

Four research pathways for understanding the role of smart technologies in accounting

Role of smart technologies in accounting

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Abstract

Purpose – This paper aims to study the role of smart technologies (e.g., artificial intelligence, Internet of Things, blockchain and analytics, among others) in the accounting environment (AE). In this context, the nuances of innovation generated by such technologies allow for tracing the merging trends in accounting research.

Design/methodology/approach – This paper uses an integrated qualitative methodology composed of structured literature analysis and systematic literature analysis to study scientific papers published and stored in prominent databases from 2000 to 2020. This paper collected a data set sharing topics related to smart technologies and innovation in the AE.

Findings – The primary findings reveal four research paths of innovation, impact, implication and intelligence in accounting research as follows: smart technologies as innovations to be managed; smart technologies as impacting tools affecting the AE in certain circumstances; smart technologies as a source generating relevant implications; and smart technologies as factors requiring new and updated knowledge, skills and abilities of actors.

Originality/value – The joint investigation of the AE and smart technologies poses a milestone for future academic and professional accounting research. This paper proposes a new framework (SMATECHacc Framework) consisting of four pathways research that can be used by future researchers to consider and construct their own research designs.

Keywords Accounting, Intelligence, Innovation, Impact, Smart technologies, Implication, Accounting environment

Paper type Research paper

1. Introduction

Over the past few years, data collection, storage and processing have become hot accounting research topics owing to the growing complexity of contemporary organizations and the environment in which they operate, survive, exchange information globally and create long-term value (de Villiers *et al.*, 2021; Lombardi *et al.*, 2020a; Nambisan *et al.*, 2017; Wessel, 2005). Smart and emerging technologies, including artificial intelligence (AI), Big Data,



Internet of Things (IoT) and blockchain, could address the need for adopting flexible and open accounting information systems, fostering collaborations and knowledge translation in the accounting environment (AE) (do Cèu and Gaspar Alves, 2010; Kozlowski, 2018; La Torre *et al.*, 2018; Mancini, 2016; Mancini *et al.*, 2016; Stainbank and Gurr, 2016).

In this scenario, smart technologies are re-configuring the AE. AI is based on several technologies imitating the human thoughts, allowing to computer machines to develop complex reasoning and operations in short time (Cristiano, 2020; Greenman, 2017; Marrone and Hazelton, 2019). IoT is an internet-based architecture based on the communication internet, energy internet and logistics internet (Rifkin, 2014; Trequattrini *et al.*, 2016). It is characterized by dynamicity and adopted at globally level using standard communication protocols and self-configuring capability of physical and virtual things (Sundmaeker *et al.*, 2010). Big Data allows for the management of enormous amounts of data from various sources using digital tool and obtaining invaluable insights through six dimensions volume, velocity, variety, veracity, variability and value (Gandomi and Haider, 2015; Morabito, 2015; Secundo *et al.*, 2017). Blockchain is the distributed ledger among several actors adopting digital tools (Carlin, 2019; Demirkan *et al.*, 2020; Lombardi *et al.*, 2021; Pimentel and Boulianne, 2020; Schmitz and Leoni, 2019) useful for “transactions conducted among various parties in a network... Every entry in a blockchain is a transaction that represents an exchange of value between participants” (CPA and AICPA, 2017, p. 3).

Academic research and professional publications have paid a great deal of attention to examine the impact of smart technologies on commercial and marketing activities (Lombardi *et al.*, 2020a), or human resource management and employment (Metallo *et al.*, 2021), strategic processes and business models (Lardo *et al.*, 2020; Schiavone *et al.*, 2021). Thus, little attention is paid to investigating the role, relevance and impact of smart technologies in the AE. Digital transformation implications on the financial and accounting function and environment are under investigation (Troshani *et al.*, 2019). On the one hand, public and private organizations can rely on growing automation levels to improve efficiency and competitiveness (Lombardi *et al.*, 2020b). Professional studies highlight some challenges that involve temporary accountants as masters of the company’s digital transformation. Business catalysts can creatively interpret different types of data (CapGemini Consulting, 2015). But which emerging innovations technologies will stimulate the financial and AE shortly? What could be the implication of digitization on accounting information, processes, methodologies and skills? What are the role and the contribution of agents in the AE in succeeding in digital transformation?

Investigating automation and accounting is not a new research topic in business administration science (Simon, 1988; Marchi, 1993). It has been an attractive field for researchers and also a significant matter for companies. It has received increasing attention every time firms and society had to face disruptive technologies, as it has happened in the past for the appearance of the first computers, or some years later with the advent of ERP systems, and today with the spread of intelligent technologies. After initial attention on efficiency, cost reduction and integration, research and practice usually focus on the effectiveness of these technological innovations and their strategic meaning to take a concrete step forward. Thus, this paper aims to ponder the current state of the art in academic studies in the relationship between the AE and emerging smart information technologies (e.g. AI, IoT, blockchain, analytics, social media).

We focused on the links between smart and information technology and financial accounting, auditing, reporting, management accounting, management control, auditing and related disciplines (AE). We aim at stimulating a renewed debate and new research concerning the interaction between digital and smart technologies and accounting

(information) systems. Thus, we investigate the relationship between information communication technology and innovation in the field of (financial and management) accounting. Furthermore, we propose a future agenda to foster innovation in the AE by underlining digital, smart and social technologies, such as accounting analytics, accounting information systems, accounting models and other relevant enterprise systems, such as management control systems, performance measurement systems, internal control systems, risk assessment and management systems, among others).

