

# ARTICLES

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## FEATURED TOPICS IN RESEARCH ON DIGITAL TRANSFORMATION: EVIDENCE FROM A BIBLIOMETRIC STUDY AND CONTENT ANALYSIS

*Temas de destaque na pesquisa em transformação digital: Evidências de estudo bibliométrico e análise de conteúdo*

*Temas destacados en la investigación sobre transformación digital: Evidencia del estudio bibliométrico y análisis de contenido*

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### ABSTRACT

Digital transformation (DT) arises in debates about trends in various industries, mainly in value creation through the innovation of products and services and how they are negotiated. DT poses new challenges to organizations, which this research aims to identify by answering: What is the structure of the literature on DT, and what themes have gained prominence in the last five years? This research conducted a systematic literature review with bibliometric analysis and content analysis. The bibliometric analysis highlighted the following discussions: strategic renewal amid DT; implementation of technologies in Industry 4.0; digitization to enable servitization; DT as an engine of innovation in business models; digital innovation management; and DT to change the consumer experience. The analyses point out avenues for further research and raise important questions for decision-makers in companies that want to reap the benefits of DT.

**Keywords:** digital transformation, digital platforms, digital innovation, digitization, systematic review.

### RESUMO

A transformação digital (TD) desponta na discussão sobre tendências em diversas indústrias, principalmente na criação de valor por meio da inovação de produtos, serviços e na forma de negócios. A TD apresenta novos desafios às organizações e, para identificar os principais, esta pesquisa visa responder: Qual é a estrutura da literatura sobre TD e quais temas ganharam destaque nos últimos cinco anos? A pesquisa foi conduzida por meio de revisão sistemática da literatura com: estudo bibliométrico e análise de conteúdo. O estudo bibliométrico destacou as seguintes discussões: renovação estratégica em meio à TD; implementação de tecnologias na Indústria 4.0; digitalização para habilitar ofertas de servitização; TD como impulsionador de inovação nos modelos de negócios; gestão da inovação digital; e TD alterando a experiência dos consumidores. As análises podem ser úteis para apontar caminhos para novas pesquisas e para ressaltar questões importantes para tomadores de decisões em empresas que desejam usufruir dos benefícios da TD.

**Palavras-chave:** transformação digital, plataformas digitais, inovação digital, digitalização, revisão sistemática.

### RESUMEN

La transformación digital (TD) surge en debates sobre tendencias en diversas industrias, principalmente en la creación de valor a través de la innovación de productos, servicios y en la forma de negociarlos. La TD plantea nuevos desafíos a las organizaciones y, para identificar los principales, esta investigación se propone responder: ¿Cuál es la estructura de la literatura sobre TD y qué temas han ganado protagonismo en los últimos cinco años? Esta investigación se valió de una revisión sistemática de la literatura con estudio bibliométrico y análisis de contenido. El estudio bibliométrico destacó las siguientes discusiones: renovación estratégica en medio de la TD; implementación de tecnologías en la Industria 4.0; digitalización para habilitar la servitización; TD como motor de innovación en modelos de negocio; gestión de innovación digital; y TD para cambiar la experiencia del consumidor. Los análisis pueden servir para señalar caminos de nuevas investigaciones, y para poner de relieve cuestiones importantes para tomadores de decisiones de empresas que quieran aprovechar beneficios de la TD.

**Palabras clave:** transformación digital, plataformas digitales, innovación digital, digitalización, revisión sistemática.

## INTRODUCTION

Digital transformation (DT) has emerged recently as a relevant topic in discussions about new trends in various industries and business models. It gained prominence for improving the performance of existing operations and creating value through innovative products and services and innovation on how they are negotiated. Various industries and companies of all sizes claim to be in a DT process (Peter, Kraft, & Lindeque, 2020). Also, start-ups or established companies from traditional industries are rethinking how to compete in the digital economy (Sebastian et al., 2017), reshaping their capabilities and priorities to innovate (Svahn, Mathiassen, & Lindgren, 2017), and making progress in building their digital structures and strategies (Hess, Matt, Benlian, & Wiesböck, 2016; Kane, Palmer, Phillips, Kiron, & Buckley, 2017).

The growing interest in DT does not outshine the strategic role of information technology (IT) for organizational transformation, which is a subject that has been debated for decades (Henderson & Venkatraman, 1990). However, DT is currently present in research and the business vocabulary, and it is important to stress the similarities and differences between research in DT and research in IT (Brocke, Schmid, Simons, & Safrudin, 2020; Wessel, Baiyere, Ologeanu-Taddei, Cha, & Blegind-Jensen, 2021) clearly identifying what is new and worth exploring in future research. While recent studies have advanced in this differentiation (Wessel et al., 2021), it is crucial to explore – as proposed in this article – the debate on the DT nomenclature, understanding the structure of the area, and topics that have been receiving attention.

Lanzolla et al. (2020) reinforce that the novelty of DT is the recent explosion of digital technologies in all types of organizations, taking the digitalization – comprehensively used to reinvent products, processes, value chains, and enter new markets – to the forefront of questions regarding strategy, organization, and management. Despite the criticisms pointing out DT as a buzzword, Klein (2020) mentions that the past two or three years have witnessed an unprecedented digitalization experience, much more comprehensive, transforming business processes, business models, customer relationships, and operations, and leading to destructive changes threatening the status quo in all business structures. Recently, Wessel et al. (2021) suggested moving beyond the dominant strategic dimension of analyzing the differences between DT and IT. They highlight differences between DT and IT, demonstrating that DT activities leverage digital technology by (re)defining an organization's value proposition while IT-enabled organizational transformation activities leverage digital technology to support the value proposition. The authors also stress that DT involves a new organizational identity, whereas IT-enabled organizational transformation enhances an existing organizational identity.

