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Research Analysis on Emerging Technologies in Corporate Accounting

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Abstract: The technological transformation has directly affected the functional areas of companies. This circumstance has been a challenge for corporate accounting, since the emerging technology allows handling a large volume of data, and providing valuable information for operational management, managerial control, and strategic planning. The aim of this study is to analyze current and future lines of research globally, during the period 1961–2019, on emerging technologies in corporate accounting. For this, bibliometric techniques were applied to 1126 articles on this subject to obtain findings on scientific production and the main subject areas. Scientific production has increased annually, so that in the last decade de 60.66% of all articles have been published. The main subject areas in which more articles were linked were business, management and accounting, social sciences, and economics, econometrics, and finance. Six lines of research have been identified that generate contributions on this topic. Furthermore, the analysis of the relevance of the keywords has detected the main future directions of research. The increasing worldwide trend of scientific production shows interest in developing aspects of this field of study. This study contributes to the academic, scientific, and professional discussion to improve decision-making based on the available information.

Keywords: accounting; business; emerging technology; management; scientific production

1. Introduction

In recent decades, the business sector is experiencing a revolution derived from technological and social trends towards digitization. This technological and digital transformation undergoes an intense readjustment in all functional areas, from production to finance and accounting [1,2]. Currently, the adoption of technologies by companies is related to a paradigm shift, where technology is perceived as a complex and interconnected environment at a global level [3,4].

In this context, accounting practices were an evident fact since the time of great civilizations, where economic culture was developed with the help of elements that made accounting activity possible [5]. Subsequently, trade between nations required recording on paper every movement that was made between merchants, which allowed the beginning of the first records. The application of mathematics contributed specially to accounting to reach the relevance that it currently occupies in economic and business sciences [6].

The 60s of the 20th century caused a change in business and its accounting activities after the emergence of computers to handle large volumes of information very quickly. Therefore, began the automation of manual accounting systems. In this way, the company claims from accounting the need to obtain useful financial information for decision-making [7]. In this way, electronic commerce is developed as a key technology in communication and the exchange of documents, giving way to automated supports in the record of financial operations. The development of accounting tools has streamlined the registration and maintenance processes of financial operations, with the generation of

financial statements, payroll management, the elimination of errors, easy visualization of financial inconsistencies, and monitoring of company loans [8,9].

On the other hand, emerging technologies that will be incorporated into companies' systems offer possibilities to handle a large volume of data, so that these technologies turn them into valuable information for operational management, managerial control, and strategic planning of the company [10]. This implies knowing the underlying principles in information management and that should guide the selection of the specific tool in the company [11].

For all these reasons, new technologies pose challenges both for researchers and for teachers and professionals of the accounting practice, in order to form a broad and flexible vision of accounting, which allows offering a useful and reliable service in the context of permanent transformation. The use of new tools or technological supports in accounting has inherent risks in the efficient management of organizations and their link with the different markets through the dissemination of accounting information [12–14].

In the review of the literature carried out, studies have been found that address this topic, so that the research questions on emerging technologies in corporate accounting refer to determining: (1) what is the knowledge structure of this topic; (2) which are the most productive journals, research institutions, and countries; and (3) which are the thematic axes that this research field develops and towards which are they evolving.

The main objective of this study is to analyze the current and future research axes at a global level on emerging technologies in corporate accounting, during the period 1961–2019, that is, since the year the first article on this research topic was published (1961) until the last full year (2019). To obtain answers to the research questions, a sample of 1126 scientific journal articles selected from the Scopus database was examined. This study uses bibliometric techniques to synthesize the knowledge base on emerging technologies in business accounting in a global context.

The main limitation found in this research is to determine if, among other variables, the number of articles published is related to (1) community regulations, (2) demands of interest groups to have information with greater speed and transparency for the decision-making process, or (3) the financing of certain public or private centers for the development of accounting software, or highlight the progress of some new technologies.

The lines of research that have been developed globally during the analyzed period refer to: (1) technology; (2) information technology; (3) cost accounting; (4) investments; (5) optimization, and (6) employment. Furthermore, research continues to evolve, so that new directions related to blockchain ontology, cybersecurity risk, big data technology, cloud accounting, artificial intelligence (AI) exposure, and involuntary unemployment have been developed.

This research involves an analysis of the scientific production and of the main actors that energize the research of emerging technologies in corporate accounting, during the period 1961–2019, as well as the identification of the lines of research and their evolution. The evolution in this field of research has been identified from the configuration of the groups of institutions, countries, and keywords, in addition to the intensity of the relationships that are developed in the latter. The results obtained are a complement to the knowledge about how technologies and digitization are affecting and transforming business accounting, and that allow establishing the relationship between science and technology, in addition to supporting the decision-making process.

To achieve the stated objective and clarify your understanding, this study is organized as follows. Section 2 justifies the relevance of the research topic, delimiting the unit of analysis and conducting a review of the most relevant aspects of the theoretical principles and base concepts of this study. Section 3 details the applied methodology. Section 4 shows the main results and their discussion in a broad context. Finally, Section 5 presents the conclusions.

2. Framework

Section 2 is the result of a previous review and analysis of the literature, while its purpose is to act as a guide and framework in the global research on emerging technologies in corporate accounting. The study is supported by the analysis of a series of theoretical principles, which together with the basic concepts define the frame of reference in this field of research. Hence, Section 2 serves as a guide for the investigation and provides a framework for the interpretation of the results.

