance. *Journal of Economic Perspectives*, *14*(4), 23–48.

Carcary, M., Doherty, E., & Conway, G. (2019). A framework for managing cybersecurity effectiveness in the digital context. In *European Conference on Cyber Warfare and Security* (pp. 78–86). Academic Conferences International.

Chen, C. (2006). CiteSpace II: Detecting and visualizing emerging trends and transient patterns in scientific literature. *Journal of the American Society for Information Science and Technology*, *57*(3), 359–377.

Chen, C. L., Lin, Y. C., Chen, W. H., Chao, C. F., & Pandia, H. (2021). Role of government to enhance digital transformation in small service business. *Sustainability*, *13*(3), 1028.

Cobo, M. J., López-Herrera, A. G., Herrera-Viedma, E., & Herrera, F. (2012). SciMAT: A new science mapping analysis software tool. *Journal of the American Society for Information Science and Technology*, *63*(8), 1609–1630.

Daim, T. U., Rueda, G., Martin, H., & Gerdsri, P. (2006). Forecasting emerging technologies: Use of bibliometrics and patent analysis. *Technological Forecasting and Social Change*, *73*(8), 981–1012.

Diem, A., & Wolter, S. C. (2013). The use of bibliometrics to measure research performance in education sciences. *Research in Higher Education*, *54*(1), 86–114.

El Hilali, W., & El Manouar, A. (2019). Towards a sustainable world through a SMART digital transformation. In *InProceedings of the 2nd International Conference on Networking* (1–8). Information Systems & Security.

Font-Cot, F., Lara-Navarra, P., & Serradell-Lopez, E. (2023). Digital transformation policies to develop an effective startup ecosystem: The case of barcelona. *Transforming Government: People, Process and Policy*, ahead-of-print, doi: 10.1108/TG-01-2023-0006.

Franks, A. L., Simoes, E. J., Singh, R., & Gray, B. S. (2006). Assessing prevention research impact: A bibliometric analysis. *American Journal of Preventive Medicine*, *30*(3), 211–216.

Garfield, E. (1972). Citation analysis as a tool in journal evaluation: Journals can be ranked by frequency and impact of citations for science policy studies. *Science*, *178*(4060), 471–479.

Gaviria-Marin, M., Merigo, J. M., & Popa, S. (2018). Twenty years of the journal of knowledge management: A bibliometric analysis. *Journal of Knowledge Management*, *22*(8), 1655–1687.

Ghi, T. N., Thu, N. Q., Huan, N. Q., & Trung, N. T. (2022). Human capital, digital transformation, and firm performance of startups in Vietnam. *Management*, *26*(1), 1–18.

Gupta, G., & Bose, I. (2022). Digital transformation in entrepreneurial firms through information exchange with operating environment. *Information & Management*, *59*(3), 103243.

Hossain, M. (2020). Frugal innovation: Conception, development, diffusion, and outcome. *Journal of Cleaner Production*, *262*, 121456.

Jadhav, D. A., Park, S. G., Pandit, S., Yang, E., Abdelkareem, M. A., Jang, J. K., & Chae, K. J. (2022). Scalability of microbial electrochemical technologies: Applications and challenges. *Bioresource Technology*, *345*, 126498.

Karagiannaki, A., Vergados, G., & Fouskas, K. (2017). The impact of digital transformation in the financial services industry: Insights from an open innovation initiative in fintech in Greece. In *InMediterranean Conference on Information Systems (MCIS)*. Association for Information Systems.

Krishnan, R. T., & Prashantham, S. (2019). Innovation in and from India: The who, where, what, and when. *Global Strategy Journal*, *9*(3), 357–377.

Kulik, A., Androsova, A., Solovjeva, N., & Zuppelo, A. (2021). Digital transformation: Problems and trends in the development of agricultural startups. *In3rd International Conference Spatial Development of Territories (SDT 2020)* (244-248). Atlantis Press.

Li, L., Su, F., Zhang, W., & Mao, J. Y. (2018). Digital transformation by SME entrepreneurs: A capability perspective. *Information Systems Journal*, *28*(6), 1129–1157.