DT has been a topic of scientific publications in both computer science and management and business fields, together with themes such as strategic management, organizational theory, business ethics, and entrepreneurship (Bailey, Faraj, Hinds, Krogh, & Leonardi, 2019). The DT literature presents a robust set of studies dedicated to discussing the advances of digital technologies and the benefits and challenges associated with each type of technology (Vial, 2019; Wiesböck & Hess, 2020). Such studies also present categories for DT application – operational processes,

customer engagement and experience, and business model innovation (Fitzgerald, Kruschwitz, Bonnet, & Welch, 2013; Wiesböck & Hess, 2020).

DT is shown here as relevant for theory and practice, where the latest emerging technologies “pose new and significant challenges to organizational science” (Bailey et al., 2019, p. 642) due to (i) their “intelligence” (ability to learn continuously) – which surpasses human performance in skilled roles; (ii) analysis capabilities – which have led to changes in organizations’ business processes and models; (iii) possibility of new approaches to innovation and collaboration within and between organizations; and (iv) rapid diffusion and adoption of technology (especially when considering the accelerated adoption/implementation in various sectors, based on the context experienced with the Covid-19 pandemic, which caused a great restriction to social circulation). Thus, this research aims to answer the following question: What is the literature structure on DT, and what themes have gained prominence in the last five years? The objective of the work is to raise and present recently discussed topics and suggestions for future research, identified through bibliometric analysis techniques.

The articles in our sample that presented bibliometric research (Holand, Svadberg, & Breunig, 2019; Dhamija, Bedi, & Gupta, 2020; Seyedghorban, Tahernejad, Meriton, & Graham, 2020) helped to clarify specific aspects in the DT literature approaching the Industry 4.0 and the digitization of supply chains. However, these studies paid little attention to empirical evidence obtained through bibliometric analysis (e.g., citation/co-citation and clusters) to understand the structure of recent DT research, the main themes, and opportunities for future research.

The next section presents a brief description of the characteristics of digital technologies and the main concepts linked to DT. Then, the research methodology is presented, describing the first stage of bibliometric analysis and the second stage of content analysis of the main references highlighted in the first stage. The criteria for obtaining the sample of articles are also presented. Finally, the research results are detailed and discussed, followed by the conclusion.

## DIGITAL TRANSFORMATION AND CONCEPTS

The DT discussion is centered on digital technologies, which can be applied individually or in combination with other technologies in different processes, operations, and purposes. This breadth of applicability can be explained by the digital technologies characteristics (digitization, automation, communication, and connectivity) (Nambisan, Lyytinen, Majchrzak, & Song, 2017), opening opportunities for gains for various industries and sectors.

These digital technology skills are not particularly new to organizations since several of them, such as computers, the Internet, and mobile systems, have been aggregating these skills in firms over the years (Korhonen, 2016). According to Korhonen (2016), some of these technologies were central to causing disruptions in the context and time they were introduced, raising digitization to new institutional levels. Some of them changed the way of working and organizing or allowed the exploration of new business models.

The evolution of digital technologies has expanded the boundaries of traditionally known skills, adding other characteristics and capabilities, primarily related to ‘intelligence’ and cognitive skills. New digital technologies and advanced techniques have significantly improved the analysis of unstructured data (e.g., texts in social media, video, and images) through speech recognition and natural language processing, expanding the scope of data analysis traditionally known and applied in organizations (e.g., business intelligence). Using these techniques and technologies in processes can result in operational gains through optimization, efficiency, and transparency (Manyika et al., 2011). In addition, several types of decision-making processes can be more data-driven (LaValle, Lesser, Shockley, Hopkins, & Kruschwitz, 2011), and some can increase the degree of automation of analysis and decision-making, contributing significantly to the evolution of autonomous and self-learning products and services (International Data Corporation [IDC], 2020).

Other digital technologies, such as cloud computing and IoT, are better known and widespread within organizations. They were introduced as isolated initiatives (with low combinations between them) and provided, in general, incremental changes (IDC, 2020; Sebastian et al., 2017). Their diffusion paved the way for increasing the firms’ digital technological base. For example, IoT systems and cloud platforms improved connectivity (between objects and consumers) and massive data collection.

Digital platforms, cloud-based systems, and other digital technologies (such as open-source software) have characteristics related to the degree of openness and flexibility of the architecture of solutions and business models. These characteristics facilitate and allow the integration of more technologies and partners to build and complement offerings (products, technologies, or services) (Nambisan, Wright, & Feldman, 2019). This has increased the scope of partners in the ecosystems and has allowed greater interaction and collaboration (Nambisan et al., 2017), bringing new managerial challenges, such as the definition of partners, a convergence of contributions from each party (resources, competencies), new threats (e.g., IT governance and security) (Nambisan et al., 2019).

These characteristics of digital technologies are directly related to the theme of DT. They can be considered pillars of transformations that seem to trigger more significant changes and at different levels of analysis, such as in business models, organizational processes, structures, strategy, and culture (Hess et al., 2016; Singh & Hess, 2017). The definitions for DT in the literature (Exhibit 1) indicate the concept’s broad and complex nature. For Rogers (2016), DT involves five strategic domains: customers, competition, data, innovation, and value. Among the definitions presented in Exhibit 1, the one that integrates almost all these domains is Singh and Hess (2017).

Recently, Wessel et al. (2021) highlighted the particularities of DT concerning the more consolidated discussion of IT-enabled organizational transformation. In addition to the strategic dimension, the authors address the differences between DT and IT regarding value proposition (re)definition and support, respectively. They stress that DT involves a new organizational identity, and IT contributes to improving the existing identity. Despite advances in conceptualizing DT, it is still not clear which are the central themes of research in this area and which themes have stood out the most in the last five years under the nomenclature of DT. Shedding light on these

issues will help understand the research produced and identify opportunities to connect the theme to other research fronts.