In a preliminary bibliographic search, in order to delimit the research problem and avoid approaches that are not related to the study, a set of articles is identified that provides evidence and an initial synthesis on the subject, in addition to allowing the definition of the objective of the investigation and extract the essential terms. Table 1 shows the main articles selected after reviewing the literature on the research topic, establishing a framework for the theoretical basis and terminology of the emerging technologies in corporate accounting. Their analysis has made it possible to determine the problem, the purpose, and the objective of the investigation, and to obtain the key terms (accounting, business, technology, and digital) to apply the methodology specified in Section 3.

Table 1. Main literature reviewed to define the scope of the study.

Ref.	Year	Article Title	Author(s)	Journal	Subject Area
[15]	2020	Blockchain technology in the future of business cyber security and accounting	Demirkan, S.; Demirkan, I.; McKee, A.	Journal of Management Analytics	BMA—M
[16]	2020	The Impact of the Disclosed R & D Expenditure on the Value Relevance of the Accounting Information: Evidence from Greek Listed Firms	Kalantonis, P.; Schoina, S.; Missiakoulis, S.; Zopounidis, C.	Mathematics	M
[17]	2019	Early evidence of digital labor in accounting: Innovation with Robotic Process Automation	Kokina, J.; Blanchette, S.	International Journal of Accounting Information Systems	EEF—BMA—DS
[18]	2019	How Will Blockchain Technology Impact Auditing and Accounting: Permission less versus Permissioned Blockchain	Liu, M.; Wu, K.; Xu, J. J.	Current Issues in Auditing	BMA
[19]	2019	The Whatness of Digital Accounting: Status Quo and Ways to move forward	Lehner, O.; Leitner-Hanetseder, S.; Eisl, C.	ACRN Journal of Finance and Risk Perspectives	BMA—DS
[20]	2019	Artificial Intelligence for Decision-Makers	Elliot, V. H.; Paananen, M.; Staron, M.	Journal of Emerging Technologies in Accounting	BMA—CS
[21]	2018	How Much Automation Is Too Much? Keeping the Human Relevant in Knowledge Work	Sutton, S. G.; Arnold, V.; Holt, M.	Journal of Emerging Technologies in Accounting	BMA—CS
[22]	2018	Sites of translation in digital reporting	Locke, J.; Rowbottom, N.; Troshani, I.	Accounting, Auditing & Accountability Journal	EEF—BMA
[23]	2017	"Big Data": A new twist to accounting	Janvrin, D. J.; Weidenmier Watson, M.	Journal of Accounting Education	SS—BMA
[24]	2015	Governing cloud computing services: Reconsideration of IT governance structures	Prasad, A.; Green, P.	International Journal of Accounting Information Systems	EEF—BMA
[25]	2011	The Role of Organizational Absorptive Capacity in Strategic Use of Business Intelligence to Support Integrated Management Control Systems	Elbashir, M. Z.; Collier, P. A.; Sutton, S. G.	The Accounting Review	EEF—BMA
[26]	2008	Acceptance of emerging technologies for corporate accounting and business tasks: An international comparison	Smith, L. M.	Advances in Accounting	EEF—BMA
[27]	2004	A continuous auditing web services model for XML-based accounting systems	Murthy, U. S.; Groomer, S. M.	International Journal of Accounting Information Systems	EEF—BMA
[28]	2001	Continuous auditing: the audit of the future	Rezaee, Z.; Elam, R.; Sharbatoghlie, A.	Managerial Auditing Journal	EEF—BMA
[29]	1989	Advanced accounting	Limmack, R.	The British Accounting Review	BMA

Ref.: Reference; BMA: Business, Management and Accounting; M: Mathematics; EEF: Economics, Econometrics and Finance; DS: Decision Sciences; CS: Computer Science; SS: Social Sciences.

This research study was based on a set of theoretical principles, which together with the basic concepts define the framework for global research on emerging technologies in corporate accounting. Additionally, a set of concepts related to the subject of study have been defined, which introduce part of the concepts that, due to their importance and connection, will be highlighted in the results and discussions.

The advancement of technology in society and in the business sector has transformed both the nature of services and products and the meaning of time at work, as well as learning processes. Currently, technology has set a new scenario in the corporate sector [30].

In this context, the digital revolution refers to the process of adding digital technology to previous analogy, mechanical, and electronic technologies [19]. At the centre of this revolution is the widespread use of digital logic circuits, and their derived technologies, such as the digital computer, the digital telephone, and the Internet [31,32].

This revolution has positive socioeconomic impacts, such as increased interconnectivity, globalization, communication, information exposure, outsourcing, and the access of small companies to more competitive markets. Digital technologies have significantly increased the productivity and performance of companies [33]. As for the negative impacts, these refer to information overload, social isolation, and saturation of the media. Likewise, this revolution allowed the ability to store and use large amounts of information, while the need for privacy and control of this information has arisen, derived from the new means of communication and information exchange [34,35].

The reviewed literature provides definitions for the basic concepts of this research topic. Consequently, some reflections on the terms and concepts used in the context of this research were included.

