



Assessing the impacts of digital transformation on internal auditing: A bibliometric analysis

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ABSTRACT

During the last years, the impacts caused by digital transformation on companies have been disruptive. Contrarily to prior technological revolutions, the current scenario is characterized by the rapid growth of innovation that has impacted organizations differently. In particular, an increasing number of organizations revised their management control systems to adequate their business models to the external pressures made by competitors and regulators. The research aims consist of a bibliometric analysis about the impacts caused by digital transformation on managerial auditing. The research reveals the existence of four independent research area: continuous auditing (Green Cluster), fraud detection (Blue Cluster), data analytics (Yellow Cluster) and technological innovation (Red Cluster). Finally, we developed a research agenda in order to address future research.

1. Introduction

The last years have been interested in the rapid growth of technological innovations that have impacted organizations in a disruptive way [1,2]. In particular, contrarily to the past, digital transformation impacted innovative and traditional sectors [3]. Furthermore, digital transformation also impacted sectors by a high degree of orientation toward technological innovation such as media and financial [4,5]. In this sense, policymakers and academics agreed about the existence of the new industrial revolution defined as Industry 4.0.

The digitalization of accounting and auditing practices represents one of the main paradigm shifts that have characterized the last years [6, 7]. This evidence was underlined by several position papers published by standard setters and practitioners. According to the IFAC, next years will be characterized by the exigence to rethink accounting professions because “*Strong finance and accounting background is no longer sufficient to become a value-add business partner over the long term*” [8]. In particular, the reports underlined the exigence for auditors to revise their paradigms to adequate their know-how toward the new challenges. Furthermore, KPMG highlights that digital transformation cannot be considered a voluntary choice for auditors due to its disruptive impact on organizations [9]. In this sense, auditing evolved from a bureaucratic

to a strategic approach to operate more effectively within a complex and dynamic scenario.

Internal auditing probably represents the primary practices interested in this evolution due to its peculiarities. Over the years, academics highlighted that internal auditing practices are directly interested in technological innovation due to their intrinsic characteristics. Contrarily to external auditing, internal auditing represents an activity characterized by different impacts on organizations [10,11]. In detail, internal auditing can be analyzed from different perspectives due to its different implications on organizations. On the one hand, internal auditing represents a process developed in order to evaluate firms' performance [12, 13]. Thus, internal auditing differs from external auditing due to the existence of different impacts on business strategies. On the other hand, internal auditing represents a process developed to identify organizations' strengths and weaknesses [14,15]. Thus, the adoption of technological features represents a factor in fostering the processes related to costs' minimization and revenues' maximization. Furthermore, regulators' increasing pressures regard new topics (e.g. data protection, non-financial reporting, cyber risks) imposed the adoption of digital devices [16,17].

While a significant number of papers have analyzed the relationship between digital transformation and external auditing [18,19], no similar

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research has been conducted on internal auditing. As evidenced by Manita et al. [7] evaluating the contribution provided by digital transformation on internal auditing practices represent one of the main challenges for management scholars. In particular, the authors underlined the need of new studies in order to fill theoretical gap about the enabling role covered by digital transformation on internal controls. In addition, the authors highlighted the opportunity for accounting scholars to shed the light about the interlinkages between digital transformation, internal auditing and corporate governance's mechanisms. A similar perspective was provided by Lombardi, de Villiers, Moscardiello and Pizzo [20]. The authors stated that the current debate on auditing is characterized by an overall absence of studies about internal auditing. In addition, they have encountered the need for compelling empirical studies and practitioner involvement in auditing studies.

In light of these considerations, the paper aims to contribute to the scientific debate on auditing through a bibliometric investigation of the main existing contributions regarding the relationship between internal auditing and digital transformation [7,21]. Similar to prior management studies, the choice to develop the study through bibliometric methods was driven by the opportunity to fill the knowledge gap about a novel and original field [22]. In fact, bibliometric represents a research method widely adopted by management scholars to *frame their streams of research in the "tangled forest" of scientific proliferation* [22]; p. 290).

Two specific research questions (RQ) guide this article. The RQ1, "*What are the main research clusters about digital transformation in internal auditing?*" allows us to systematize the current knowledge about the enabling role covered by digital transformation on internal auditing. The RQ2, "*What are future research topics about digital transformation in internal auditing?*" helps set a research agenda about future studies on digital transformation in auditing. Furthermore, in order to bridge the knowledge gap between academics and practitioners, a non-academic co-author was involved in the research to enhance the managerial contributions of the paper [21,23].

According to this evidence, the paper's contributions are manifold. Firstly, the paper contributes to the scientific debate on auditing through a first systematization of the existing knowledge. In fact, to the best of our knowledge, this is the first bibliometric analysis about digital transformation in internal auditing [7]. Regarding the second contribution, the involvement of an expert contributes to fill the knowledge gap between academics and practitioners [21]. Finally, the research extends the scientific knowledge about the contribution provided by digital transformation and Industry 4.0 on accounting and auditing processes [19].

The paper is structured as follows: Section 2 analyses the current debate about digital transformation in auditing, Section 3 describes the methodological approach used within the study, Section 4 consists in the descriptive analysis of the main findings collected while Section 5 consists in some reflections about the main implications related to the research. Finally, Section 6 consists of the concluding remarks.

2. Background

In the last decade, many organizations integrated digital features in their processes [24]. This paradigm shift was driven by increasing investments made by companies on R&D, which represents a critical item for the achievement of competitive advantage. In fact, digitalization impacted on different strategic areas such as marketing, supply chain management and risk management [25]. However, evaluating the real impacts caused by digital transformation on companies represents an activity characterized by a high degree of complexity [1]. In fact, despite similarities between the three dimensions, digitization, digitalization and digital transformation are three independent topics [26]. Prior studies agreed that digitization and digitalization are part of digital transformation [27]. In detail, the authors stated that digitization consists of the transition of analog information into a digital format (i.e.,

into zeros and ones) while digitalization represents the adoption of digital devices within business processes. Another interesting perspective was provided by Knudsen [28] in a literature review about the impacts generated by digitalization in accounting practices. Knudsen suggests that digitalization represents the *trait d'union* between digitization and digital transformation due to its peculiarities, and agrees with Verhoef et al. [27] regarding the centrality of digital transformation within the discussion.