### Exhibit 1. Definitions of DT

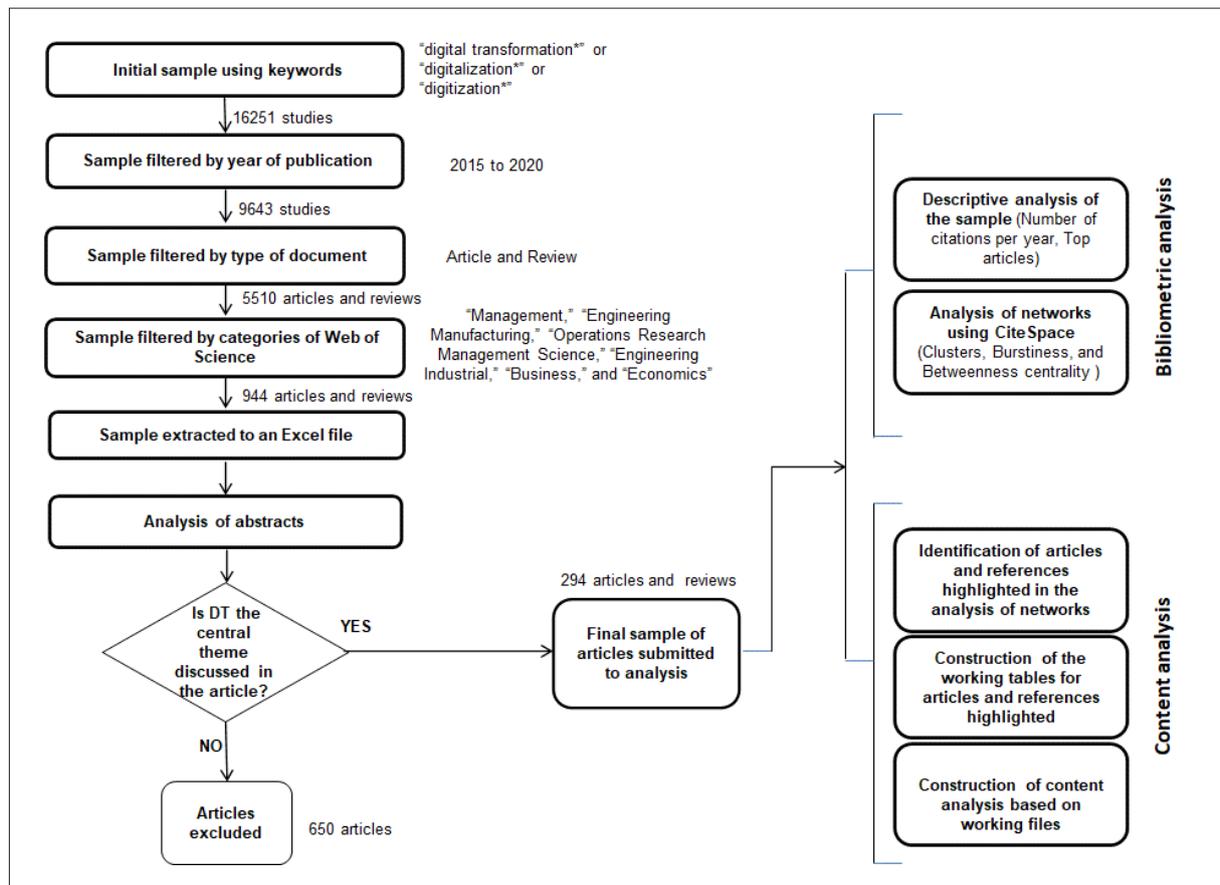
Definition	Source
"concerned with the changes digital technologies can bring about in a company's business model, which result in changed products or organizational structures or in the automation of processes."	Hess et al. (2016, p. 124)
"includes the networking of actors such as businesses and customers across all value-added chain segments, and the application of new technologies [...] requires skills that involve the extraction and exchange of data as well as the analysis and conversion of that data into actionable information. This information should be used to calculate and evaluate options, in order to enable decisions and/or initiate activities."	Schallmo and Williams (2017, p. 4)
use of "new digital technologies, such as social media, mobile access, analytics or embedded devices to enable major business improvements like enhancing customer experience, streamlining operations or creating new business models [...] expresses the comprehensiveness of the actions that need to be taken when organizations are faced with these new technologies"	Singh and Hess (2017, p. 2)
"process that is used to restructure economies, institutions and society on a system level."	Rachinger, Rauter, Müller, Vorraber, and Schirgi (2019, p. 1144)
"process where digital technologies play a central role in the creation as well as the reinforcement of disruptions."	Vial (2019, p. 118)
"is an ongoing process of strategic renewal that uses advances in digital technologies to build capabilities that refresh and replace an organization's business model, collaborative approach, and culture."	Warner and Wäger (2019, p. 344)
"is a learning process that requires integrating technology, business and learning strategies in an entrepreneurial-oriented organization"	North, Aramburu, and Lorenzo (2020, p. 245)

Source: Prepared by the authors.

## METHODOLOGY

A systematic literature review was carried out in two stages: (i) bibliometric analysis to identify and select the main theoretical references on digital transformation (DT) through quantitative analysis of a sample of publications and citations; (ii) content analysis of the main bibliographic references, selected from the studies collected in the first stage (Figure 1).

Figure 1. Process of systematic review



Source: Prepared by the authors.

The strategy of combining these two approaches has been used to identify emerging topics and trends among the most discussed themes and fields. Also, the strategy helps to identify gaps in the literature (Agostini & Nosella, 2019; Gomes, Facin, Salerno, & Ikenami, 2018). The justification for using bibliometric analysis is given by the ability of citation analysis to identify critical scientific works and their interrelationships (Chai & Xiao, 2012; Chen, 2006).