The concept of business refers to the economic–social unit, composed of human, material, and technical elements, with the objective of obtaining profits through their participation in the market for goods and services, making use of productive factors, such as capital, labor, and material resources [36]. The basic function of the company is to coordinate these factors of production to produce the goods and services that society demands. Hence, the company integrates them in an economically efficient way, generating knowledge. In this line, the term corporate refers to the elements or individuals that make up a company, as well as to characterize events related to the activity of the company [37,38].

On the other hand, the concept of accounting refers to the discipline in charge of the analysis and presentation of the financial information of a company, through accounting statements, in order to be able to study, measure, and analyze the assets (assets, rights, and obligations of the economic subject) and determine the state of its economy and finances [39,40]. Therefore, accounting oversees recording and accounting for operations derived from the economic activity of a company in accounting documents, such as: purchases and expenses, sales and income, acquisitions, salaries, loans, or bank and cash movements [41,42].

All the economic and financial information of a company is reflected truthfully in the financial statements, to allow the appropriate decision-making by the stakeholders and shareholders of the business. Business accounting ensures the profitability of the company, in addition to having the obligation to offer it to the Public Administration. Likewise, it allows knowing the evolution and financial trajectory of the company and determining financial strategies with a vision towards the future [43].

For this reason, the objective of accounting is to adjust the information to the true image of its assets, that is, to prepare the annual accounts that adjust to the reality of the company. These accounts will report on the economic–financial situation of the company, the results of the year and the causes of said results [44].

In this order, the companies obliged to keep accounting must unify the accounting criteria to harmonize the accounting information, so that the economic–financial reality of the company becomes transparent. Moreover, the effectiveness of accounting in a company depends on its optimal functioning,

both in future viability and from a legal perspective [45,46]. For this reason, a company, properly managed, must be able to justify income and expenses, to avoid fraud and tax problems.

For years, computer systems have offered solutions that allow automating the management and registering the company's accounts in the cloud, to give security to the data. In this sense, a company must (1) compile the accounting documentation, that is, the income, expenses and operations of the company; (2) reflect income and expenses in the journal; (3) comply with obligations of the tax system; (4) have a daily record of all the economic events of the company to know the financial situation and take stock of the economic activity; and (5) check that the collections and payments are registered correctly, as well as check that the minutes, accounts, and balances are correct [47–49].

Therefore, in this context, corporate accounting is the technique that allows one to register, control, and know the economic movements of a legal person constituted by a group of several people with a common purpose, in addition to the need to inform internal users and external information about the situation of the company [50].

In this sense, technological advances are incorporated into the specific systems of companies, making possible the option of handling a large amount of data, and turning this data into valuable information in organizations, for operational management, management control, and strategic planning. Technological tools or supports include hardware and software [25,51,52].

The processes for collecting, processing, storing, recovering, and communicating accounting information have been changing, although the problem remains how to interpret the information needs of different types of users to design information systems that, incorporating new technologies, maintain the integrity of the data and ensure a reasonable degree of reliability at the different levels of the source, process, file, and transfer. The quality of the information depends on the reliability of the data from which it arises, the processes that generate it, and the models that are used to externalize it [53,54].

In this order, it is necessary to specify how it has transformed technological and digital advances in a discipline such as accounting. The traditional, mechanical, and repetitive procedure to keep the accounts of a certain company has become obsolete, since the financial and accounting results should be produced while the data of a company is produced. This brings advantages in the decision-making process of the company [55].

The impact of technological and digital advances in recent years are precipitating the traditional paradigm of management and communication of accounting information, while it rethinks the form of the interrelation of individuals and organizations.

With regard to offering added value to accounting based on the needs of the employer, certain technological tools make it possible to streamline the process, such as (1) ERP (enterprise resource planning), that is, business process management software that allows use of a system of integrated applications to manage a business and automate back office functions related to technology, services, and human resources [56] or (2) Cloud, which allows all financial and accounting information to be stored so that the client can have access to it in real time, providing economic advantages, and the possibility of sharing company information [57].

Within a conceptualization of accounting as applied social science or as social technology, with information and communications technology it becomes not only a new tool to guarantee efficient communications, but also an object of study for this discipline.

In recent years, accounting research has been oriented to the analysis of the impact produced by new information technologies through the potential they offer for the development of new tools for the analysis, modeling, and communication of information, in addition to the consequences in the behavior of individuals within and between organizations, and the need to evaluate and ensure the reliability of the accounting information systems that incorporate them [58,59].

In this line, the interest in the impact of technology on the distribution of accounting information and the impact of information and communication technologies in business has led to the development

of research in this regard, so that they have even been the basis for the development of new computer products and services to offer reliability [60].

3. Materials and Methods

Section 3 provides a basic description of the bibliometric methodology applied in the study, the inclusion and exclusion criteria of data to determine the sample of articles analyzed, and the processing of the data in relation to the objective of the research.

3.1. Bibliometric Method and Data Gathering

Bibliometrics applies mathematical and statistical methods to scientific literature, to analyze the activity of a certain scientific field. This methodology was started by E. Garfield in the middle of the 20th century, and since then it has become generalized in the analysis of scientific research and has contributed to reviewing knowledge in multiple disciplines. In this way, bibliometrics has evolved from reflection on scientific development, and from the availability of numerous databases accessible to the researcher [61,62].