One of the main processes affected by digitalization is internal auditing. Internal auditing activities have been historically interested in the impacts caused by the introduction of new technology due to the direct relationship between digitization and auditing activities [29]. However, the main changes to internal auditing processes have occurred during recent years due to the disruptive impacts caused by technological innovation. The Institute of Internal Auditors [30] has observed the need to evolve from a traditional, point-in-time, forensic-based, checklist approach to a digital approach based on new technologies. The development of new devices in recent years has impacted the auditors' profession. The wide adoption of technological features for data extraction and analysis, fraud detection, internal control evaluation, electronic commerce control, and continuous monitoring has managerial implications related to the disruptive impacts digitalization has caused to the internal auditing profession [31]. Furthermore, the intense activities regulators conduct on data protection and non-financial reporting have required the development of new practices based on digital infrastructures [16,32]. In particular, the regulation has facilitated the improvement of internal auditing processes by identifying stricter requirements about new topics such as data protection and cyber-risks. Finally, the widely adoption by companies of digital features in their operations increases the

The scientific debate has been also interested by the paradigm shift that has characterized internal auditing's practices. Furthermore, the relevance of the topic was also underlined by policy makers and consulting firms [33,34]. In the last few years, many academics started to evaluate the enabling role covered by digital transformation on auditing processes. In particular, a wide number of studies underlined the disruptive impacts caused by digital transformation on activities characterized by a high degree of standardization and repetitiveness [17,18]. Furthermore, other studies paid specific attention to innovative tools such as blockchain, smart contracts and IoT [21,35].

However, despite the existence of common traits between external and internal auditing, only few academics paid specific attention to internal auditing. In fact, as evidenced by Manita et al. [7]; filling the knowledge gaps about the disruptive impacts caused by digital transformation on internal auditing represent one of the main future challenges for accounting scholars. In addition, the theoretical contribution published by Lombardi et al. [21] sheds the light about the lack of scientific knowledge about the implementation of new technologies in auditing. In particular, the authors highlighted that the current debate is characterized by an overall absence of evidence-based research. In this sense, they underlined the opportunity to involve practitioners in their research in order to mitigate the knowledge gaps between theories and praxis.

3. Research methods

The analysis was conducted through a mixed approach based on bibliometric analysis and literature review. The choice to evaluate the field through the adoption of two alternative research methods was driven by the opportunity to contribute to the advancement of the scientific knowledge through more focused analysis. In fact, despite the existence of similarities between the two research methods, many scholars highlighted the existence of relevant differences caused by their different perspectives. In detail, bibliometric analysis consists of a set of quantitative techniques used to evaluate physical published units, or of bibliographic units, or of the surrogates for either [36] while the main of

the literature review is to summarize the state of the art in order to identify future research direction [37]. In this sense, the combination of the two methods allows researchers to provide a comprehensive review of the scientific field [38,39].

In order to ensure the reliability of the analysis, the authors defined a research protocol based on specific criteria so that the study can be reproduced by other academics [40]. Although prior studies agreed that reliability and validity tests can be excluded in literature review analysis, the choice to define specific criteria follows the methodological approach used in prior studies of digitalization in accounting and auditing practices [6,41].

The paper selection was conducted on Scopus, which represents one of the main databases used by management scholars [22,42]. In fact, the last years have been characterized by a rapid growth of studies based on data extracted from Scopus [39,43]. The selection involved identifying papers using the words *audit** and *digit** in their abstract, title, or keywords. The criteria favored the inclusion of papers about the relationship between auditing activities and all the three dimensions of digital transformation distinguished in the literature (digitization, digitalization and digital transformation). Thus, the search criteria avoided the risk of excluding papers that analyze the phenomenon from different perspectives [27].

The analysis was limited to articles classified by Scopus as “Business & Management”. The choice to consider only scientific journals was driven by the opportunity to enhance the reliability of the analysis through the evaluation of peer-reviewed documents. Furthermore, the analysis was not limited to papers published within a given time span so as to have the opportunity to evaluate the evolution of the field over the years. Finally, we considered only articles published in English language.

The dataset extracted from Scopus consists of 142 articles. After preliminary cross-validation made by the authors through the analysis of alternative databases such as WoS and EBSCO [22], 37 papers were excluded. In detail, we excluded paper that analyzes auditing from perspectives not related to auditing (e.g. biology, chemistry) and paper not related to the specific field of the internal auditing. In addition, to ensure the analysis’ reliability, a non-academic has been involved in the research. The choice to collaborate with a non-academic scholar follows as evidenced by Sharma and Bansal [23] about the lack of impacts generated by review studies on management practices. Thus, we included in the research an expert independent auditor to avoid the criticisms caused by the differences of knowledge between academics and practitioners [44].

The 105 articles were analyzed using Bibliometrix and VosViewer, which represent two of the main software used by academics to conduct detailed analysis through the integration of first and second-order indicators [45,46]. The need to operate with different indicators is related to the opportunity to develop a bibliometric research characterized by an adequate degree of objectivity. In fact, prior studies have suggested that combining two or more indicators will produce a more detailed representation of the field, avoiding any risk of bias caused by the analysis of a synthetic indicator [1,47].

Furthermore, the keywords have been analyzed through network analysis and overlay analysis [46]. Network analysis uses distance to evaluate the relationship between two or more keywords. Also, the VosViewer analysis uses colour to show a high degree of similarity between keywords in the map. As regards the overlay analysis, it consists of a graphical evaluation of the research trends. In particular, overlay analysis favors the comprehension of the main topics discussed by academics over the years.

4. Findings

4.1. Descriptive analysis

Since 1985, 105 articles about digital transformation in auditing

activities have been published in 72 journals included in Scopus (Fig. 1). The peak has been achieved in 2020 with 23 articles while the average number of citations per paper is equal to 10.29. The analysis reveals that the field appears comparatively unexplored until 2015, probably because of the rapid development of technological features that have characterized recent years. Thus, the descriptive analysis confirms the novelty and the originality of this field.

4.2. Performance analysis

The comprehension of the scientific impact of a source represent a complex activity due to the high degree of subjectivity, which characterize these types of analysis. In this sense, we adopt a stratified approach based on the combination between different indicators.