## Sample

The Clarivate Analytics Web of Science database was chosen to generate the sample. This tool allows the extraction of a set of metadata, such as abstracts, authors, institutions, number of citations, cited references, journal impact factor, which are essential for carrying out a bibliometric analysis.

The search terms were “digital transformation\*” or “digitalization\*” or “digitization\*.” The search resulted in 16,251 works. Filters were applied to refine the initial sample, as described below.

For the “year of publication” from 2015 to 2020, 9,643 works remained. For the “type of document,” the filters “article” and “review” were considered since this type of document undergoes peer review and has a complete set of metadata in the Web of Science database. After this refinement, the sample presented 5,510 articles.

Then, among the first 100 “Web of Science Categories,” we chose to use “Management,” “Engineering Manufacturing,” “Operations Research Management Science,” “Industrial Engineering,” “Business,” and “Economics.” These are categories of interest in this bibliometric analysis related to discussions about DT and its connection with operations management, Industry 4.0, business models, and economics. With this further refinement, the sample had 944 articles.

The abstracts of the 944 articles were read, examining whether DT was the central theme discussed in the article or only mentioned without being part of the study’s theoretical framework. After this procedure, 650 articles were excluded, leaving a final sample of 294 articles published between 2015 and 2020.

After completing the sampling process, the export file was generated containing all metadata available in the Web of Science database for the 294 articles. The file was then imported to the software CiteSpace (Chen, 2006).

## Content analysis procedures

Content analysis followed a structured process, adapted from Pashaei and Olhager (2015). Starting from the reading of the articles that stood out in the bibliometric analysis (which consisted of analysis of cluster, burstiness, and betweenness centrality), files were created to summarize, organize, and analyze information on authors, themes, year of publication, research objectives, research methods, main theoretical implications, main practical implications, opportunities for future research, and clusters. For example, cluster analysis allowed identifying which research topics and which researchers could be associated with more mature and emerging lines of research. We identified how the authors employ the DT concept and its evolution based on these working files. Additionally, a systematic search for gaps and opportunities for future research was carried out. These specific working files helped to highlight the main contributions and opportunities for future research in each cluster. These opportunities were examined to verify if they had already been addressed by other researchers present in the selected sample. This systematic process led to a map of opportunities for academic research.

## RESULTS OF THE SYSTEMATIC LITERATURE REVIEW ON DIGITAL TRANSFORMATION

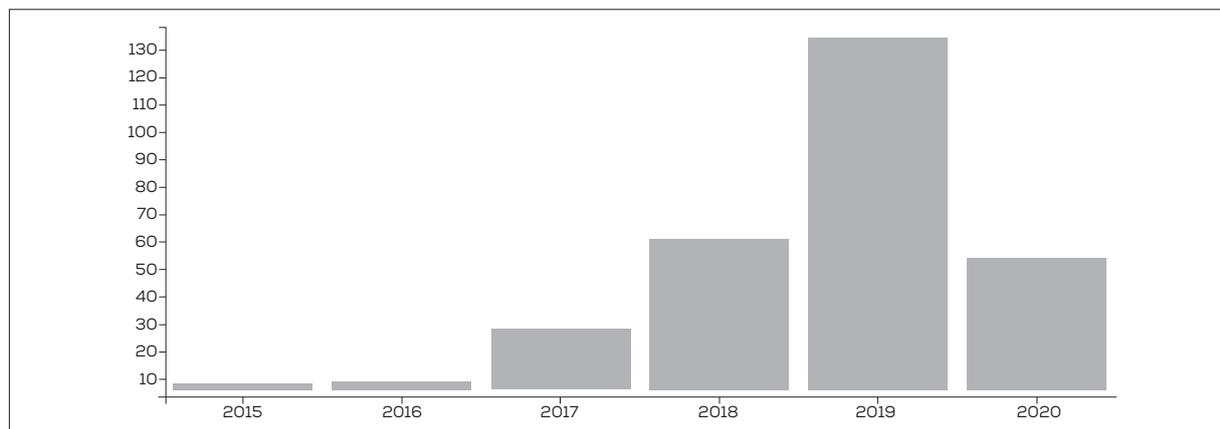
This section presents the results of the quantitative analysis of the sample of 294 articles obtained from the bibliometric analysis. It also shows the results of the content analysis carried out with the articles and the references that stood out in the bibliometric analysis.

## Quantitative analysis

The evolution of the research on digital transformation (DT) from 2015 to 2020 was observed through the bibliometric analysis, considering the number of publications over the years. Graphic 1 shows a recent trend of growth in the number of articles focused on DT using this terminology (including “digitalization\*” or “digitization\*”), with a peak of 134 articles published in 2019.