It has also become an indispensable tool for managers and specialists in management or in organizations that develop research or innovation programs. Quantitative studies, based on bibliometrics, enrich the understanding and description of the dynamics of activity and scientific production [63]. In recent years, bibliometric methodology has encouraged the revision of different schools of scientific knowledge. It has been used by numerous scientists, including management, finance, economics, and education [64]. Bibliometric indicators are the instruments used to measure the results of scientific activity in any of its manifestations [65]. Likewise, studies on the scientific literature make it possible to identify certain relationships between documents in a given area of research and, thus, to recognize subdisciplines or trace historical development and progress in an area of interest [66,67].

The aim of the study was to analyze current and future lines of research at a global level, between 1961 and 2019, on emerging technologies in corporate accounting. To achieve this objective, a quantitative analysis has been carried out using bibliometric techniques. Based on the revised literature of the study topic, highlighted in Table 1, the terms chosen in the search string have been: accounting, business, digital, and technology.

At present, there is no doubt about the importance and advantages of bibliographic databases, and that the quality and validity of a study will depend on them. Some studies have tried to answer which database is more suitable to be used for bibliometric work. The presence of two large scientific databases, Web of Science (WoS) and Scopus, raises the important question of the comparison and stability of the statistics obtained from the different data sources. Previous analyses between both databases have not given a clear winner, since everything depends on what you want to analyze, the discipline in question, and the period of analysis [68,69]. In this research, both databases have been evaluated, so that, in volume of articles, WoS (Core Collection) has yielded a total of 377 compared to 1126 by Scopus, in the same temporal coverage of 1961–2019.

The process followed in the selection of the sample adjusts the flowchart in Figure 1, according to the preferred reporting items for systematic reviews and meta-analyses (PRISMA) [70]. Thus, in phase 1 (identification), 129,532 records were identified from the Scopus database, considering all the fields for each of the key terms in the search (accounting, business, digital, and technology), all types of documents, and all data in the subfield "data range" (all years-august, 2020). Search terms were identified from the first literature review (see Table 1).

In the next phase 2 (screening) the option of "article title, abstract and keywords" was chosen in the field of each term, so that 127,141 records were excluded. Then, in phase 3 (eligibility), of the 2391 records, only the articles were selected as the document type, to guarantee the quality derived from the peer review process. In this phase, 1099 documents were excluded.

In the last phase 4 (included), of the 1292 records, 166 documents were excluded, so the sample included 1199 articles, both open and non-open access. Finally, in order for the final sample to not be distorted with articles from the health areas, 73 records from the subject areas were excluded: medicine; biochemistry, genetics and molecular biology; immunology and microbiology; health professions; pharmacology, toxicology, and pharmaceutics; dentistry; veterinary, and neuroscience. Therefore, the final sample included 1126 scientific articles.

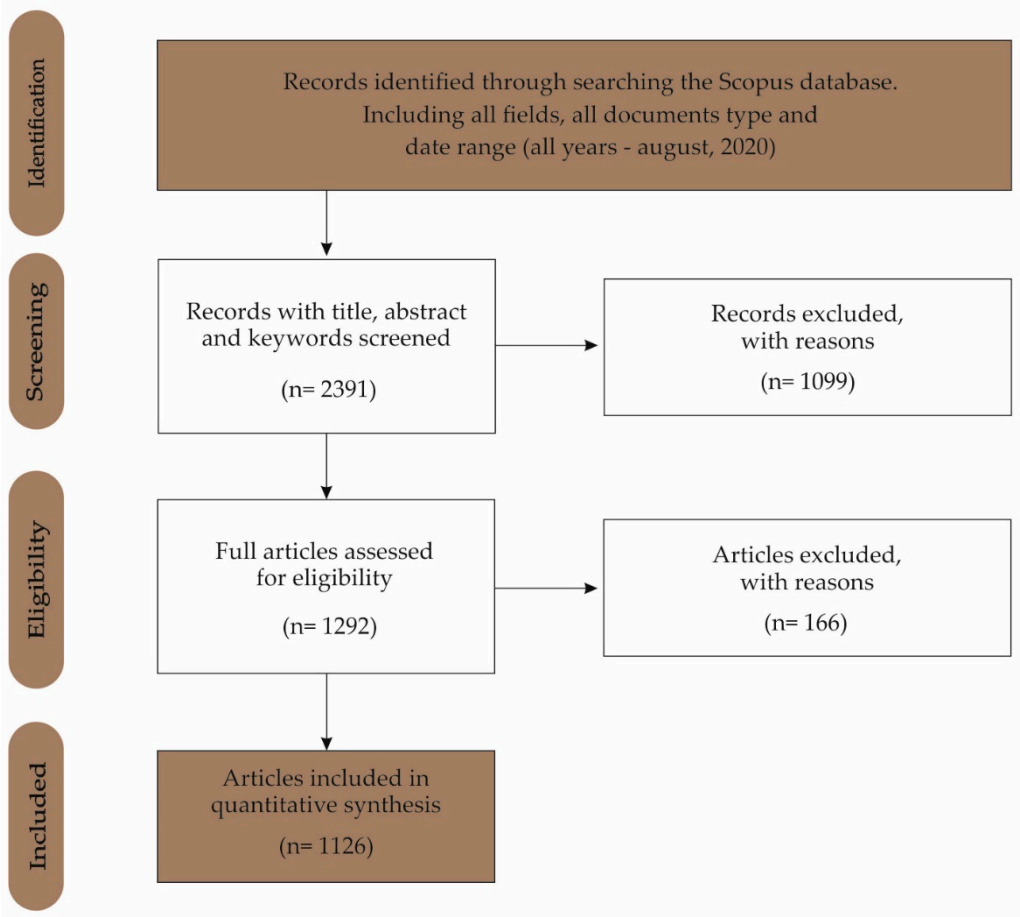

Figure 1. Flowchart based on preferred reporting items for systematic reviews and meta-analyses (PRISMA).