4.2.1. Documents

The analysis of the documents reveals the coexistence of several contributions within the field that have impacted on the scientific knowledge differently (Table 1). On a hand, the citation analysis reveals the pivotal role covered by papers about specific dynamics that characterize auditing such as the methodological approaches [48,50] and behaviors [31,53]. On the other hand, the limitation of the analysis on the local citation reveals that only the methodological paper are central within digital auditing’s field. Furthermore, the analysis reveals the high degree of attention paid by scholars toward specific research area such as big data and data analytics [51,52]. Finally, an analysis on the references considered within the 105 papers was conducted. This analysis completes the research through interesting insights about the roots of the field. In particular, one of the main interesting results is represented by the inclusion of the theoretical paper published by Benford [49]. Although the paper was developed in order to contribute to a research question not related to the auditing activities, the seminal contribution of Benford has been widely considered by academics and practitioners. In fact, it represents one of the main paradigms used to assess the reliability of accounting information [48].

As regards the development of the topic, the keyword analysis reveals that the documents’ contents evolved over the years (Fig. 2). In fact, despite traditional concepts such as accounting information systems, earning management and Benford’s law maintain a central role within the debate; the last years were interested by the rapid growth of new topics such as Artificial Intelligence, Blockchain and Big Data [20, 58,59]. Furthermore, the progressive attention paid to the digitization of the process confirms the direct connection between theory and practices in auditing due to the high degree of attention paid by policy makers and practitioners to the dematerialization of the accounting activities [60].

4.2.2. Sources

The bibliometric analysis reveals contradictory findings about

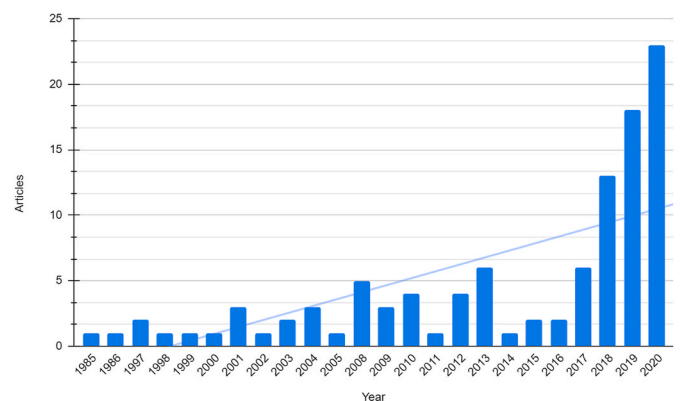


Fig. 1. Activity indicators. Source: Our elaboration on data extracted from Scopus.

Table 1
Citation analysis. Authors-level analysis.

Global Cited			Local Cited			Local References	
Paper	Total Citations	TC per Year	Document	Year	Local Citations	Cited References	Citations
[48]; AUDITING	116	46.400	[48]; AUDITING	1997	9	BENFORD, F. [49],	10
[50]; AUDITING	104	52.000	[51] INT J ACCOUNT INF SYST	2010	4	CARSLAW, C., (1988)	7
[31]; INT J ACCOUNT INF SYST	59	45.385	[52]; AUDITING	2005	3	ELLIOTT, R.K. (2002)	4
[53]; J INFO SYST	51	39.231	[50]; AUDITING	2002	3	THOMAS, J.K. (1989)	4
[54]; MANAGE AUDIT J	50	26.316	DRAKE PD, 2000, J ACCOUNT EDUC	2000	3	CAO, M., CHYCHYLA, R., STEWART, T. (2015)	3
[51]; INT J ACCOUNT INF SYST	36	30.000	[31]; INT J ACCOUNT INF SYST	2009	2	DURTSCHI, C., HILLISON, W., PACINI, C., (2004)	3
[55]; INT J ACCOUNT INF SYST	36	17.143	[54]; MANAGE AUDIT J	2003	2	VENKATESH, V., MORRIS, M.G., DAVIS, G.B., DAVIS, F.D. (2003)	3
DRAKE PD, 2000, J ACCOUNT EDUC	32	14.545	[56]; MANAGE AUDIT J	1998	2	YOON, K., HOOGDUIN, L., ZHANG, L. (2015)	3
[56]; MANAGE AUDIT J	32	13.333	TAN BS, 2019, AUST ACCOUNT REV	2019	1	ALLES, M., BRENNAN, G., KOGAN, A., VASARHELYI, M.A [57].	2
[52]; AUDITING	27	15.882	[53]; J INFO SYST	2009	1	BANKER, R.D., CHANG, H., KAO, Y.-C. (2002)	2

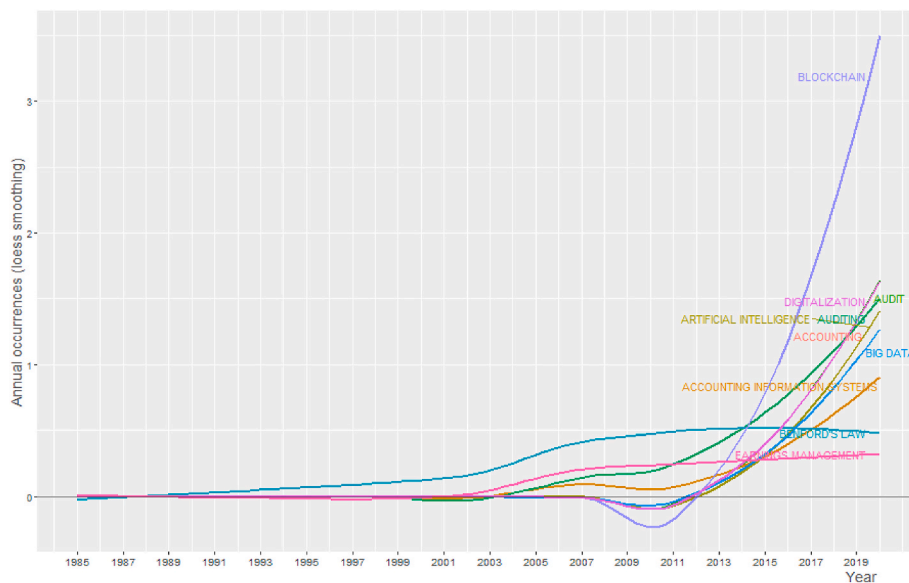


Fig. 2. Words' growth.

Table 2
Citation analysis. Journal-level analysis.