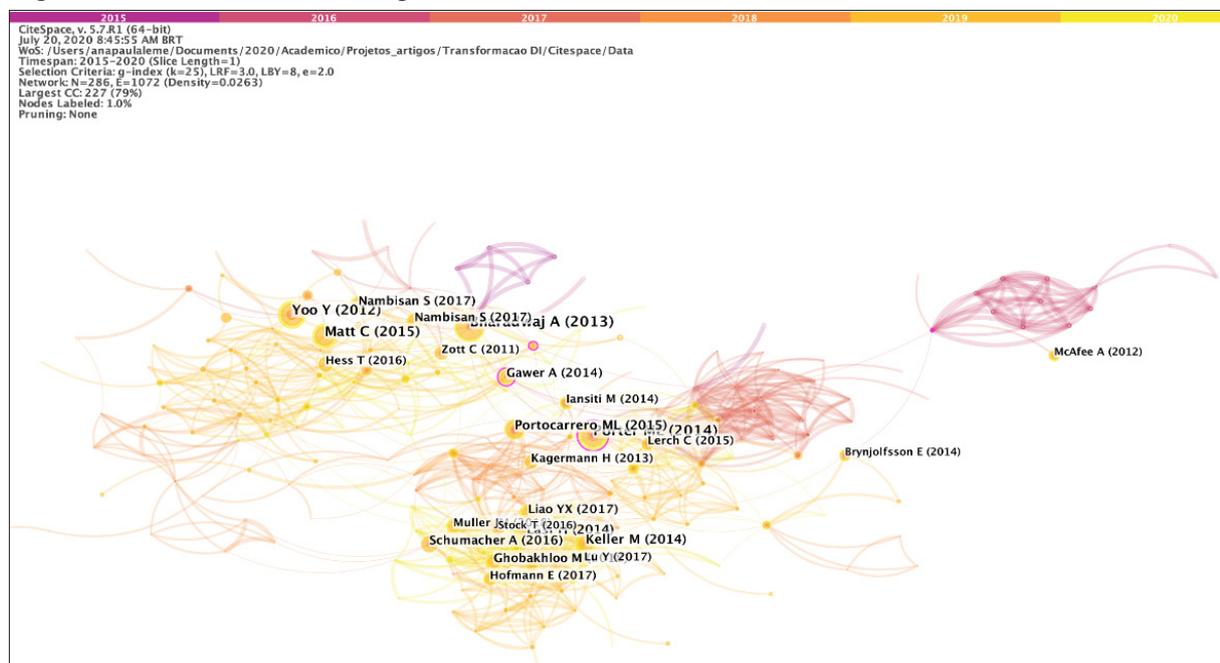
We performed the co-citation analysis using the software CiteSpace (Chen, 2006). The network shown in Figure 2 represents the evolution of the theme, in which each point on the graph represents a node that is a citation – nodes identified with the authors’ names are the most cited references in the database. The connections between nodes (lines) are co-citation links.

**Graphic 1.** Number of publications per year



Source: Prepared by the authors.

**Figure 2.** Co-citation network generated by CiteSpace

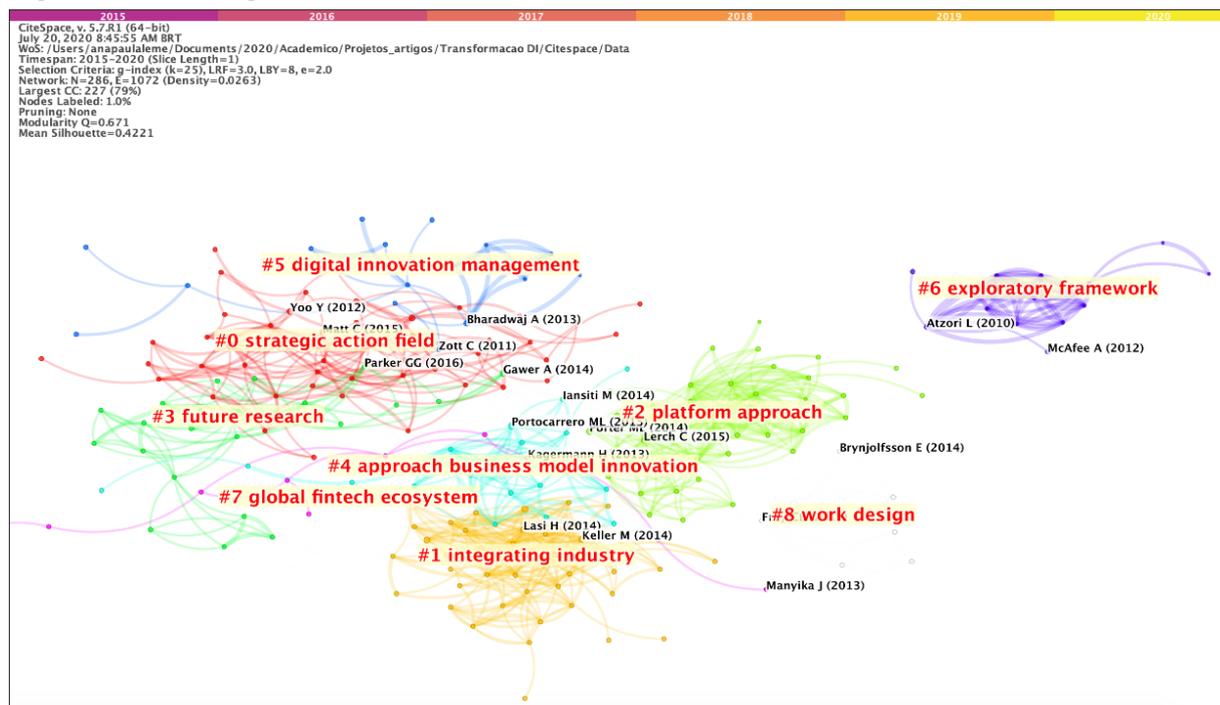


Source: Generated by CiteSpace (Chen, 2006).

The CiteSpace software made it possible to build clusters (groups of works that deal with a subject from a certain point of view) from a set of citations. Cluster generation is determined by the groups observed in the co-citation network and can receive terminology based on words used in the title, keywords, and abstract of the articles of the references that form the cluster. CiteSpace contains tools that automatically generate these groups. Figure 3 shows the result obtained in generating clusters for the sample of 294 articles and their references.

CiteSpace's cluster generation function allows identifying a set of co-cited references representing a shared topic or a line of research. The algorithm used does not allow overlapping nodes in different clusters. After running the clustering algorithm, the software offers visualization of the clusters found, presenting the network modularity (Q), which “measures the extent to which a network can be decomposed to multiple components, or modules” (Chen, 2014, p. 32). Distinct clusters tend to have a “Q” value close to 1, while modularity below 0.30 means that the algorithm could not find an evident separation between nodes.