Regarding the period covered by this research, the search selected records of subfields of the title, abstract, and keywords, in the period that contains the publication of the first article on the research topic (1961) until the last full year (2019), that is, the last 59 years, in the same way that it has been applied successfully in various scientific studies [71–74].

The representation of this sample of documents is supported by the proven quality of the Scopus database, with respect to the indexing protocol, in addition to the systematic procedures of the search criteria.

3.2. Data Processing

In the data processing phase, the collected data was translated into usable information. This processing must be carried out correctly so as not to negatively affect the results obtained from the data. Hence, from the data in its raw form, they were converted to a more readable format, such as tables and figures, giving them the necessary form and context to be interpreted, so as to allow conclusions to be drawn and aid decision-making.

In this study, the variables analyzed were the year of publication, subject area, journal, research institution where the author is affiliated, country of affiliation of the author of the publication, and the keywords that define the publication.

Bibliometric studies distinguish three types of indicators: (1) quantity, which refer to counts to measure the productivity of authors, institutions, and countries; (2) quality, referring to the impact of the publications; and (3) structural, which measure the connections established between the different drivers of a given field of research.

Therefore, to measure the impact of the research, the quality indicators have been used: (i) h-index, which represents both the productivity and the impact of a scientific or academic agent (author, journal, research institution, or country), determines the measurement of the professional quality of scientists, based on the number of citations they have received on their scientific articles and, furthermore, a scientist or researcher will have an h-index if she/he has published a certain number of scientific articles with at least that certain number of citations for each one [75]; (ii) SCImago journal rank (SJR) indicator, which refers to the scientific influence of academic journals, and indicates the average number of weighted citations received during a selected year per document published in that journal during the previous 3 years [76]; (iii) CiteScore, which is obtained from the calculation of the number of citations in a year received by academic articles published in a journal in the 3 immediately preceding years, divided by the total number of articles published during those same 3 years; and (iv): source normalized impact per paper (SNIP), which counts the number of citations received by a journal for three years divided by the potential citation from the journal's scientific field [77].

Among the relationship indicators, co-authorship analysis has been used to understand and evaluate the patterns of scientific collaboration at the institutional and country levels, based on bibliographic data that provide information on the authors' institutional affiliations and their geographic location. Co-authorship analysis studies the social structure of a research field. In co-authorship networks, nodes represent authors, institutional affiliations, or countries, which are connected when they share the authorship of an article. Moreover, co-authorship of a document is an official declaration of the participation of two or more authors, research institutions, or countries. Scientific collaboration is defined as the interaction within a social context between two or more scientists, which facilitates the exchange of meaning and the fulfillment of tasks in relation to a shared objective [78].

Moreover, among the different bibliometric techniques, relationship indicators have been used to determine the semantic structure of the articles in the sample and, thus, to carry out possible disciplinary or thematic separations, that is, to identify the invisible borders and the evolution of the contents. These indicators measure the relationships and connections between words [79].

In this study, the analysis of the keywords has allowed the detection of the main current and future research topics, based on the co-occurrence analysis, since the scientific texts can be reduced to the set of joint appearances between the words that compose it [80].

The occurrence refers to the frequency of each lexical unit (keyword) in the context units that constitute it (articles). Hence, co-occurrence is the frequency of appearance of some terms next to others and even their syntactic or semantic evaluation. The co-occurrence of two terms will be high if they frequently appear together in one set of articles and rarely do so separately in the rest, that is, if the terms co-occur (appear together) in one sentence, they are likely to be semantically related [81]. Thereby, co-occurrence analysis refers to the proximity relationship of two or more terms in a unit of text.

The network based on the co-occurrence method provides a graphical visualization of the relationships of the concepts represented in the documents. Therefore, the co-occurrence analysis allows strongly related concepts to be grouped within the set of articles. For these reasons, in a research topic, this method allows one to deduce the relevant terms and extract the schools of thought or thematic axes [82,83].

For the analysis of the sample of the 1126 articles, the VOSviewer software (version 1.6.15., University of Leiden, Leiden, The Netherlands) was applied and using the relationship indicators

through co-occurrence analysis, which provides data on the interactions and the evaluation of subject-matters, to measure the activities of research networks. This tool allows you to view relationship maps and network links between keywords [84].

Network mapping refers to the process of establishing the connection and structure of the network with the aim of mapping the dynamics of science, in this case, of a given field of research, and exploring the underlying structure of similarities and interrelationships between articles [85].