We used a mixed qualitative methodology composed of structured literature review (SLR) and systematic literature analysis to conduct a primary bibliographic investigation (Massaro *et al.*, 2016; Petticrew and Roberts, 2006; Post *et al.*, 2020; Secundo *et al.*, 2020; Van Eck and Waltman, 2017). We constructed the research protocol (Kraus *et al.*, 2020), adopting the horizontal time from 2000 to 2020. After the initial screening and comparing opinions among authors, our final data set was composed of 26 core articles. In this context, our study findings reveal four research paths of innovation, impact, implications and knowledge in accounting research. We provide original and novel results contributing to the literature on the AE and smart technologies (Vasarhelyi *et al.*, 2015; Alles, 2015; Marshall and Lambert, 2018; Smith, 2018; Munoko *et al.*, 2020; De Santis and D'Onza, 2021). We construct a new framework (SMATECH_{acc} Framework) consisting of four pathways research has followed, which can be used by future researchers to consider and construct their research designs.

The remainder of this paper is organized as follows. Section 2 presents the methodological framework used in this study. Section 3 shows the main findings. Section 4 presents implications, conclusions and a future research agenda.

2. Methodological framework

We adopted the SLR, integrated with the systematic literature and bibliometric review (Lombardi and Secundo, 2021; Tranfield *et al.*, 2003; Petticrew and Roberts, 2006; Post *et al.*, 2020; Secundo *et al.*, 2020; Van Eck and Waltman, 2017). Thus, we constructed the research protocol (Kraus *et al.*, 2020; Massaro *et al.*, 2016) following our research aims, fostering renewed debates and new research paths from the interaction between digital and smart technologies and the AE, illuminating the way to future research.

We used the Scopus database (www.scopus.it) to collect articles composing our data set. Our search query allowed us to select documents (only articles in final publication status) using the primary input on “Article title, Abstract, Keywords,” adopting the Boolean operator (AND-OR) in the search too. Also assuming the business, management and accounting subject area, we composed our search query through the keywords identified in the call for papers by Meditari Accountancy Research titled “Discovering the relationship between the Accounting Environment and Smart Technologies: Charting the new and thrilling challenges” with the purpose to propose an overview and cover all topics by which several scholars singularly replied (Bartolacci *et al.*, 2021; De Santis and D'Onza, 2021; Ferri *et al.*, 2021; Lamboglia *et al.*, 2021; Lombardi and Secundo, 2021; Nicolò *et al.*, 2021; Tingey-Holyoak *et al.*, 2021). Particularly, we investigated the connection, on one side, among “accounting” and “innovation” and, on the other side the following keywords (as an alternative):

- Artificial intelligence
- Internet of Things
- Intellectual capital
- Smart technologies
- Blockchain

- Analytics
- Social media
- XBRL
- Big Data
- Digital ecosystems
- Collaborative platform

Starting from a primary result of 96 documents collected over the horizontal time 2000–2020 (twenty years, until the end of 2020), we obtained 51 articles after including previous criteria of the search. After a wide discussion path among authors and the reading of documents, we decided to develop the systematic literature analysis and bibliometric analysis (through VoSWiever) on 26 core articles composing our final data set (Table 1) even if some relevant articles in the field could be additionally collected extended the horizontal time and keywords. We excluded articles that were not relevant for our research topic, as paper concerning innovation and/or smart technologies but not in an AE, or paper which consider accounting and innovation but do not consider any smart technology.

In the light of the research protocol (Massaro *et al.*, 2016) and adjusted investigation processes, we pose the following research questions:

- RQ1.* What is state of the art in the joint investigation between accounting and innovation and smart technologies?
- RQ2.* What are the implications for future research of the intersection between accounting environment, innovation and smart technologies?

Interestingly, our qualitative and bibliometric analysis represents the main lead background in the connection between the AE (pushing on innovation systems) and new and smart information technologies. The following sections report the bibliometric investigation and the systematic analysis to achieve a deep research path for the next future agenda.

3. Bibliometric and systematic analysis

This section is directed to present the main results by the bibliometric investigation and systematic analysis on the built data set with the purpose to answer our research questions.

3.1 Highlights and bibliometric analysis

Thus, we assert the newest of this field of publications during the last 20 years. We highlight an increasing number of articles published since 2017 (Figure 1). Thus, we assert the newest of this field: this is a recent and emerging topic investigated by Scholars.

The top eight sources in which articles composing our data set are published are listed below (Table 2). The most relevant sources are “Journal of Accounting Education” and “Journal of Emerging Technologies in Accounting” in the light of the number of articles published on the topic treated in this research. We also presented for each source the positioning in the Chartered ABS ranking (<https://charteredabs.org/academic-journal-guide-2018/>) following the last release.

The total number of citations of articles composing our data set is 432, including citations by 2021 of published articles until 2020 (Table 3). We emphasize that most citation activities are registered in the last years, especially during 2019 (80 citations) and 2020 (115 citations). We also included the list of top ten articles ranked by total citations (Table 4).

Authors	Year	Title	Source title
Alles, M.G.	2015	Drivers of the use and facilitators and obstacles of the evolution of big data by the audit profession	<i>Accounting Horizons</i>
Ashley, M.J., Johnson, M.S.	2018	Establishing a secure, transparent, and autonomous blockchain of custody for renewable energy credits and carbon credits	<i>IEEE Engineering Management Review</i>
Ballou, B., Heitger, D.L., Stoel, D.	2018	Data-driven decision-making and its impact on accounting undergraduate curriculum	<i>Journal of Accounting Education</i>
Cai, C.W.	2018	Disruption of financial intermediation by FinTech: a review on crowdfunding and blockchain	<i>Accounting and Finance</i>
Cavicchi, C., Vagnoni, E.	2018	Intellectual capital in support of farm businesses' strategic management: a case study	<i>Journal of Intellectual Capital</i>
Escobar-Rodríguez, T., Gago-Rodríguez, S.	2012	"We were the first to support a major is innovation." Research into the motivations of Spanish pioneers in XBRL	<i>Revista de Contabilidad-Spanish Accounting Review</i>
Gray, G.L., Miller, D.W.	2009	XBRL: Solving real-world problems	<i>International Journal of Disclosure and Governance</i>
Lee, C.S., Tajudeen, F.P.	2020	Usage and impact of artificial intelligence on accounting: Evidence from Malaysian organizations	<i>Asian Journal of Business and Accounting</i>
Lenny Koh, S.C., Genovese, A., Acquaye, A.A., Barratt, P., Rana, N., Kuylenstierna, J., Gibbs, D.	2013	Decarbonising product supply chains: Design and development of an integrated, evidence-based decision support system-the supply chain environmental analysis tool (SCEnAT)	<i>International Journal of Production Research</i>
Liu, C., Yao, L.J., Sia, C.L., Wei, K.K.	2014	The impact of early XBRL adoption on analysts' forecast accuracy - Empirical evidence from China	<i>Electronic Markets</i>
Marshall, T.E., Lambert, S.L.	2018	Cloud-based intelligent accounting applications: Accounting task automation using IBM Watson cognitive computing	<i>Journal of Emerging Technologies in Accounting</i>
Martić, V., Lalević-Filipović, A., Radović, M.	2017	XBRL implementation in the banking sector in Montenegro	<i>Journal of Central Banking Theory and Practice</i>
Munoko, I., Brown-Liburd, H. L., Vasarhelyi, M.	2020	The Ethical Implications of Using Artificial Intelligence in Auditing	<i>Journal of Business Ethics</i>
Paulevich, S.V., Khorin, A.N., Potanina, Y.M	2019	Change from economic analysis to operational analytics and corporate analysis in innovative entrepreneurship	<i>Academy of Entrepreneurship Journal</i>