Most Relevant Sources							Local cited	
Source	h_index	g_index	m_index	TC	NP	PY_start	Sources	Articles
INTERNATIONAL JOURNAL OF ACCOUNTING INFORMATION SYSTEMS	5	8	0,24	146	8	2001	THE ACCOUNTING REVIEW	90
AUDITING	5	6	0,20	290	6	1997	ACCOUNTING	58
MANAGERIAL AUDITING JOURNAL	4	6	0,17	95	6	1998	ACCOUNTING HORIZONS	52
JOURNAL OF EMERGING TECHNOLOGIES IN ACCOUNTING	2	4	0,22	17	5	2013	JOURNAL OF INFORMATION SYSTEMS	47
QUALITY - ACCESS TO SUCCESS	2	2	0,67	5	3	2019	JOURNAL OF ACCOUNTING AND ECONOMICS	46
ACADEMY OF ACCOUNTING AND FINANCIAL STUDIES JOURNAL	1	2	0,11	4	2	2013	INTERNATIONAL JOURNAL OF ACCOUNTING INFORMATION SYSTEMS	44
ACCOUNTING, AUDITING AND ACCOUNTABILITY JOURNAL	1	2	0,10	23	2	2012	AUDITING: A JOURNAL OF PRACTICE & THEORY	38
AUSTRALIAN ACCOUNTING REVIEW	2	2	0,11	18	2	2004	JOURNAL OF ACCOUNTING RESEARCH	38
DECISION SUPPORT SYSTEMS	2	2	0,10	24	2	2001	STRATEGIC FINANCE	33
IEEE TRANSACTIONS ON ENGINEERING MANAGEMENT	0	0	0,00	0	2	2020	MIS QUARTERLY	32

sources' contribution to the debate about digital transformation in auditing activities (Table 2). In particular, it is possible to identify the lack of interlinkage between the main sources in term of articles yearly published and the main sources cited by the authors. In particular, the main sources in terms of paper publishes are the International Journal of Accounting Information Systems (8), Auditing (6) and Managerial Auditing Journal (6) while the sources with the highest number of citations are The Accounting Review (90), Accounting (58) and Accounting Horizons (52). This evidence can be related both to the novelty of the field and both to the high degree of contamination which characterize the field. Thus, the paper about digital transformation in auditing are usually published in journals with a clear focus on technological innovation and managerial audit while the main theoretical sources used to develop the analysis are published in consolidated accounting journals.

Although the criticisms shown above, the last years have been interested by a paradigm shift related to the transition from traditional sources such as Audit and Managerial Auditing Journal to a more specific journals such as the International Journal of Accounting Information Systems, Journal of Emerging Technologies in Accounting and Quality-Access to success (Fig. 3). However, the transition from journals that analyze auditing from a theoretical perspective to journals focuses on processes and systems could represents a limit for the development of the field due to their generalist approach.

This reflection is confirmed by the three-field plot about the interlinkage between cited sources, sources and keywords (Fig. 4). Although the five sources stems from similar roots, the analysis reveals that Auditing and Managerial Auditing are focuses on traditional research area while the International Journal of Accounting Information Systems, Quality-Access to Success and Journal of Emerging Technologies in Accounting analyze frontier's topic. Thus, the fragmentation of the field does not favour the advancement of the field due to the lack of interlinkage between research sub-areas.

4.3. Science mapping

4.3.1. Network analysis

The network analysis reveals four different research areas about digitalization in auditing (Fig. 5). Despite the interlinkages between the four clusters, the analysis reveals specific clusters' characteristics. The field appears consolidated and possesses an adequate degree of knowledge regarding the different impacts of digital transformation on

auditing practices. In detail, network analysis reveals the existence of four independent research areas that analyze continuous auditing (Green Cluster), fraud detection (Blue Cluster), data analytics (Yellow Cluster) and technological innovation (Red Cluster).

Research Area 1: The Green Cluster regards studies about continuous auditing. The attention paid by academics toward continuous auditing is due to the enabling role of technological innovation. On this point, Woodroof and Searcy [55] defined continuous auditing as a natural evolution of the integration of technology into the auditing domain. Furthermore, Singh et al. [61] emphasized that the implementation of continuous auditing practices requires the adoption of technological features to mitigate the timing of the operations. The authors highlighted the benefits of implementing ERP systems within organizations to avoid delays from the acquisition of data and the validity check by internal auditors. In addition, a large part of studies analyzed the enabling role covered by XBRL. In recent years, an intense debate has developed about XBRL, but only a few studies analyzed the impacts on internal audit practices [41]. Academics have paid less attention to XBRL in auditing than to accounting and accountability. However, the main findings collected over the years underline the potential of the use of XBRL systems [53]. Liu [62] argued that XBRL's main implication for auditors is the opportunity to move from aggregated to disaggregated and personalized data. Thus, the contribution of XBRL is twofold. The first is data standardization, which can increase the accuracy of analysis [63], while the second consists of the opportunity to analyze on a real-time basis [54].

Research Area 2: The Blue Cluster consists of studies about fraud detection. Fraud analysis represents a historical topic within the debate. However, as revealed by co-citation analysis, the field is characterized by a high degree of integration between traditional and innovative arguments. This is confirmed by the presence of studies based on the essay published by Benford [49]. The main contribution to the field is the analysis conducted by Nigrini and Mittermaier [48]. These authors analyzed the potential positive impacts of implementing digital analysis within organizations. Based on the case study of a German firm that operated in Oil&Gas, the authors found positive results in term of timing and reliability. Furthermore, the early study by Nigrini and Mittermaier was extended in further research. In particular, Nigrini and colleagues analyzed the enabling role of digitalization from different perspectives, such as sampling procedures and data diagnostics [64,65]. Other studies analyzed the integration of digital procedures in order to avoid some of the main risks caused by the adoption of Benford's law [52,56,66].

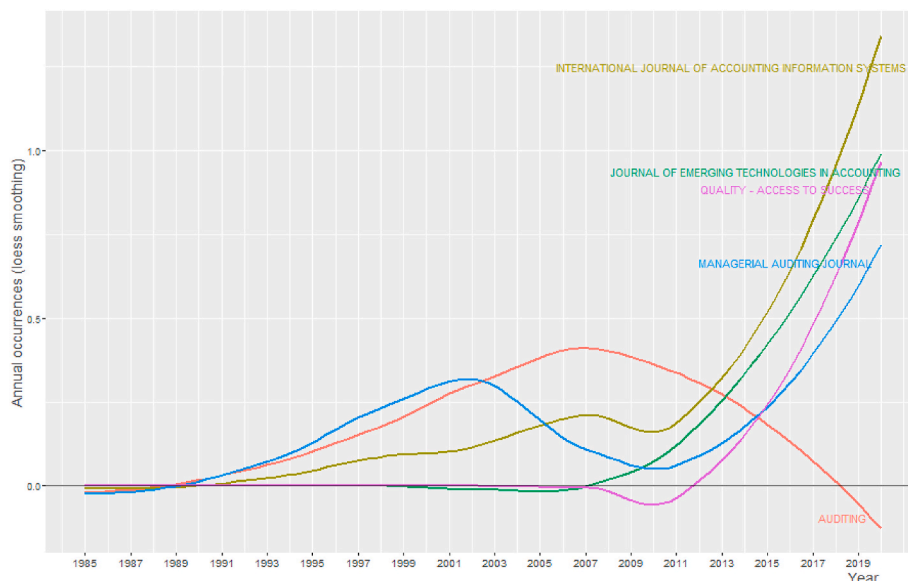


Fig. 3. Journal analysis.