3.3. Concepts for Keyword Analysis

The terminology of the VOSviewer tool has been used in this study. In consequence, Link is the connection or relationship between two elements (scientific articles), that is, it refers to the co-occurrence links between terms. The total link strength indicates that each link has a strength, represented by a positive numerical value. The higher this value, the stronger the link will be, and in the case of concurrent links, indicates the number of articles in which two terms appear together. On the other hand, the terms and links together constitute a network, and a cluster is a set of terms included in a map. Additionally, groups do not need to exhaustively cover all the elements on a map, that is, there may be terms that do not belong to any cluster.

The attributes used for the description of the terms have been those of weight and score, represented by numerical values. Therefore, the weight of a term indicates the importance of the article in the whole of the sample analyzed, that is, in the field of research studied. A term with a higher weight is considered more important than an item with a lower weight. Hence, if a term has a weight, for example, twice as high as the weight of another term, the first term is twice as important. In a map display, items with a higher weight are displayed more prominently than items with a lower weight. For a given term, the weight of the link attribute indicates the number of links a term has to other terms, while the weight of the link strength attribute indicates the total strength of the links of a term with other terms.

VOSviewer is based on a scientific classification system at the article level starting from [86]:

1. Determine the relationship of the publications: from a set of articles the relationship of each pair in this set is determined, to produce hierarchical classification systems. Each article belongs to a single research area at the lowest level of a ranking system, each research area at the lowest level in turn belongs to a unique research area at the second lowest level, and so on.
2. Group the articles to build the basic structure of a classification system: the articles are grouped into research areas and the research areas are organized in a hierarchical structure. The grouping technique is based on modularity. VOSviewer's clustering algorithm allows communities to be detected in a network, which considers modularity, that is, a measure that assesses the quality of community structures. Therefore, VOSViewer's modularity-based clustering provides networks where nodes are densely connected internally within groups, but without external connection between different groups. In this manner, it unifies the mapping and grouping approaches, in addition to dividing the research carried out in documents [87].
3. Labeling research areas: to complete the construction of the classification system, labels are assigned to research areas. These labels are obtained by extracting appropriate terms from the titles and summaries of the articles that belong to a research area.

Therefore, continuing with the punctuation attribute, it allows one to classify by relevance the terms that appear in the titles and summaries of the articles that belong to the research area. For this, the calculation of the relevance score for each term in a research area allows one to deduce that the terms with a higher relevance score provide a better prediction to identify a future line of research [86,88,89].

In this sense, given term x in research area a in a classification system, which in turn is part of research area b. Hence, the relevance score of term x in research area a is calculated as:

$$\textit{Relevance score} = \frac{n_{ax}}{n_{bx} + c}, \quad (1)$$

where n_{ax} and n_{bx} denote the number of items in areas a and v in which the x term occurs, respectively.

This calculation of term relevance scores is based on the balance or compensation of the following considerations (which is denoted by parameter c): (i) the frequency of appearance of the term x in area a, in relation to the frequency of appearance of the term x in area b can be considered as an indication of the relevance of the term x for area a; and (ii) the absolute frequency of occurrence of term x in area a can also be considered as an indication of the relevance of term x [86].

The findings obtained are valuable for a group of actors involved in scientific research on emerging technologies in corporate accounting and that require an examination of past and future information, such as economists, mathematicians, investment analysts, academics, researchers, research institutions, universities, government agencies, or service providers, among others.

4. Results and Discussion

Section 4, first, presents and discussed the main results of the evolution of scientific production in a global context on emerging technologies in corporate accounting. Subsequently, the distributions of articles by subject area and journals were analyzed. Then, the productivities of the main research institutions and countries were examined. Later, the results obtained from the analysis of the main keywords associated with this field of research were discussed, which allowed us to identify the main current lines. Finally, based on the relevance of the terms, the main future directions of research were identified.

4.1. Evolution of Scientific Production

Figure 2 shows the evolution of the number of articles on global research on emerging technologies in corporate accounting, from 1961 to 2019. It is observed that, of the 1126 articles during the 59-year period examined, 414 have been published in the last 5 years (2015–2019), that is, 36.77% of all documents, while in the last decade (2010–2019) 683 articles (60.66%) have been published. Likewise, it is important to note that, in the first year analyzed, 1961, only one article was published, while, in 2019, the last year studied, a volume of 129 articles (11.46%) was published. These figures confirm the interest that the research topic arouses in recent years in the scientific and academic community at an international level, with a growing publication since the beginning.

Relatedly, Figure 2 shows the exponential trend line that illustrates the growing relationship between the number of articles published on emerging technologies in corporate accounting along the time horizon examined, since the curve shows its goodness with a R^2 of 0.8635, assuming the growing popularity of the research area under study.

On the other hand, the first article on this subject dates from 1961, with the title "A Digital Storage "Language" for Engineering and Production Information" (from May 1963 it continued to be called IEEE Transactions on Industrial Electronics), published in the journal *American IRE Transactions on Industrial Electronics*, by author Bennett, W.S. [90].

Likewise, the most cited article, with 1127 citations in August 2020, was published in 1986 by the *American journal Strategic Management Journal*, under the title "Networks: Between markets and hierarchies", and was written by Thorelli, H.B. [91].