(continued) (alphabetical order)

Table 1.
Data set

Authors	Year	Title	Source title
Qin, L.	2011	XBRL, semantic web and web services	<i>International Journal of Business and Systems Research</i>
Reepu	2019	Blockchain: Social innovation in finance and accounting	<i>International Journal of Management</i>
Riggins, F.J., Klamm, B.K.	2017	Data governance case at KrauseMcMahon LLP in an era of self-service BI and Big Data	<i>Journal of Accounting Education</i>
Rozario, A.M., Thomas, C.	2019	Reengineering the audit with blockchain and smart contracts	<i>Journal of Emerging Technologies in Accounting</i>
Singh, S., Singh, S.	2016	Accounting for risk in the traditional RFM approach	<i>Management Research Review</i>
Smith, S.S.	2018	Implications of next step blockchain applications for accounting and legal practitioners: A case study	<i>Australasian Accounting, Business and Finance Journal</i>
Smith, S.S., Petkov, R., Lahijani, R.	2019	Blockchain and cryptocurrencies – considerations for treatment and reporting for financial services professionals	(2019) <i>International Journal of Digital Accounting Research</i>
Susarla, A., Barua, A., Whinston, A.B.	2010	Multitask agency, modular architecture, and task disaggregation in SaaS	<i>Journal of Management Information Systems</i>
Taylor, E.Z., Dzurandin, A.C.	2010	Interactive financial reporting: An introduction to extensible business reporting language (XBRL)	<i>Issues in Accounting Education</i>
Troshani, I., Janssen, M., Lymer, A., Parker, L.D.	2018	Digital transformation of business-to-government reporting: An institutional work perspective	<i>International Journal of Accounting Information Systems</i>
Troshani, I., Parker, L.D., Lymer, A.	2015	Institutionalising XBRL for financial reporting: Resorting to regulation	<i>Accounting and Business Research</i>
Zemánková, A.	2019	Artificial intelligence and blockchain in audit and accounting: Literature review	<i>WSEAS Transactions on Business and Economics</i>

Table 1.

The most relevant articles in terms of citations are by Susarla *et al.* (2010) “Multitask agency, modular architecture, and task disaggregation in SaaS (68 citations) and Alles (2015) “Drivers of the use and facilitators and obstacles of the evolution of big data by the audit profession” (65 citations).

Additionally, we determined the occurrences of keywords (Table 5) through the groupings method evaluating the frequency of keywords by VoSviewer. We used all keywords by authors, editors and publishers recurring at least two times, adopting a full counting path as statistical criteria in analysing data by VoSviewer. We found two main clusters of keywords as reported in Table 6 and Figure 2.

As shown from Table 5 and Table 6, articles in our data set primarily concern blockchain, eXtensible Business Reporting Language (XBRL), AI and Big Data concerning smart technologies. However, they deal with accounting/auditing, digital/financial reporting, innovation and economic analysis with regards to the AE. These papers mainly

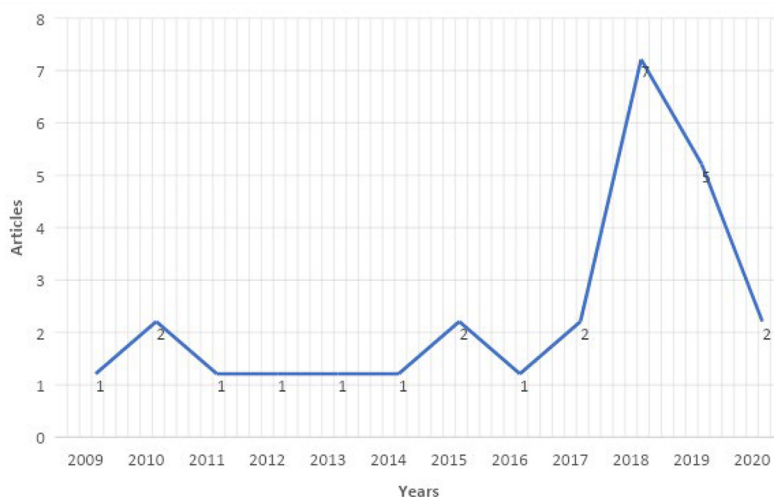


Figure 1.
Publication trends

Sources	No. of articles	ABS ranking
<i>Journal of Accounting Education</i>	2	2
<i>Journal of Emerging Technologies in Accounting</i>	2	1
<i>Academy of Entrepreneurship Journal</i>	1	
<i>Accounting and Business Research</i>	1	3
<i>Accounting and Finance</i>	1	2
<i>Accounting Horizons</i>	1	3
<i>Asian Journal of Business and Accounting</i>	1	
<i>Australasian Accounting Business and Finance Journal</i>	1	1

Table 2.
Top eight sources

analyze supply chain or entrepreneurship as the context in which those technologies and accounting issues are investigated.