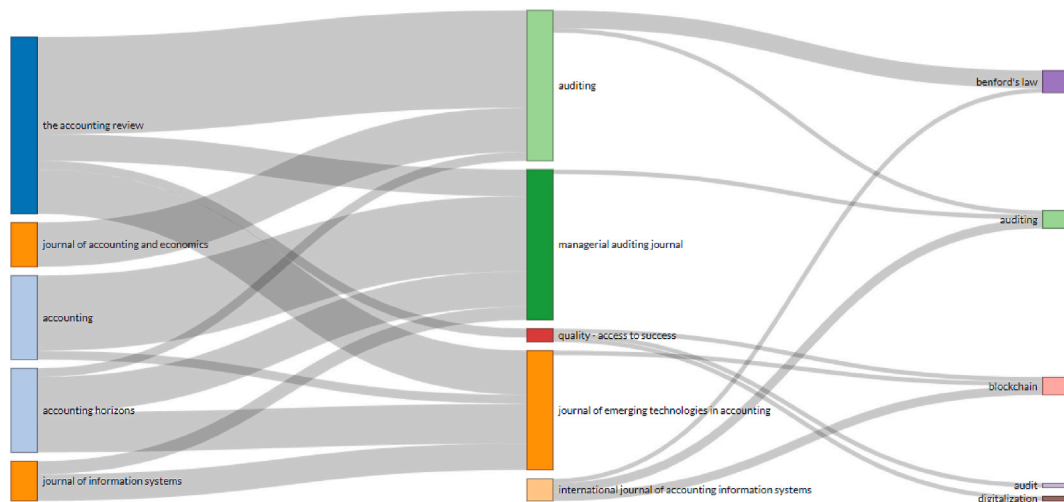


Fig. 4. Three-field plot.

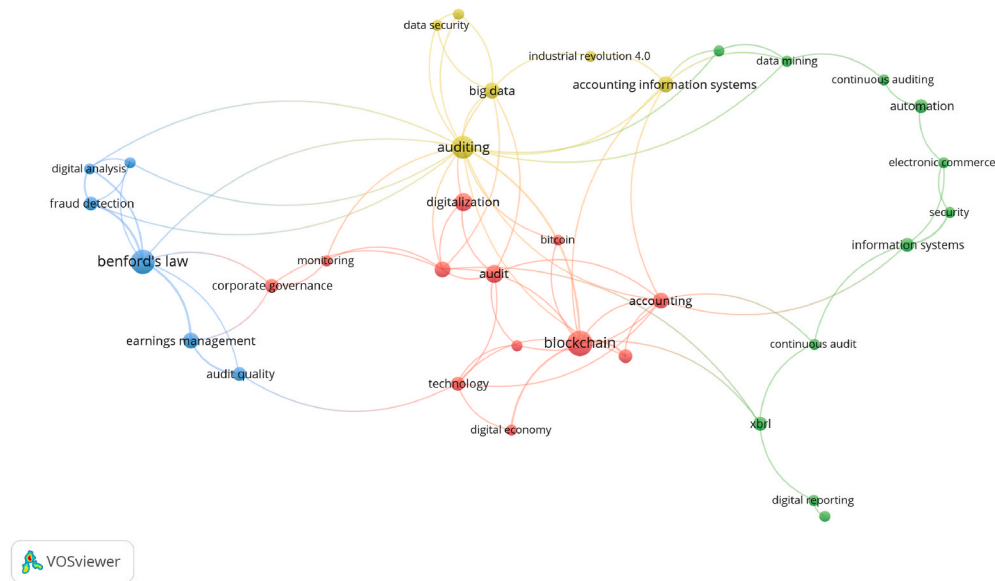


Fig. 5. Keyword analysis. Network analysis.

Research Area 3: The Yellow Cluster is composed of papers about data analytics. Since the theoretical foundation proposed by Benford [49]; academics have considered data analysis the main information source in auditing activities. According to Debreceny and Gray [51]; p.159), detecting financial reporting misconduct is the main challenge for contemporary internal auditors. In particular, these authors argue that the milestones of this paradigm shift were the promulgation of SAS 99 (Consideration of Fraud in a Financial Statement Audit) by the Auditing Standards Board and the enactment of Sarbanes–Oxley Act by the U.S. government. However, data analysis requires the preliminary activity of data mining, an activity which may be highly complex due to potential resistance from internal auditors toward technological innovation [31]. A critical study conducted by Frishammar et al. [67] on internal auditing practices confirms this observation, highlighting that current frameworks are not flexible enough to accommodate the adoption of practices based on openness, digitalization and servitization. Similarly, the first studies conducted about AI and big data analytics reveal that the road ahead, their wide diffusion, requires a rethinking of the current auditing framework [58,68].

Research Area 4: The Red Cluster consists of studies about some of the

main technological innovation that have characterized the last years such as Blockchain and Smart contracts. In detail, the fourth cluster consists of keywords related to the impacts caused by digital auditing on different internal dynamics such as processes, controls, and corporate governance’s archetypes. Furthermore, the Red Cluster covers a central role within the analysis due to the direct and indirect interlinkages with the other clusters. In this sense, it represents a standalone clusters due to its different perspectives of analysis. As regards the specific contents, the study conducted by Tiberius and Hirth [59] reveals that Blockchain systems could be enablers for continuous auditing practices. Tiberius and Hirth’s analysis focused on the risks and opportunities for auditors caused by the integration of new practices within their activities. A similar analysis was provided by Mosteanu and Faccia [20] in their research about the impacts of digitalization on financial reporting practices. In particular, they highlighted the existence of a positive correlation between the implementation of new technological features and the reduction of human errors in accounting and auditing practices. Furthermore, it increases the depth of the audit and reducing residual risks. In this sense, these impacts favour the development of control systems characterized by the highest degree of effectiveness. Finally,

some studies began a discussion about the barriers to effective implementation of Blockchain in auditing [57,69].