Furthermore, the most relevant article, that is, the contribution that most closely matches the search terms in the Scopus database, has been cited 13 times, from its publication in 2016 to August 2020. This article was published in the journal *Chinese Journal of Education for Business*, with the title "Preparing accounting graduates for digital revolution: A critical review of information technology competencies and skills development", and written by the authors Pan, G. and Seow, P.-S. [92].

In this research topic, 96.28% of scientific articles are written in English (1087). This circumstance is related to the fact that the publication in this language broadens its audience, as happens widely in the searches carried out in the Scopus database [93]. Furthermore, the articles have been published in other languages with less representation: Spanish (12, 1.06%), Russian (8, 0.71%), Chinese and German

(5, 0.44% each), Lithuanian (4, 0.35%), Portuguese (3, 0.27%), Croatian (2, 0.18%), and Arabic, Czech, and French (1, 0.09% each).

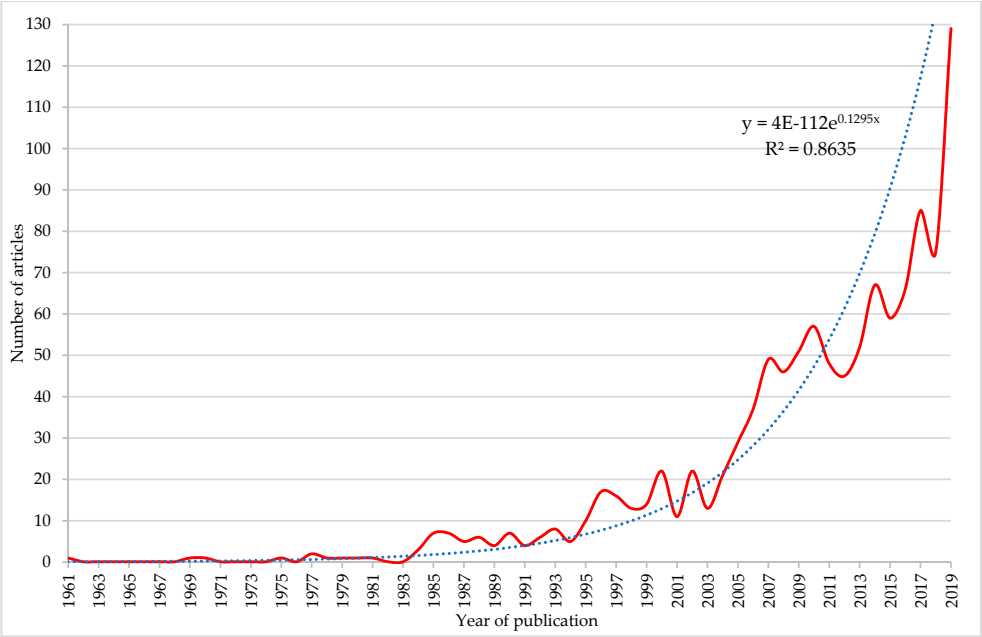

Figure 2. Number of articles by year and trend line (1961–2019).

4.2. Subject Areas and Scientific Journals

In the Scopus database, journals are assigned to 27 main subject categories, as well as 313 specific subject categories. They can be used to limit or reduce the set of elements in the sample, as indicated in Section 3.2 of this study.

Therefore, the 1126 articles are classified into 18 subject areas. In this sense, an article could be classified only in one area or in more than one subject area. There is a correlation between the thematic areas and the journals where the articles are published, the editor being the journal who catalogues each article in the thematic areas, according to their criteria and experience.

Figure 3 presents the 10 main subject areas where articles on emerging technologies in corporate accounting are classified. Business, management, and accounting is the category that collects the highest number of articles (584 published articles, 24.84%), followed by Social Sciences (299, 13.53%). They are followed by economics, econometrics, and finance (264, 11.95%), engineering (261, 11.81%), computer science (238, 10.77%), decision sciences (131, 5.93%), environmental science (111, 5.02%), energy (68, 3.08%), materials science (52, 2.35%), and mathematics (46, 2.08%). The rest of the subject areas do not reach 2% of the published documents.

The 1126 research articles in emerging technologies in corporate accounting have been written by 664 international affiliations. The 15 scientific journals with the highest production in this research field are presented in Table 5. Moreover, 60% of the journals in this ranking are British, four American, two Dutch, and the remaining 20% are of Turkish, Australian, and Indian origin, with one each.

The British journal, *International Journal of Accounting Information Systems,* is the one that has contributed the most to the subject of study, with 18 articles, and it is also the one with the highest h-index (11). They are followed in production by the *American Journal of Information Systems* (16) and the *British Journal of Accounting Education* (15). As for the h-index, it is followed by the *British Accounting Education*, with 8 out of 12 published articles.

It is noteworthy that of the 15 journals in this ranking, the scope and objectives of four of them were related to education. This result confirms that accounting education is a discipline with technological

challenges that seeks to link accounting with information and communications technologies (ICT), to evaluate the impact of the use of technology and digitization in education [94,95].