Furthermore, Figure 2 highlights that AI and blockchain technologies are investigated in relationship with accounting and auditing in terms of innovation, while research focused on Big Data technology is connected with the auditing field and economic analysis and referred to the context of supply chains and firms. We also developed the bibliographic coupling analysis with a minimum of one citation adopting the full counting path. Assuming the analysis of the articles sharing the same references (Boyack and Klavans, 2010), we retrieved three clusters (Figure 3 and Table 7) that we adjusted after some research discussion. Clusters emphasize selected articles on a specific topic.

Year	Citations received by the papers published each year												
	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Citations	0	1	12	13	26	23	25	25	38	43	80	115	31
Number of articles	1	2	1	1	1	1	2	1	2	7	5	2	

Table 3.
Citation per year

Table 4.
Top-ten articles per
citations

Authors	Title	Year	Source Title	Citations
Ashley, M.J., Johnson, M.S.	Establishing a secure, transparent, and autonomous blockchain of custody for renewable energy credits and carbon credits	2018	<i>IEEE Engineering Management Review</i>	17
Troshani, I., Janssen, M., Lymer, A., Parker, L.D.	Digital transformation of business-to-government reporting: An institutional work perspective	2018	<i>International Journal of Accounting Information Systems</i>	15
Cai, C.W.	Disruption of financial intermediation by FinTech: a review on crowdfunding and blockchain	2018	<i>Accounting and Finance</i>	39
Marshall, T.E., Lambert, S.L.	Cloud-based intelligent accounting applications: Accounting task automation using IBM Watson cognitive computing	2018	<i>Journal of Emerging Technologies in Accounting</i>	13
Alles, M.G.	Drivers of the use and facilitators and obstacles of the evolution of big data by the audit profession	2015	<i>Accounting Horizons</i>	65
Troshani, I., Parker, L.D., Lymer, A.	Institutionalising XBRL for financial reporting: Resorting to regulation	2015	<i>Accounting and Business Research</i>	17
Liu, C., Yao, L.J., Sia, C.L., Wei, K.K.	The impact of early XBRL adoption on analysts' forecast accuracy - Empirical evidence from China	2014	<i>Electronic Markets</i>	16
Lenny Koh, S.C., Genovese, A., Acquaye, A.A., Barratt, P., Rana, N., Kuylenstiern, J., Gibbs, D.	Decarbonising product supply chains: Design and development of an integrated evidence-based decision support system-the supply chain environmental analysis tool (SCEnAT)	2013	<i>International Journal of Production Research</i>	57
Susarla, A., Barua, A., Whinston, A. B.	Multitask agency, modular architecture, and task disaggregation in SaaS	2010	<i>Journal of Management Information Systems</i>	68
Taylor, E.Z., Dzurainin, A.C.	Interactive financial reporting: An introduction to extensible business reporting language (XBRL)	2010	<i>Issues in Accounting Education</i>	27
Gray, G.L., Miller, D.W.	XBRL: Solving real-world problems	2009	<i>International Journal of Disclosure and Governance</i>	30

Table 5.
Co-occurrence keywords

Keyword	Occurrences
blockchain	7
xbri	7
accounting	5
artificial intelligence	5
audit	2
auditing	2
big data	2
carbon	2
digital reporting	2
economic analysis	2
entrepreneurship	2
financial reporting	2
innovation	2
smart contracts	2
supply chains	2

For instance, regarding XBRL, three clusters were identified by using bibliometric coupling analysis. The first cluster included two articles investigating the causes and motivation of obstacles or difficulties during the early stage of XBRL adoption. The second cluster analyzed the introduction of XBRL technology in an international comparison. In this cluster, technologies in the AE are investigated from a macro perspective in terms of interaction between institutions and other actors, understanding the relevance and impact of voluntary and mandatory innovations. The two studies included in the cluster aim to understand the impact of different behaviors of countries, or different roles of actors in the AE, on the speed and effectiveness of introducing emerging technology as XBRL. The third cluster includes two articles concerning XBRL adoption to investigate why early adopters decide to use emerging technology. These two studies adopt a micro perspective considering XBRL users and their impact on their work and decision processes. The other research areas were similarly clustered, and insights integrated into the findings and discussion.

3.2 Highlighting the content analysis results

To achieve a more comprehensive map of the emerging research areas, the authors performed a manual content analysis by carefully and independently reading all 26 core papers. At the end of this process, previous clusters were adjusted the following research aims of the paper. Four emerging research areas were identified as follows:

- *Research area 1:* Smart technologies as innovations to be managed in the AE;

Cluster 1 (red colour)	Cluster 2 (green colour)
Accounting	Auditing
Artificial intelligence	Big data
Audit	Carbon
Blockchain	Economic Analysis
Innovation	Entrepreneurship
Smart Contracts	Supply Chains