4.3.2. Overlay analysis

The overlay analysis integrates the main findings collected through network analysis with insights about the evolution of the field over the years (Fig. 6). This analysis reveals that the main topics analyzed by academics during the last two years are features introduced by Industry 4.0. Many academics have started to analyze the enabling roles of Blockchain, smart contracts and AI in auditing. Their analysis shows a need to evolve from traditional auditing practices to more sophisticated practices based on the innovations generated by Industry 4.0. Thus, academics have tried to introduce to the scientific debate new insights based on the combination of theoretical and managerial perspectives related to the development of innovative approaches in auditing.

4.3.3. Density analysis

A density analysis was conducted in order to understand the central debates on digital transformation in auditing (Fig. 7). Unlike to network and overlay analysis, density analysis evaluates the topics' centrality through a heat map that does not consider interlinkages and temporal dynamics. Density analysis reveals a mixed approach adopted by academics. On the one hand, as revealed by overlay analysis, an intense debate has developed about the managerial and theoretical implications of implementing Blockchain technology in the auditing profession. On the other hand, widely analyzed topics such as digitization and Benford's law remain central within the debate. Thus, the main topics analyzed within the current debate regard arguments discussed within a temporal period starting in 1938.

5. Discussions

In the last few years, academics and practitioners underlined the need to evaluate the contribution provided by digital transformation on accounting and auditing professions [70,71]. As evidenced by Manita and colleagues [7]; the comprehension of the enabling role covered by emerging technologies represents a critical issue for academics due to the disruptive impacts caused on accounting and auditing practices. In particular, a study conducted by PWC [72] highlighted that risk management will be one of the main strategic areas affected by this paradigm shift. In this sense, internal auditors will have to rethink their traditional

paradigms to embed new technologies in their evaluation programs. However, despite the disruptive impacts caused by digital transformation on internal auditing, the scientific debate was characterized by a limited attention paid by academics on the topic. In fact, prior review studies underlined the need of new research to fill the theoretical gaps through evidence based analysis characterized by an adequate degree of balance between theoretical and managerial perspectives [7, 21].

The bibliometric analysis was conducted to systematize the scientific knowledge about digital transformation in auditing. Although review studies are usually considered research methods characterized by the lack of managerial implications, many academics underlined the opportunity to bridge the knowledge gaps between academics and practitioners through the development of multidisciplinary research teams [23]. Thus, we included in the research team an internal auditor to bridge the knowledge gaps between the two groups. In this sense, our study will contribute to the systematization of the existing knowledge through the adoption of a critical approach inspired by the need to identify relevant topics for academics and practitioners [21].

5.1. What are the main research clusters about digital transformation in internal auditing?

In recent years, an intense debate has developed about the impacts of digital transformation on business strategies [6,41]. This evolutionary trend has affected internal auditing activities because digital features have disrupted highly standard practices. In particular, the analysis reveals that much of the research involves analysis of prior auditing protocols and existing regulation.

Although digitalization is usually considered a recent topic, practitioners and academics of internal auditing practices have traditionally paid constant attention to opportunities related to the integration of new technological features in consolidated auditing protocols [51,66]. In particular, a large number of studies have been conducted about the development of new technological features based on Benford's law [49]. This is also shown by the comprehensive inclusion of references about Sarbanes-Oxley and other rules [73]. Thus, despite an overall approach based on the exigence to analyze current technological frontiers, the roots of the field are in the past.

Bibliometric analysis reveals that a large part of the studies about digital transformation in auditing has been focused on innovation.

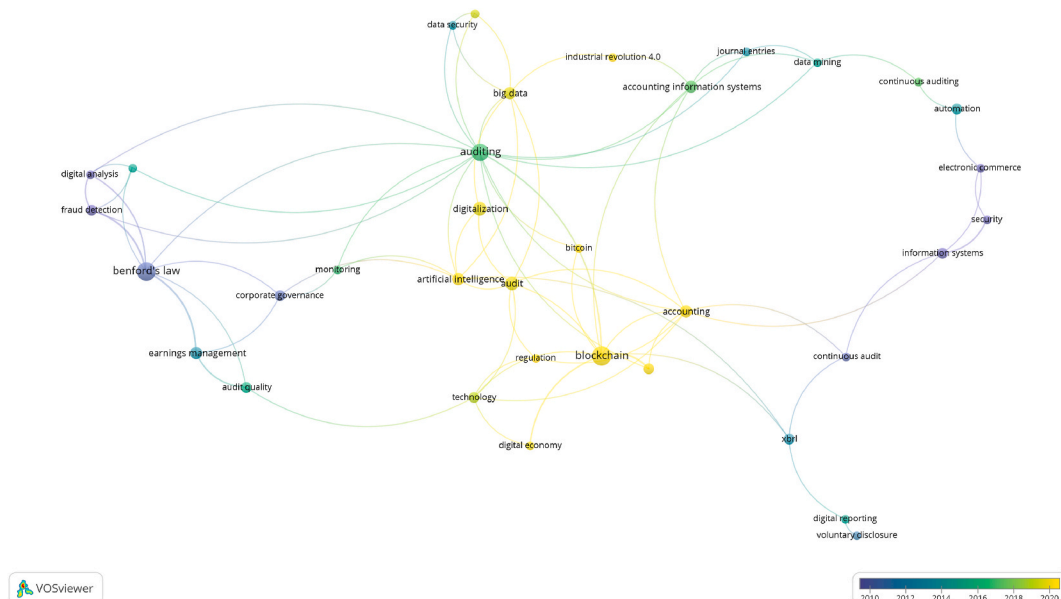


Fig. 6. Keyword analysis. Overlay analysis.