Lima, F., Rainatto, G. C., & de Almeida Andrade, N. (2019). Exponential organizations and digital transformation: Two sides of the same coin. *International Journal for Innovation Education and Research*, *7*(10), 385–404.

Lisa, S., Ibrahim, D. Y., & Borges, G. L. (2020). The success of startups through digital transformation. *International Journal of Open Information Technologies*, *8*(5), 53–56.

Magistretti, S., Pham, C. T. A., & Dell'Era, C. (2021). Enlightening the dynamic capabilities of design thinking in fostering digital transformation. *Industrial Marketing Management*, *97*, 59–70.

Martínez-Caro, E., Cegarra-Navarro, J. G., & Alfonso-Ruiz, F. J. (2020). Digital technologies and firm performance: The role of digital organisational culture. *Technological Forecasting and Social Change*, *154*, 119962.

Meho, L. I., & Yang, K. (2007). Impact of data sources on citation counts and rankings of LIS faculty: Web of Science versus Scopus and Google Scholar. *Journal of the American Society for Information Science and Technology*, *58*(13), 2105–2125.

Merigó, J. M., Gil-Lafuente, A. M., & Yager, R. R. (2015). An overview of fuzzy research with bibliometric indicators. *Applied Soft Computing*, *27*, 420–433.

Mithas, S., Krishnan, M. S., & Fornell, C. (2005). Why do customer relationship management applications affect customer satisfaction? *Journal of Marketing*, *69*(4), 201–209.

Mongeon, P., & Paul-Hus, A. (2016). The journal coverage of web of science and scopus: A comparative analysis. *Scientometrics*, *106*(1), 213–228.

Paoloni, P., & Modaffari, G. (2021). Business incubators vs start-ups: A sustainable way of sharing knowledge. *Journal of Knowledge Management*, *26*(5), 1235–1261.

Paul, J., Lim, W. M., O'Cass, A., Hao, A. W., & Bresciani, S. (2021). Scientific procedures and rationales for systematic literature reviews (SPAR-4-SLR). *International Journal of Consumer Studies*, *45*(4), O1–O16.

Persson, O., Danell, R., & Schneider, J. W. (2009). How to use Bibexcel for various types of bibliometric analysis. *Celebrating Scholarly Communication Studies: A Festschrift for Olle Persson at His 60th Birthday*, *5*, 9–24.

Podsakoff, P. M., MacKenzie, S. B., Podsakoff, N. P., & Bachrach, D. G. (2008). Scholarly influence in the field of management: A bibliometric analysis of the determinants of university and author impact in the management literature in the past quarter century. *Journal of Management*, *34*(4), 641–720.

Prabhu, J. J. (2020). Digitalization and ecosystem changes global entrepreneurship: A systematic review. *International Journal Of All Research Writings*, *1*(11), 1–7.

Pritchard, A. (1969). Statistical bibliography or bibliometrics. *Journal of Documentation*, *25*(4), 348–349.

Rey-Martí, A., Ribeiro-Soriano, D., & Palacios-Marqués, D. (2016). A bibliometric analysis of social entrepreneurship. *Journal of Business Research*, *69*(5), 1651–1655.

Sreenivasan, A., & Suresh, M. (2022). Future of healthcare start-ups in the era of digitalization: Bibliometric analysis. *International Journal of Industrial Engineering and Operations Management*, *4*(1/2), pp. 1-18.

Srisusilawati, P., Rusydiana, A. S., Sanrego, Y. D., & Tubastuvi, N. (2021). Biblioshiny R application on islamic microfinance research. *Library Philosophy and Practice*, *2021*(5096), 1–24.

Subramaniam, M., Iyer, B., & Venkatraman, V. (2019). Competing in digital ecosystems. *Business Horizons*, *62*(1), 83–94.

Tang, D. (2021). What is digital transformation?. *EDPACS*, *64*(1), 9–13.

Thompson, J. D., & Bates, F. L. (1957). Technology, organization, and administration. *Administrative Science Quarterly*, *2*(3), 325–343.

Tischlinger, D., & Van Wordragen, B. (2019). What are the critical success factors of start-ups in the digital transformation? *A Multiple Case-Study*, 92.