**Figure 3.** Clusters generated for the sample of 294 articles and their references



Source: Generated by CiteSpace (Chen, 2006).

## Content analysis

The content analysis of clusters and articles that stood out in the cluster analysis performed in the CiteSpace tool are presented in this section.

Cluster #0, called the ‘strategic action field,’ has strategic renewal amid DT as its main theme. The cluster has the least homogeneous field of references (silhouette 0.69) and the largest size (72 references). The adoption of new digital technologies makes it necessary to reinvent

the way of managing innovation and strategy within a company (Lichtenthaler, 2020; Nambisan et al., 2017). The main articles from the base of this cluster indicate this strategic renewal through the development of dynamic capabilities (Warner & Wäger, 2019). They also highlight the use of digital platforms, examining their role in value proposition and creation (Pousttchi & Gleiss, 2019) and competitive performance (Cenamor, Parida, & Wincent, 2019).

Cluster #1, called ‘integrating industry,’ refers to studies that focus on implementing technologies associated with Industry 4.0 (I4.0), also called ‘the factory of the future.’ The cluster is formed by homogeneous publications (silhouette 0.899) and presents works with the most recent references (average year 2016) compared to the other clusters. Research in this cluster proposes frameworks for implementing I4.0, suggesting that an implementation framework should go beyond technology-related issues to consider a holistic framework encompassing organizational, strategic, or managerial issues (Pessot et al., 2020). The studies focus on manufacturing companies, primarily supply chain management and logistics (Garay-Rondero, Martinez-Flores, Smith, Morales, & Aldrette-Malacara, 2020; Ghadge, Kara, Moradlou, & Goswami, 2020). The articles with the most coverage within the cluster are from the *Journal of Manufacturing Technology Management*. The publications also assess facilitators and barriers to implementing I4.0, such as data-driven management and human capital, which are decisive for productivity in the context of automation technology (Camiña, Díaz-Chao, & Torrent-Sellens, 2020).

Cluster #2, ‘platform approach,’ groups homogeneous studies (silhouette 0.867) related to servitization and digitization themes. Servitization refers primarily to the transformational process that aims to offer integrated solutions that may involve products and services to add value to the firm (Cenamor, Sjodin, & Parida, 2017; Coreynen, Matthyssens, & Bockhaven, 2017). Articles from this cluster analyze how digitization can enable and change servitization processes and offerings (Cenamor et al., 2017; Coreynen et al., 2017; Frank, Mendes, Ayala, & Ghezzi, 2019; Kohtamäki, Parida, Patel, & Gebauer, 2020), analyze the effects of this relationship on performance (Cenamor et al., 2017; Kharlamov & Parry, 2020; Kohtamäki et al., 2020; Martín-Peña, Sanchez-Lopez, & Diaz-Garrido, 2019), training (Coreynen et al., 2017; Lenka, Parida, & Wincent, 2017), and the most applied digital technologies in servitization (Cenamor et al., 2017; Frank, Dalenogare, & Ayala, 2019). In addition, these studies indicate that digital technologies help the processes related to the monitoring of products and services (Martín-Peña et al., 2019). This enables adding new services (such as personalized services from the information captured) to current offers (Coreynen et al., 2017) and promoting more innovation in services and business models (Frank, Mendes, et al., 2019), radically changing the relationship with consumers (Coreynen et al., 2017). They may even adopt business models of co-creation with consumers (Lenka et al., 2017). Finally, the studies of this cluster build the intersection of servitization and digitization themes that until then were discussed in other literature (Coreynen et al., 2017).

Cluster #3, ‘future research,’ presents less homogeneous studies than the others (silhouette 0.759), and the average year of reference is 2015. The main focus is implementing I4.0 in business models and the financial sector of companies, mainly in manufacturing. The articles in this cluster (from 2018 to 2020) discuss how the adoption of different I4.0 technologies can

positively or negatively affect industrial performance (Dalenogare, Benitez, Ayala, & Frank, 2018), economic development (Maresova et al., 2018), and the managerial challenges (Schneider, 2018) of a company. The articles also address small and medium-sized enterprises (SMEs) and how I4.0 affects their creation, capture, and value proposition, considering that different forms of implementation bring different types of innovation in each of these elements (Müller, Buliga, & Voigt, 2018), and how digital technologies trigger changes in business processes (Garzoni, Turi, Secundo, & Vecchio, 2020).

Cluster #4, ‘approach business model innovation,’ presents a set of articles that are not as homogeneous as most other clusters (silhouette 0.838). Although the main topic is business model and 4.0 technologies, there are also articles discussing implementation (Lichtenthaler, 2020) and the effect of 4.0 technologies in addition to the discussion of business models (Dalenogare et al., 2018; Kohtamäki et al., 2020). Schneider (2018), author of the most cited article in this cluster, conducted a literature review and identified six thematic areas on the challenges of managing I4.0 (the area of business model is one of them). Thus, this cluster presents a comprehensive discussion on management challenges and effects of technology 4.0, including performance analysis of technologies (Dalenogare et al., 2018).

Cluster #5, named ‘digital innovation management,’ presents a set of references that discuss digitization and its relationship with end customers in organizations, with references related to marketing functions or focused on retail industries (Hagberg, Sundstrom, & Egels-Zanden, 2016). The average year of these references is 2011, with a high silhouette value (0.948), despite having a much smaller size (14 references) than the others analyzed. The articles in this cluster discuss digitization in the retail sector, debating how digitization can change products and services, processes (distribution), and business models (virtual stores) (Hagberg et al., 2016; Orlandi, 2016). It is mentioned that digital technologies can also bring consumers closer to organizations, either through intelligence associated with data analysis (Orlandi, 2016) – which allows for more personalized offers – or by improving communication through digital channels (Hagberg et al., 2016), enabling co-creation processes (Hagberg et al., 2016; Orlandi, 2016).