Table 6.
Cluster of keywords

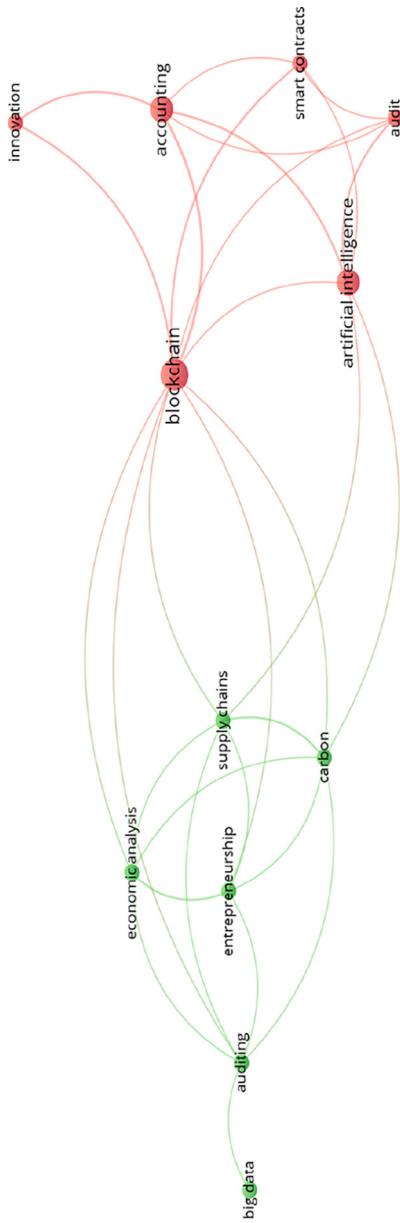


Figure 2.
Co-occurrences
keywords

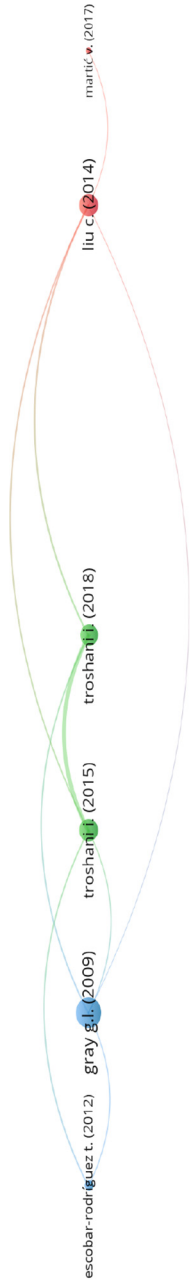


Figure 3. Bibliographic coupling

- *Research area 2:* Smart technologies as impacting tools that affect the AE only in certain circumstances;
- *Research area 3:* Smart technologies as a source that generates relevant implications for the future of the AE; and
- *Research area 4:* Smart technologies as factors that require new and updated knowledge, skills and abilities (KSA) of actors in the AE.

Following the previous clustering path, we identify emerging research areas emphasizing the current body of knowledge and future streams of research in the intersection between smart technologies and the AE. As shown in [Table 8](#), many articles analyze smart technologies as tools that can affect (positively or negatively) the AE (second research area). The other articles are evenly distributed in the remaining three classes: six articles are located in the first and the third research area because they focus on the emerging technologies as an innovation or as a source of implications for the future. Last, four articles are located in the fourth class because they focus on smart technologies as a challenge for education.

From a technological perspective, our data set analyzed mainly XBRL (8), blockchain (6), Big Data analytics (5) and AI (4), while in terms of the AE, they concern financial reporting (9), accounting (8), auditing (6) and FinTech (2).

3.2.1 Research area 1: smart technologies as innovations to be managed in the accounting environment. The first research area considers the adoption of smart technologies as a process of innovation in the AE involving some actors, generating organizational change. It could represent an opportunity or a threat. To seize all the opportunities and to limit risks and threats, the innovation process must be managed. In this research area, there are some theoretical studies and few empirical investigations. Many articles focus on XBRL (five papers); little attention is dedicated to other types of technologies, or specific firms or industries, without any distinction between the private and public sector.

The researchers investigated the innovation process from a number of perspectives. First, an institutional perspective, which considers all the agents involved in implementing and spreading innovations driven by emerging technologies in the accounting field. These articles aim to understand how to create a better or more efficient way to introduce these innovations and generate timeliness, wide and effective impact on firms, economic and

Table 7.
Cluster by
bibliographic
coupling

Cluster	Articles
1 (red color)	Liu <i>et al.</i> (2014) and Martić <i>et al.</i> (2017)
2 (green color)	Troshani <i>et al.</i> (2015) and Troshani <i>et al.</i> (2018)
3 (blue color)	Escobar-Rodríguez and Gago-Rodríguez (2012) and Gray and Miller (2009)

Table 8.
Research area by
content analysis

Research area	No. of papers
1. ST as innovation	6
2. ST as tools	10
3. ST as a source of implications	6
4. ST as challenges for KSA	4
Total	26

institutional environments (Troshiani *et al.*, 2015, 2018; Martić *et al.*, 2017). This perspective stimulates a collective and collaborative vision of an effective innovation process regarding emerging technologies. Second, the users' perspective to investigate adopters' motivations, stimulates and obstacles in implementing emerging technologies. The aim is to understand if users consider technologies and related changes as a short-term fashion or long-term opportunity (Gray and Miller, 2009; Susarla *et al.*, 2010; Escobar-Rodriguez and Gago-Rodriguez, 2012).

Instead of an economical and efficiency perspective, Troshiani *et al.* (2015) adopt an institutional and organizational perspective to predict emerging technologies' implementation and use as XBRL. According to this framework, the actors involved (as software vendors, users, industry associations and government) in the innovation process have to develop and share an organizing vision, which is fundamental to engage them in the diffusion of an uncertain innovation. Troshiani *et al.* (2018) use an empirical approach based on interviews and document analysis to compare certain countries' institutional work in introducing business digital reporting in XBRL. They underline that two factors are determinant for the spreading of digital reporting: its mandatory adoption, to stimulate all the actors involved and a multi-agent perspective, to mobilize all actors of the business reporting domain "including regulators, business, intermediaries, software developers, professional accounting and industry associations" (Troshiani *et al.*, 2018, p. 32). The authors argue that the disruption from traditional to digital reporting requires an institutional change that disconnects regulation from the former and reconnects it to the latter.

The perspective of users is considered to understand under what circumstances the adoption and acceptance of such technologies can be pushed as fast as possible and can help in the innovation of the accounting processes. Studies argue that relevant factors in achieving widespread adoption of the XBRL and in accelerating its diffusion is the sharing of information about its advantages (Gray and Miller, 2009) or the pioneers' intuition and their ability to visualize the possibilities of the XBRL (Escobar-Rodriguez and Gago-Rodriguez, 2012), while for the outsourcing of IT services are organizing the interdependencies between client and provider (Susarla, 2010).