Van Eck, N., & Waltman, L. (2010). Software survey: VOSviewer, a computer program for bibliometric mapping. *Scientometrics*, *84*(2), 523–538.

Van Eck, N. J., & Waltman, L. (2014). CitNetExplorer: A new software tool for analyzing and visualizing citation networks. *Journal of Informetrics*, *8*(4), 802–823.

Verhoef, P. C., Broekhuizen, T., Bart, Y., Bhattacharya, A., Dong, J. Q., Fabian, N., & Haenlein, M. (2021). Digital transformation: A multidisciplinary reflection and research agenda. *Journal of Business Research*, *122*, 889–901.

Vial, G. (2021). Understanding digital transformation: A review and a research agenda. *Managing Digital Transformation*, *6*(1), 13–66.

Vieira, E., & Gomes, J. (2009). A comparison of Scopus and Web of Science for a typical university. *Scientometrics*, *81*(2), 587–600.

Westerman, G., Bonnet, D., & McAfee, A. (2014a). The nine elements of digital transformation. *MIT Sloan Management Review*, *55*(3), 1–6.

Westerman, G., Bonnet, D., & McAfee, A. (2014b). *Leading digital: Turning technology into business transformation*. USA: Harvard Business Press.

Yoon, B., & Lee, S. (2012). Managing technological knowledge for supporting R&D activities: Scientometrics-based approach. *Knowledge Management Research & Practice*, *10*(3), 237–251.

Further reading

Del Rowe, S. (2017). Digital transformation needs to happen: The clock is ticking for companies that have been unwilling to embrace change. *Crm Magazine*, *21*(10), 30–33.

Ebert, C., & Duarte, C. H. C. (2018). Digital transformation. *IEEE Software*, *35*(4), 16–21.

Florek-Paszkowska, A., Ujwary-Gil, A., & Godlewska-Dzioboń, B. (2021). Business innovation and critical success factors in the era of digital transformation and turbulent times. *Central and Eastern European Online Library*, *17*(4), 7–28.

Gray, J., & Rumpe, B. (2017). Models for the digital transformation. *Software & Systems Modeling*, *16*(2), 307–308.

Hirsch, J. E. (2010). An index to quantify an individual's scientific research output that takes into account the effect of multiple coauthorship. *Scientometrics*, *85*(3), 741–754.

Horlacher, A., & Hess, T. (2016). What does a chief digital officer do? Managerial tasks and roles of a new C-level position in the context of digital transformation. *In 2016 49th Hawaii International Conference on System Sciences (HICSS)* (5126–5135). IEEE.

Kempegowda, S. M., & Chaczko, Z. (2018). Industry 4.0 complemented with ea approach: A proposal for digital transformation success. *In 2018 26th International Conference on Systems Engineering (ICSEng)* (1–6). IEEE.

Thelwall, M. (2008). Bibliometrics to webometrics. *Journal of Information Science*, *34*(4), 605–621.

Vanclay, J. K. (2007). On the robustness of the h-index. *Journal of the American Society for Information Science and Technology*, *58*(10), 1547–1550.

Ziyadin, S., Suieubayeva, S., & Utegenova, A. (2019). Digital transformation in business. *InInternational Scientific Conference "Digital Transformation of the Economy: Challenges, Trends, New Opportunities"* (408-415). Springer, Cham.

About the authors

Aswathy Sreenivasan is a research scholar at Amrita School of Business, Amrita Vishwa Vidyapeetham, Coimbatore, India. She holds a Master's degree in Business Administration from Amrita Vishwa Vidyapeetham, India. Her field of study is Agility in Startups Operations, Lean in Startups Operations. Her research interests include sustainability, service operations. She is currently working on Lean and agility in Startups.

M. Suresh is an Associate Professor at Amrita School of Business, Amrita Vishwa Vidyapeetham, Coimbatore, India. He holds a PhD in Project Management from Indian Institute of Technology, Bombay, India and Master's in Industrial Engineering from PSG College of Technology, Coimbatore, India. His research interests include issues related to lean and agile operations and performance management. He has authored several papers in Operations Management. He is also a member of International Society on Multiple Criteria Decision Making. M. Suresh is the corresponding author and can be contacted at: m_suresh@cb.amrita.edu