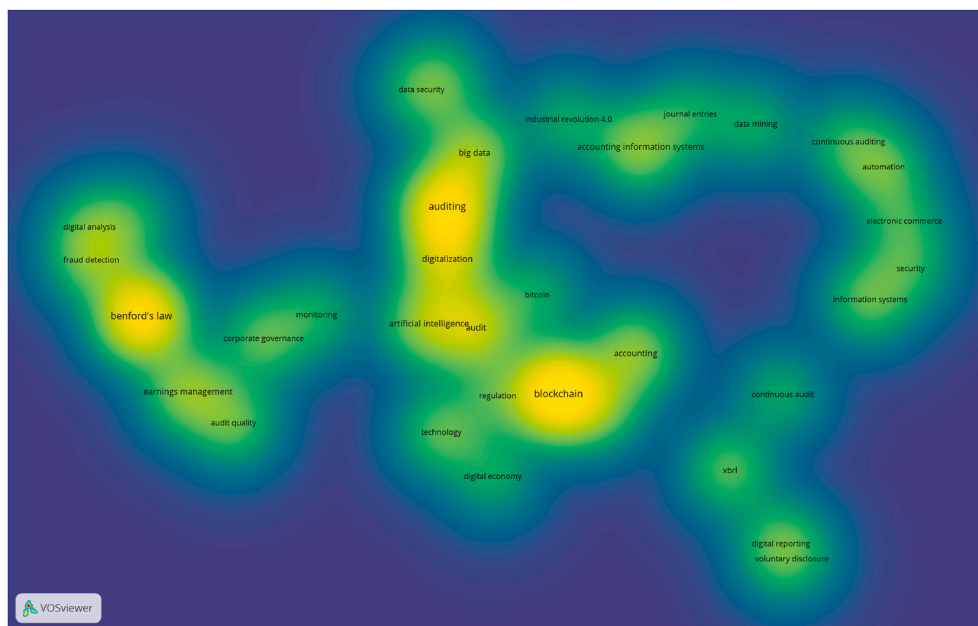


Fig. 7. Keyword analysis. Density analysis.

Academics have considered the phenomenon as an evolutionary process based on the implementation of new technologies to increase auditing activities' effectiveness and reliability [50,74]. Thus, despite the fast growth of technological innovation during the last few years, academics consider digital transformation in auditing a central topic. In particular, many of these studies have underlined the need to evolve from a static to a dynamic approach to favour the development of continuous auditing approaches [55,59]. Other studies highlighted the disruptive impacts of digitization on the auditing profession [51,75]. In this sense, the scientific discussion of digital auditing is influenced both by technological innovation and the need to provide managerial insights useful for practitioners and firms.

As described above, the accounting field shows a great deal of crossover with the auditing profession. Academic studies have tried to provide useful insights to favour the digital transformation of a highly standardized profession. The contribution of standardization to digital transformation is twofold. On the one hand, standardization favours the implementation of digital features. In particular, academic studies with qualitative research methods underline the enabling role of digitalization for traditional and novel auditing activities such as internal control, data protection and fraud detection [20,76]. On the other hand, auditing activities can be negatively affected by cultural barriers. –In fact, the implementation of these practices requires a dialogue with management. In this sense, the adoption of technological devices to engage with directors and managers represents an activity characterized by complexities related to the necessity to discuss with them. Some academics have tried to evaluate which factors impact the adoption of technological features in the audit. A study conducted by Kim et al. [31] observed that internal auditors are usually more interested in integrating practices that are less complex in their activities. The same perspective was confirmed in the study conducted by Tiberius and Hirth [59] regarding the impacts of digitalization on the auditing profession. Those authors highlighted, through a survey conducted on a sample of experts, that digitalization is not considered a criticism due to the central role played by auditors' knowledge and skills.

The collected evidence reveals that accounting scholars play an enabling role within the debate. The findings could be summarized through the identification of common traits between constraints and opportunities related to the digital transformation of the auditing profession.

Bibliometric analysis reveals the four independent research clusters in the discussion. These four clusters have been classified as being about continuous auditing (Green Cluster), fraud detection (Blue Cluster), data analytics (Yellow Cluster) and technological innovation (Red Cluster). However, the interpretative analysis suggests similarities due to the high degree of contamination in the field. Unlike other accounting and auditing topics, digital transformation is a sub-field extensively contaminated with other subjects such as IT, strategic management and engineering. Additionally, new forms of corporate reporting have proliferated in recent years. Thus, the auditing field has evolved due to both technological innovation and innovation in corporate reporting.

5.2. What are the future research topics about digital transformation in internal auditing?

The future research about digital transformation in internal auditing will be driven by technological innovation and corporate reporting strategies. Thus, new research lines cannot be identified ex-ante without analyzing the evolutionary pathways of the next years. However, the bibliometric analysis allowed us to identify underdeveloped research areas that could represent future research directions for auditing scholars (Table 3).

Research Area 1: According to Deloitte [70]; continuous auditing will pose one of the main opportunities for internal auditors. However, the wide diffusion of continuous auditing practices is made more difficult by the lack of widespread understanding about its effectiveness. The implementation of continuous auditing practices within organizations requires in-depth knowledge about the opportunities costs related to the investment in these practices. On the point, several studies have started to identify possible research areas to contribute to the debate on continuous auditing. In particular, these studies analyzed the possible implications of the investments in information systems [51,78]. These practices should be rethought given the inclusion, within the ERP systems, of data not directly related to traditional bookkeeping practices.

An example is an information about cybersecurity and supply chains [17,79]. Furthermore, Industry 4.0 has played a central role, favouring the development of new features that could enable the transition toward implementing digital processes in the auditing profession. Blockchain is one such innovation. In particular, academics underline Blockchain's potential enabling role in auditing in terms of data reliability and

Table 3
Research gaps: an overview.

Cluster	Relevant Keywords	Relevant Articles	Research gaps
Green	<ul style="list-style-type: none"> • Continuous auditing • Automation • XBRL 	[50,55, 61]	<p>RG1.1. What are the main cultural barriers that negatively impact on the implementation of continuous auditing practices?</p> <p>RG1.2. What digital features will contribute to the development of continuous auditing practices?</p> <p>RG1.3. What are the significant impacts of the adoption of Blockchain systems? What are the primary limits of Blockchain in auditing?</p>
Blue	<ul style="list-style-type: none"> • Benford's law • Fraud detection • Earning Management 	[48,52, 64]	<p>RG2.1 How will digitalization foster a predictive auditing approach to boost fraud prevention?'</p> <p>RG2.2 What are the risks caused by the adoption of technological procedures in data analysis?</p> <p>RG2.3 What are "new frauds" in the current scenario?</p>
Data analytics	<ul style="list-style-type: none"> • Accounting Information Systems • Big Data • Data Security 	[31,51, 67]	<p>RG3.1 How will the auditor role evolve as a result of digital transformation?</p> <p>RG3.2 What are the ethical implications related to the implementation of AI in auditing?</p> <p>RG3.3 What are the digital features that will support big data analytic activities?</p>
Emerging technologies in auditing	<ul style="list-style-type: none"> • Blockchain • Digital Economy • Bitcoin 	[20,59, 77]	<p>RG4.1 What are the new frontiers of auditing?</p> <p>RG4.2 What are the implications of the exigence to analyze non-financial data?</p> <p>RG4.3 What will the future competencies for auditors be?</p>

security [77,80]. At the same time, certain studies have discussed the limits of a significant transaction to Blockchain systems [57,81].