3.2.2 Research area 2: smart technologies as tools that affect the accounting environment only in certain circumstances. The second research area considers smart technologies as tools that can be implemented to automate accounting information processes. Currently, many articles in this area focus on blockchain (4) and AI (3). Articles investigate the following two streams of research:

- how smart technologies affect firms and accounting processes by exploring under what conditions and requirements those impacts are relevant and positive (Liu *et al.*, 2014; Marshall and Lambert, 2018; Cai, 2018; Rozario *et al.*, 2019; Reepu, 2019; Zemankova, 2019; Lee and Tajuden, 2020); and
- how to design tools able to enhance accounting information management to meet environmental issues (Koh *et al.*, 2013; Ashley and Johnson, 2018) or stakeholders' needs (Paulevich *et al.*, 2019).

Studies mainly highlight economic and cost savings, efficiency in accounting and operational processes, as smart and emerging technologies are implemented to perform structured or semi-structured processes. It is very relevant to understand how those technologies affect companies' processes from the strategic and management perspectives and to isolate the determinants that enable those kinds of impacts.

Lee and Tajuden (2020) developed an analysis of AI-based accounting software in the accounts payable functions, proposing a structured report to collect and transmit

information about possible opportunities and threats coming from AI. The authors called for similar research in other fields of the accounting software application “such as accounts receivable, inventory and bookkeeping functions as a whole” (Lee and Tajuden, 2020, p. 235), also considering the subfield of AI as robotic process automation and performing quantitative study based on surveys and not qualitative research with case studies. An interesting federative framework in the field of task automation for accounting and auditing is proposed by Marshall and Lambert (2018). They assert that a key impact of smart technology in the organizational perspective is the collaboration between accountant experts and cognitive computer models based on AI in problem-solving and knowledge development networks. An interesting stream of research regards the organizational effect of human-computer interaction in managing the cooperation between humans and AI to generate valuable accounting services.

Another study in the stream of AI for auditing processes is Zemankova (2019), which maps AI tools (genetic algorithms/programming, fuzzy systems, neural networks, hybrid systems) with audit tasks (analytical review procedures, classification, materiality assessments, decisions regarding going concern principle, bankruptcy prediction) to provide an overview of which type of AI should better support specific audit tasks. The paper also underlines threats related to AI applications related to the regulatory environment, privacy issues, labor market implications and ethical pressure. Further research could be developed, according to the author, to improve knowledge in cost/benefit analysis of AI projects and to understand to what extent audit tasks could be automated. Rozario and Thomas (2019) consider Blockchain and smart contracts as technologies able to support auditing processes and developed a framework for external audit and smart audit procedures. They underline how those technologies push a revision of roles and actors involved in the audit AE and stimulate the evolution of the financial statement paradigm “from a retroactive audit framework to a proactive audit framework” (p. 34). Compared to the benefit of technology implementation in auditing procedures, there are some issues to be investigated as if a smart audit is more beneficial than a traditional audit; what should be the balance between audit quality, as requested from firms, and audit litigation risk, as perceived from the auditors; and what are the risks and the effects of inappropriate use of smart technologies by actors involved in audit processes.

XBRL technology is also tested concerning its impact on forecast quality from the analysts' point of view to demonstrate that in the early adoption period, forecast quality and accuracy could be low because XBRL is not a well-known technology, while over time, it can contribute to value creation (Liu *et al.*, 2014). Cai (2018) discussed the implications of blockchain and crowdfunding on the financial industry through a systematic review of influential papers. The author observed that research in this field is fragmented and still in its infancy; however, more investigations are required to develop new theories and a cross-disciplinary approach to interpret emerging issues and topics like the changing nature of intermediaries and their risk; the comparison between traditional financial intermediation and new channels and platforms. The second stream of research includes three articles dealing with environmental and sustainability accounting (Koh *et al.*, 2013; Ashley and Johnson, 2018) and stakeholders accounting (Paulevich *et al.*, 2019). Blockchain technology has the potential to simplify data collection and management for the accounting of complex transactions, as in the case of renewable energy credits and carbon credits. It could be a means to reduce costs and time of the accounting processes, and to enhance the effectiveness of tracking, reconciling and auditing of energy credits necessary to monetize incentives for end-users (Ashley and Johnson, 2018). Cloud computing could be an effective platform for a decision support system for carbon emission accounting and management in a supply-chain

context (Koh *et al.*, 2013). Finally, analytics is considered the basic tool to address stakeholder information needs integrating internal and external data in innovative enterprises (Paulevich *et al.*, 2019).

3.2.3 Research area 3: smart technologies as a source that generates relevant implications for the future of the accounting environment. The third research area includes articles that investigate the implications of smart and emerging technologies for the future. They contain a call to adopt a futuristic approach to interpret the link between technologies and the AE to address opportunities or issues before they arise. One of the most relevant implications concerns ethical problems in using and adopting AI technologies to automate particular companies' accounting processes. Munoko *et al.* (2019) investigated the ethical implications of emerging technologies in accounting by examining AI in auditing. They developed a methodology and a comprehensive framework to predict risks, ethical implications and policy recommendations for AI, including developers, auditors and regulators. The authors call for research based on an integrated approach that stimulates collaboration between stakeholders in the accounting profession to elaborate "practical guidelines and effective governance over the use of AI."

Smith (2019) uses a forward-looking approach in investigating blockchain implications on legal, accounting and financial professions. He analyzed what legal and accounting professionals "should be aware of moving forward" (Smith, 2019, p. 78), considering the evolution of several next step applications in the Blockchain context such as lightning network, payment channels and stable coins. According to the author, blockchain pushes toward a transition of professionals' roles into service partners or trusted advisors that base their portfolio of services on interdisciplinary skills and abilities, partnerships with technical experts, practitioners and other stakeholders. This transition required a continuous learning approach to follow and anticipate the evolution of technologies in the Blockchain space. Still, it could also imply opportunities for a new offering of services in information and education. Some work opportunities could arise from advisory services in different cryptocurrencies and support services in information and misinterpretation of these technologies and applications for potential clients.