Cluster #6, ‘exploratory framework,’ has 14 references, with the average year of publication 2011, which is later than the other clusters and related to a single focal article by Hagberg et al. (2016), which also stands out along with other articles in Cluster #5. This article argues that digitization has caused a major ongoing transformation in the retail sector, approaching it with four elements: exchanges, offerings, settings, and actors.

The main articles in Cluster #7, ‘global fintech ecosystem,’ discuss the impacts of digital technologies. The name suggested by CiteSpace reflects one of the researched industries (Fintechs) and the investigated impact (on ecosystems) (Basole & Patel, 2018). However, other articles also analyze impacts on subsidiaries (Szalavetz, 2019) and retail banks (Pousttchi & Dehnert, 2018). The references of this cluster are, on average, from 2013, and it is a smaller cluster than the others (10 references), possibly because it is a topic explored before the cut of the research base used in this study (from 2015 to 2020). The reference with the highest degree of centrality and

frequency of citation comes from a report of recommendations for the competitiveness of the German industry, which disseminated the term Industry 4.0 (Kagermann, Wahlster, & Helbig, 2013).

Cluster #8, ‘work design,’ comprises a relatively small base (six references), and the main theme is consumer experience. The average year of references in this cluster is 2015. Some references focus on the discussion on the experience of consumers in digital channels, emphasizing the importance of reconciling a unique experience in operations in physical and virtual channels. The adoption of an omnichannel strategy, understood as an integrated multichannel approach to sales and marketing, is considered essential (Hansen & Sia, 2015).

From the co-citation network, it is possible to identify that some of the references of the 294 articles represent a change in the focus of the theoretical discussion over time (Freeman, Roeder, & Mulholland, 1979). This change is highlighted in the co-citation network through the calculation of the Sigma indicator (in CiteSpace), which points out the references of the articles in the sample with high betweenness centrality. These references connect different clusters (Chen, 2006) and thus help identify bridges between different theoretical discussions on a given topic. The references with high betweenness centrality (pivotal references) analyzed are detailed in Table 1.

The network’s pivotal references address strategy themes (Gawer & Cusumano, 2014; Porter & Heppelman, 2014), management tools (Nylén & Holmström, 2015), studies related to the application of digital technologies in various industries (Lerch & Gotsh, 2015), in addition to two literature reviews and suggestions for future research: business model innovation (Foss & Saebi, 2016) and Industry 4.0 (Liao, Deschamps, Loures, & Ramos, 2017). Cluster #4 has the highest number of articles among the 10 clusters with the highest Sigma, representing a cluster with a theme that influences the others. We highlight the strategic lens related to digital technologies (Porter & Heppelmann, 2014) and implications for management (Baines & Lightfoot, 2014; Gawer & Cusumano, 2014), and the article by Atzori, Iera, and Morabito (2010), which influenced research on digital technologies applied in different segments of the industry. It is noteworthy that Foss and Saebi’s (2016) study on business model innovation is highly influential. The results presented here offer an overview of the main intellectual bases that have influenced research in the last five years.

**Table 1.** Pivotal references supporting the articles

Sigma	References	Cluster #	Topic
0,14	Atzori et al. (2010)	6	Internet of things: what has been done and what must be done
0,13	Porter and Heppelmann (2014)	4	Strategic and operational implications of smart and connected products
0,12	Nylén and Holmström (2015)	3	Tools to manage new types of digital innovation processes
0,11	Gawer and Cusumano (2014)	4	Management of competition related to platform-based innovation

Continue

**Table 1.** Pivotal references supporting the articles

Concludes

Sigma	References	Cluster #	Topic
0,10	<a href="#">Lerch and Gotsh (2015)</a>	3	General overview of service digitization in industrial firms
0,10	<a href="#">Foss and Saebi (2016)</a>	1	Review and future agenda on business model innovation
0,09	<a href="#">Baines and Lightfoot (2014)</a>	4	How practices and technologies (e.g., IT) are organized to render advanced services (servitization) in manufacturing companies
0,09	<a href="#">Bharadwaj, Sawy, Pavlou, and Venkatraman (2013)</a>	5	Digital business strategy: combination of IT and business strategies
0,07	<a href="#">Afuah and Tucci (2012)</a>	4	Highlights the advantages of crowdsourcing to create solutions for a company's problems compared to other options (internal resources or outsourcing). The access to IT may boost such advantages
0,06	<a href="#">Liao et al. (2017)</a>	1	Review about Industry 4.0 and future agenda

Source: Prepared by the authors.

Additionally, to understand the themes that stood out in the researched database, we analyzed the burst citation indicator on CiteSpace, based on the co-citation network. This indicator helps to point out the highly cited articles soon after they are published, suggesting a possible discussion about emerging topics. Table 2 presents the references resulting from this analysis.

The articles in Table 2 show a research effort to identify the impacts of digital technologies – of DT both in the organizational context (strategy, organization for innovation, concerns with network capacity) and in broader contexts, such as in society and at work. In this sense, there are opportunities to advance this understanding, exploring how DT impacts different levels and themes of management. As the transformation is in process, there is an opportunity to explore organizations and countries at different stages and contribute to the advancement of management literature.

**Table 2.** Citation burst in the last five years

Reference	Strength	Beginning of the burst	End of the burst	Topic
<a href="#">Yoo, Henfridsson and Lyytinen (2010)</a>	3.1439	2017	2018	A new product architecture created by digital technology leads to deep changes in how the company prepares to innovate
<a href="#">Kohtamäki, Partanen, Parida, and Wincent (2013)</a>	2.2333	2017	2017	Expands the discussion about the impact of industrial services on performance. The research shows the moderating effect of network capabilities
<a href="#">Alstyn et al. (2016)</a>	2.1619	2018	2018	The focus of strategy shifts from traditional 'pipeline' businesses to 'platform' businesses, from resource control to resource orchestration
<a href="#">Loebbecke and Picot (2015)</a>	1.9762	2019	2020	How digitization drives the transformation of businesses and society

Source: Prepared by the authors.