Future studies in this area could address the following research gaps (RG):

RG1.1. What are the main cultural barriers that negatively impact on the implementation of continuous auditing practices?

RG1.2. What digital features will contribute to the development of continuous auditing practices?

RG1.3. What are the significant impacts of the adoption of Blockchain systems? What are the primary limits of Blockchain in auditing?

Research Area 2: Fraud detection plays a central role in the debate. Benford's law probably represents the main topic analyzed by academics due to its wide diffusion in the auditing profession. The theoretical paradigm proposed by Benford [49] has been extended through the analysis of the potential integration of digital features within the analysis. Thus, the scientific debate has included a high degree of attention to potential innovations that may be useful in avoiding the risks caused by the adoption of standardized practices. In particular, these studies analyzed the enabling role technological features play both in terms of sampling strategies and error detection [52,66]. Also, other authors introduced new reflections about fraud detection based on the adoption of empirical analysis to detect frauds and anomalies [73].

Future research on this area could address the following gaps:

RG2.1 How will digitalization foster a predictive auditing approach to boost fraud prevention?'

RG2.2 What are the risks caused by the adoption of technological procedures in data analysis?

RG2.3 What are "new frauds" in the current scenario?

Research Area 3: Data management represents a strategic driver for companies. However, adequate data management cannot be achieved without significant attention, being paid to data analysis. Data analysis is a complex activity that has changed auditors' profession. Auditors require data in order to conduct real-time analysis of organizations, and the current scenario is characterized by the wide adoption of big data during decision-making processes. Furthermore, the study conducted by La Torre et al. [16] observes the adverse effects on the auditing profession caused by the identification of new activities. Discussion of the ethical implications of implementing new digital features to support auditors has increased rapidly in recent years [7,58]. The ethical debate includes reflection about the impacts of digital features such as AI and big data analytics.

Future research in this area could address the following gaps:

RG3.1 How will the auditor role evolve as a result of digital transformation?

RG3.2 What are the ethical implications related to the implementation of AI in auditing?

RG3.3 What are the digital features that will support big data analytic activities?

Research Area 4: The last years have been interested by the development of new technological features that have impacted on auditing professions in a disruptive way. Within this scenario, Blockchain and smart contracts are two of the main features to consider due to their direct connection with some of the main concepts that inspired auditing professions such as transparency, irrefutability and data protection [82,83]. However, only few studies have been developed about them due to their novelty. In this sense, the academics could covered a central role within this early stage through the development of evidence-based studies able to identify the main strengths and weakness behind the adoption of these features. In addition, the future research could be addressed to discuss about the ethical implications related to the digitalization of activities that have been historically characterized by the central role of the auditors. Finally, the next years will be interested by the effects of the increasing pressures made by policy makers about the need to consider non-financial dynamics within the organizations. Thus, the need to rethink auditing practices will represents a promising field of research for the accounting scholars interested to contribute to a complex

RG4.1 What are the new frontiers of auditing?

RG4.2 What are the implications of the exigence to analyze non-financial data?

RG4.3 What will the future competencies for auditors be?

6. Conclusion

6.1. Lessons learned

The last years have been interested in progressive attention paid by organizations toward the risks and opportunities related to the development of new technologies [84]. The experience of Blockbuster and Kodak underlines the risks related to the lack of flexibility about the disruptive impacts caused by digital transformation [1]. In this sense, the reflections about the impacts caused by digital transformation regard both SMEs and large firms. Furthermore, the current scenario is characterized by the exigence to rethink accounting and auditing professions in order to mitigate the negative externalities caused by robotization, automation and AI [6,7].

Within this scenario, internal auditors represent a strategic player that has been historically interested in the effects caused by innovation

on their practices [64]. Contrarily to other accounting and auditing professions, the impact caused by digital transformation on internal auditing can be considered more similar to opportunities than constraints [17,50]. This evidence is confirmed by the findings collected within the paper as regards the coexistence of traditional and innovative topic within a scientific field characterized by a high degree of contamination with internal auditing practitioners. Furthermore, the analysis reveals that some of the main technological features that have been introduced during the last years are parts of the current debate on internal auditing [59,69,85].

6.2. Main contributions, limitations, and future research

The alignment of the knowledge between academics and practitioners represent one of the main challenges for accounting scholars. In this sense, our paper tried to combine theoretical and managerial implications within a common umbrella. The reasons behind our choice are multiple. As evidenced by Bartunek and Rynes [44]; the international debate is characterized by the tension between academics and practitioners caused by the different expectative as regards the contribution of scientific papers. In this sense, the development of scientific studies characterized by an adequate degree of integration between “scientific” and “practical” impacts represent an activity characterized by several criticisms. In particular, this evidence is more substantial in review studies than empirical or normative research [23]. In this sense, the choice to develop a bibliometric analysis under the supervision of an expert was related to the opportunity to combine the two challenges within the research. On a hand, we have found that the scientific debate is characterized by a high degree of attention paid by academics as regards the main digital innovation that has characterized the last years. On the other hand, we highlighted the high degree of contamination made by practitioners on the debate. In this sense, our findings will positively contribute to the development of new studies that integrate managerial and theoretical implications [23,44].

Like every literature review, the paper suffers from criticisms related to its strengths. In particular, the choice to focus the analysis on a specific field limits the research stream to a few numbers of contributions. Furthermore, the exclusion of the conference proceedings could represent a limit for a sufficient comprehension of the field due to its novelty. In this sense, future research can be addressed to fill this gap through the analysis of the contribution provided by international scholars within scientific conferences. Furthermore, other studies could be conducted as regards the contribution provided by scholars within journals not included in our scope.

Declaration of competing interest

All co-authors have seen and agree with the contents of the manuscript and there is no financial interest to report. We certify that the submission is original work and is not under review at any other publication.

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