Singh and Singh (2016) discussed the enhancement of information capacity of data as a relevant opportunity offered by Big Data analytics. The authors underline the importance of companies and researchers finding "new and innovative ways to mine the data and draw managerially useful insights from it" (p. 215). In particular, they developed a risk-adjusted measure to estimate customer value, based on data from a customer relationship management database, which enrich the traditional recency, frequency and monetary value (RFM) analysis with the integration of risk of each customer measured considering "the probability of meeting minimum sales requirement, probability of being active and regularity of purchases made by the customer" (Singh and Singh, 2016, p. 227). The authors identify an exciting and valuable stream of research in developing new measures that can help companies understand customers and plan strategies and compare the effectiveness of traditional and advanced measures based on data collected through new technologies.

Big data and analytics is also the topic of Alles (2015). The author wonders what the implications of Big Data and analytics are for internal and external auditors and discusses possible drivers of big data, facilitators and obstacles. The author argues that the disruptive nature of Big Data in the auditing field is still an open question and that three main factors will shape the use of Big Data in the auditing profession in the future. They are the international audit standards, which can consider the use of Big Data not as an option for auditors but as an opportunity to extend the source of audit evidence outside the traditional accounting ledger; technological advances, which could offer Big Data software and

automated tools easy to use facilitating the integration of Big Data analysis into the audit procedures; and, finally, market forces which can contribute to reducing the difference between supply and demand of experts in Big Data.

Qin (2011) discussed the implications of the integration between XBRL, semantic web and web services, highlighting the importance of the investigation concerning those technologies and their joint effects. The author argues that there is a vacuum in studies that consider the joint impact of those technologies and investigate “how they work together to reshape the future business information interchange over the Internet” (p. 445).

Among this area of research, only one contribution (Smith *et al.*, 2019) discusses the implications of smart technologies on financial reporting, tax compliance and auditing considering cryptocurrency and crypto assets. The authors investigate the current state of the art in academic research and practitioner publications. They argue that despite the numerous publications currently available, there are “limited guidance and advice for how organizations will treat these various assets moving forward.” Organizations can follow several options in treating cryptocurrency for financial and tax reporting, and currently, there is no fit-all solution. Furthermore, this subject is constantly changing because technologies are evolving; therefore, additional research is needed to compare the consequences on the financial results of different treatments.

3.2.4 Research area 4: smart technologies as factors that require new and updated knowledge, skills and abilities of actors in the accounting environment. The fourth research area includes articles in education and skills, focusing on smart technologies, developing skills and configuring training courses to develop adequate competencies. This research area includes two studies that developed teaching materials useful to integrate skills and competencies training in university courses and programs (Taylor and Dzurainin, 2010; Riggins and Klamm, 2017). It could be considered an exciting field of investigation because, even if it is relevant to help companies accelerate digital financial transformation, it is also relevant to help young scholars develop adequate competencies. One of the cases mentioned above concerns the tradeoff between the control over data assets through adequate data governance and user innovation advantages through extensive adoption of self-service business intelligence tools (Riggins and Klamm, 2017). The second teaching case proposes an interesting experience with the concept of XBRL and the interpretation of financial information.

The fourth stream of research also includes studies aiming at understanding what KSA are required to manage information to support decision-making in a data-driven environment, characterized by the presence of Big Data and analytics and other emerging technologies. Ballou *et al.* (2018), surveying accounting practitioners and academics, find that data analytics should be taught across the entire accounting curriculum and integrated with traditional technical accounting knowledge within accounting courses. Furthermore, the authors invite attention to creating a scientific method mentality based on the ability to define research questions, identify theories, collect data, test models and formulate solutions to support decision-making. This paper underlines the importance of innovation in the accounting curriculum and the demand for more research to understand the optimal mix of accounting topics and data analytics KSA within undergraduate accounting courses. Furthermore, many other contributions are requested to cope with the entire field of smart technologies.

Finally, Cavicchi and Vagnoni (2018) investigate what human capital skills could represent luggage competencies and abilities to exploit sustainability in agricultural firms through smart technologies. The paper introduces a strategic perspective to map smart technologies related to competencies, as the ability to improve the firm’s competitive

advantage by leveraging technological innovation. From this perspective, the identification of competencies related to climate-smart agriculture requires “human capital’s basic skills of interaction with technology to make the innovation work, but learning and management competencies are required for the technology to be used in strategic planning and deployment” (p. 696).

4. Recent scholars’ reply

In the light of the four research pathways (RP) retrieved in our analysis, we show an overview of the scholars’ reply to the call launched by Meditari Accountancy Research titled “Discovering the relationship between the Accounting Environment and Smart Technologies: Charting the new and thrilling challenges.” The aim is to create a profitable connection between topics investigated by recent studies and the four RP, as summarised in Table 8.

RP1 (smart technologies as innovations to be managed in the AE) is enriched by the following studies. [De Santis and D’Onza \(2021\)](#) investigate the legitimization process of Big Data and data analytics in financial auditing, showing it has more advanced in the professional audit environment instead of in the audit community. Results proposed by authors can mainly enrich the audit strategy and quality and foster the innovation of audit practices. [Tingey-Holyoak et al. \(2021\)](#) investigate the management innovations in the agriculture sector, developing a renewed framework. The authors propose creating a connection between temporal, biophysical and management decision-making in the accounting, soil moisture and climate monitoring tool on-farm.