## DISCUSSION

The content analysis revealed themes developed in DT studies, highlighting a greater concentration of research related to strategic renewal, with particular attention to the discussion about platforms (Alstynne, Parker, & Choudary, 2016). The analysis revealed the existence of outstanding interest in the implementation of DT and its impacts on business, organization, and society (Loebbecke & Picot, 2015). In this section, we discuss these themes, pointing out research opportunities.

As previously evidenced (especially in Cluster #0), DT drives innovation and, more specifically, digital platforms related to innovations in products, services, and business models. In this context, future studies could focus on the role of platforms as enablers and as a central pillar in fostering innovation (Agostini, Galati, & Gastaldi, 2020; Wiesböck & Hess, 2020), on strategies in platform design (which define platform openness and flexibility, for example), and how companies can use existing platforms to improve their innovation efforts (Agostini et al., 2020). In addition, it is known that platforms increase the participation of different partners in the innovation ecosystem (Nambisan et al., 2017, 2019), which may represent higher management complexity. In this sense, future studies could focus on how to increase integration between ecosystem actors (including client-firm interaction). Also, studies could explore governance processes that are more appropriate for the innovation ecosystem (Agostini et al., 2020) and how this ecosystem can promote more disruptive innovation (Palmié, Wincent, Parida, & Caglar, 2020) linked to this digital context.

Another important axis is the implementation of DT, which emphasizes the need to consider organizational, strategic, and managerial issues (Pessot et al., 2020). However, although several studies present implementation frameworks (Garay-Rondero et al., 2020; Ghadge et al., 2020), future research still needs to test the frameworks empirically (Queiroz, Pereira, Telles, & Machado, 2020). The expansion of empirical research may increase the scope of tests regarding sample size (Ghadge et al., 2020), the types of sectors analyzed (Zangiacomi, Pessot, Fornasiero, Bertetti, & Sacco, 2020), and the contexts of different countries (Queiroz et al., 2020; Zangiacomi et al., 2020). There are studies in manufacturing companies with a research focus on supply chain management and logistics; another suggestion for future studies is to analyze how processes and management systems focused on implementation can be integrated into organizational management (Garay-Rondero et al., 2020).

In addition to a general implementation framework, an in-depth understanding of the company's dimensions and interrelationships in the context of DT are also topics to be better explored. A prominent topic is the construction of digital capabilities (Wiesböck & Hess, 2020) and how to relate them to other organizational capabilities (Cenamor et al., 2019; Warner & Wäger, 2019), for example, with those developed in the innovation processes involving platforms and ecosystems (Vial, 2019), or even how specific strategic objectives affect organizational structures and managerial capabilities (Pessot et al., 2020).

The impact of DT is another topic that stands out in recent studies, related to the performance of the organization (Cenamor et al., 2017; Coreynen et al., 2017; Kohtamäki et al., 2020; Martín-Peña et al., 2019) and the adoption of new work processes, such as co-creation favored by digital skills (Frank, Mendes, et al., 2019; Lenka et al., 2017). In this context, future studies can explore DT as a facilitator for service innovation, for example, understanding how new servitization business models were developed from digital technologies (Kharlamov & Parry, 2020).

## CONCLUSION

A systematic literature review was conducted to identify the themes that characterize studies on digital transformation (DT), emphasizing those worth exploring in future research. We obtained a list of authors and publications that stand out in this field. Our findings are helpful both to clarify ongoing research and point out avenues for new research on DT. Also, the results highlight important issues to be considered by decision-makers in companies that wish to enjoy the benefits of DT and point out trends for future research. These trends emerge from the future recommendations collected during the cluster analysis, which present the recent discussions in the field, emphasizing the debate on strategic renewal (particularly the issue of platform business, shifting the perspective of resource control to a perspective of resource orchestration). There are also opportunities for research on DT implementation models that can be validated with in-depth empirical studies that help advance the understanding of organizational dimensions and their interrelationships in the context of DT. Finally, studies on impact have advanced in the context of organizations, the business environment, and society as a whole. However, there are still opportunities for research in other areas, given that, to a certain extent, DT represents a contemporary phenomenon.

This research searched the Web of Science with a cut in the following categories: “Management,” “Engineering Manufacturing,” “Operations Research Management Science,” “Industrial Engineering,” “Business,” and “Economics,” and with filters in “Article” and “Review.” Thus, studies outside this set were excluded, which is a limitation of the study. This limitation also occurs in the selection of keywords used in the search, which considered terminologies related to the word digital, namely: “digital transformation\*” or “digitalization\*” or “digitization\*.” Thus, studies that have discussed the same concept of DT, but using different terminology, were not considered, which may be the case of studies that use the name of Information and Communication Technology (ICT). Future studies may seek to integrate terminologies to understand the evolution of discussions on IT-enabled organizational transformation.

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## AUTHOR'S CONTRIBUTIONS

Ana Lucia Figueiredo Facin, Ana Paula Franco Paes Leme Barbosa, Cristiane Matsumoto and Mário Sérgio Salerno worked on the conceptualization and theoretical-methodological approach. The theoretical review was conducted by Cristiane Matsumoto. Data collection was coordinated by Ana Lucia Figueiredo Facin. Ana Lucia Figueiredo Facin, Ana Paula Franco Paes Leme Barbosa, Cristiane Matsumoto and Ana Flavia Safady da Gama Cruz participated in the data analysis. Ana Lucia Figueiredo Facin, Ana Paula Franco Paes Leme Barbosa, Cristiane Matsumoto and Mário Sérgio Salerno participated in the writing and final review of the manuscript.