RP2 (smart technologies as impacting tools that affect the AE only in certain circumstances). [Bartolacci et al. \(2021\)](#) propose the investigation of the XBRL as a language for corporate financial reporting and, at the same time, a technological innovation. The authors propose the bibliometric and systematic review of central studies between 2001 and 2019 showing the impact and benefits of XBRL on the corporate system and financial reports and the way to be traced, also assuming the users’ and regulators’ perspectives. In their study, [Lamboglia et al. \(2021\)](#) present the conceptual knowledge structure supporting the connection between digital technologies and the auditing profession. The authors propose several results through a bibliometric analysis, such as adopting auditing’s continuous auditing and monitoring, use of software tools, connections with information systems. [Nicolò et al. \(2021\)](#) develop their study on the online (via web) intellectual capital disclosure (ICD) proposing connected determinants. The authors identify the website as an innovative tool supporting the ICD: it is an effective tool in sharing information.

RP3 (smart technologies as a source generating implications for the future of the AE) is enriched by [Lombardi and Secundo \(2021\)](#), showing the relationship between smart and digital technologies and organizations’ reporting processes. Through an SLR, the authors analyze data analytics and digital technology effects on corporate reporting (in the last two decades). The authors emphasize smart technologies can increase the effectiveness of corporate reporting processes, shortly also enhancing transparency and accountability for shareholders and stakeholders.

RP4 (smart technologies as factors that require new and updated knowledge, skills, and abilities of actors) welcomes the newest studies reported below. [Ferri et al. \(2021\)](#) analyze the intention and capacity of professional auditors to adopt disruptive technologies. The authors present an investigation of employees by the Big 4 in Italy and particularly to the factors motivating auditors’ readiness to adopt the blockchain. In the implementation of blockchain, predictors are performance expectancy and social influence.

5. Conclusions, implications and future research

This research has been motivated by the call for research by Meditari Accountancy Research titled “Discovering the relationship between the Accounting Environment and Smart Technologies: Charting the new and thrilling challenges,” answering RQ1 and RQ2. We used a mixed qualitative method (Massaro *et al.*, 2016; Petticrew and Roberts, 2006; Post *et al.*, 2020; Secundo *et al.*, 2020; Van Eck and Waltman, 2017) to present the state of the art and implications by the connection between the AE and emerging smart information technologies.

Results of this study are directed to enrich existing literature (de Villiers *et al.*, 2021; De Santis and D’Onza, 2021; La Torre *et al.*, 2018; Lombardi *et al.*, 2020a; Mancini, 2016; Mancini *et al.*, 2016; Nambisan *et al.*, 2017; Stainbank and Gurr, 2016; Troshani *et al.*, 2019; Wessel, 2005) drafting the current state of the art and contributing in clearly defining four emerging research areas as leading backgrounds for the next few years.

Interestingly, smart technologies in the AE are regarded as follows:

- innovations to be managed;
- impacting tools;
- source of yet undiscovered implications for the future; and
- challenges for KSA.

Such results can widely orient scientific and practical communities in guiding new and not discovered research issues and changes. Scientific knowledge and research investigations in the intersection between smart technologies and AE are at an early stage, but this is a promising area that attracts a growing number of studies even if some limitations of this analysis is declared (e.g. some missing articles in the field owing the timeline stop adopted in the investigation). As shown by the most frequent keywords and accounting concepts and their connections, research is currently fragmented between some smart technologies and different AE components.

Our analysis showed that the most prominent journals are the *Journal of Accounting Education* and *Journal of Emerging Technologies in Accounting*, which published two papers each. This result is coherent with two areas of research (no. 2 and no. 4) related to smart technologies as an impacting tool and as a challenge for education. Our results confirm the need for more research to help accountants, accounting systems and processes and accounting tools keep up with technology innovations and benefit from implementing emerging technologies. This paper supports the request for developing additional research on every smart technology applied in each AE component to deepen our knowledge of these solutions’ potential concerning the traditional ones.

This study has several theoretical and practical implications. Firstly, it offers some suggestions about a future agenda for research in smart technologies in the AE considering the following research questions:

Research area 1: smart technologies as an innovation process:

RQ1.1. What is an effective organizational ecosystem asset able to facilitate a fast and reliable implementation of smart technologies in the AE?

RQ1.2. What are the roles and the contribution to each agent of the ecosystem?

Research area 2: smart technologies as a tool

RQ2.1. What are the positive and negative impacts of the different technologies in the accounting contexts?

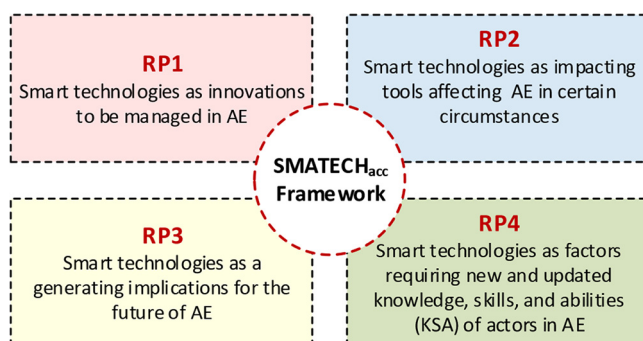


Figure 4.
SMATECH_{acc}
framework

RQ2.2. Which are the most effective frameworks and models to evaluate and control smart technologies investments?

Research area 3: smart technologies as the implication for the future

RQ3.1. What are the factors that contribute in the future to the successful implementation of smart technology innovations?

RQ3.2. Which intelligent technology capabilities are useful for which accounting processes to improve their effectiveness?

Research area 4: smart technologies and education

RQ4.1. What content must be taught at university to enable smart technologies to better integrate with accounting contexts?

RQ4.2. What are the pivotal capabilities for accountants' readiness to embrace smart technologies?

Thus, we construct a new framework on the role of smart technologies in accounting research (SMATECH_{acc} Framework) consisting of four RP that future researchers can use to consider and construct their research designs in the AE (Figure 4).

Although this study presents several limitations, using a defined set of keywords could be expanded in future research and use several databases to compare results in the data set composition phase. Additionally, the utilization of some quantitative methods can validate current results. However, the future research paths are mainly directed towards validating the four emerging research areas collecting evidence by organizations (private and public) in international scenarios.

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Further reading

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