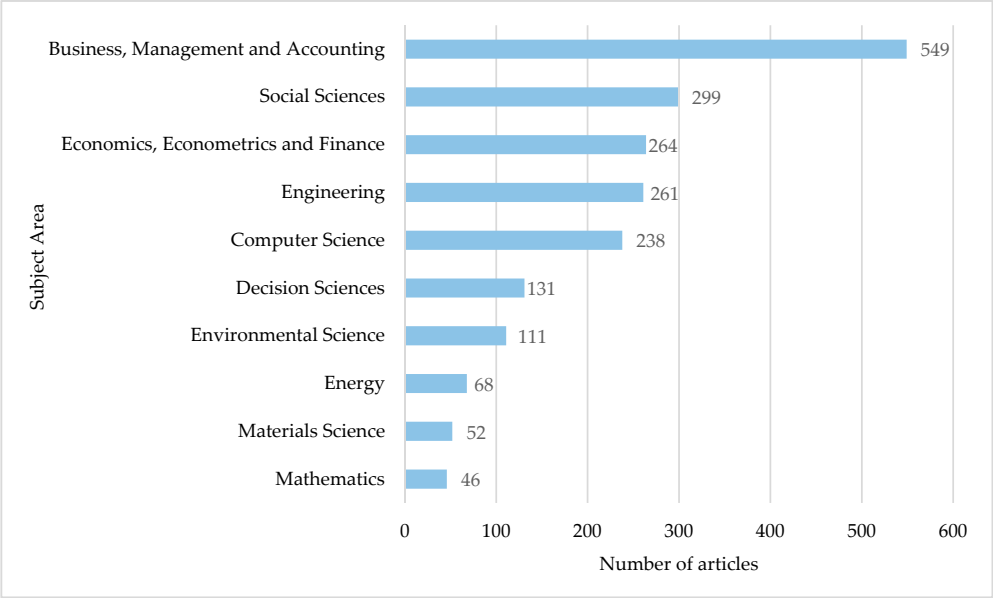

Figure 3. Top 10 subject areas (1961–2019).

Likewise, 11 journals published during the last year analyzed, a result that also reflects interest in this topic. On the other hand, of the 15 journals, 5 published the first article during the last decade (2010–2019), and 6 during the previous decade (2000–2009).

The Dutch journal *Climatic Change*, although its aims and scope are focused on the entire problem of climate variability and change, the journal itself indicates that it contemplates interdisciplinary research, including those related to economics, which includes accounting, from the point of view of the responsibility of accounting in climate change, and from the consideration of this as an accounting variable [96].

In relation to the SJR indicator, *Climatic Change* is also the one with the highest value, with 1.908, considering that it has contributed to this topic with eight articles from 2005 to 2019. It is followed by the *British Accounting Auditing and Accountability Journal*, with 1.459 in nine contributions, from 2007 to 2017. On the other hand, the *Journal of Intellectual Capital* has the highest values for the CiteScore (8.6) and SNIP (2.290) metrics, with eight articles published on this topic.

Business, management, and accounting is the subject area where the articles of the 15 most productive journals were classified the most, in the same way that it happened with all the articles in the sample. In order of importance, it was followed by social sciences, and economics, econometrics, and finance. Although less important, the articles on this topic are also grouped into the subject areas: decision sciences, computer science, engineering, Earth and planetary sciences, and environmental science.

Table 2 also shows the main keywords of the 15 most productive journals on this topic. The most used keyword in the research is "Accounting", where in three journals it is the most used (*Turkish Online Journal of Educational Technology, Accounting Auditing and Accountability Journal*, and *International Journal of Scientific and Technology Research*). In relation to the main term, another series of keywords are related to it, such as: accounting information systems, accountability, accountancy, accounting education, accounting events, accounting firms, accounting principles, auditing, accounting standards, intellectual capital, and management accounting.

Table 2. Top 15 scientific journals (1961–2019).

Journal	C	A *	H *	1A *	LA *	SJR *	CS *	SNIP *	KW1	KW2	KW3	Subject Area
International Journal of Accounting Information Systems	UK	18	11	2004	2019	0.619	4.4	1.496	Digital Reporting	Technology Acceptance	XBRL	BMA-DS-EEF
Journal of Information Systems	USA	16	7	2011	2019	0.780	4.0	1.671	IT Governance	Accounting Information Systems	Business Value of IT	BMA-CS-DS
Journal of Accounting Education	UK	15	7	1998	2019	0.481	3.2	1.592	Accounting Education	Higher Education	Technology	BMA-SS
Accounting Education	UK	12	8	1995	2019	0.520	2.8	1.238	Information Technology	Teaching	Accountancy	BMA-SS
Journal of Emerging Technologies in Accounting	USA	11	5	2009	2019	0.490	2.3	0.879	Technology Adoption	Artificial Intelligence	Continuous Monitoring	BMA-CS
Journal of Productivity Analysis	NL	11	5	2006	2017	0.888	3.2	1.429	Efficiency	Productivity	Accounting	BMA-EEF-SS
Managerial Auditing Journal	UK	10	7	1997	2019	0.468	2.7	1.271	Information Technology	Accounting	Auditing	BMA-EEF
Turkish Online Journal of Educational Technology	TU	10	1	2015	2017	0.126	0.4	0.263	Accounting	Simulation	Academic Achievement	SS
Accounting Auditing and Accountability Journal	UK	9	4	2005	2019	1.459	4.9	1.879	Accounting	Accounting Standards	Alienation	BMA-EEF
Australasian Accounting Business and Finance Journal	AU	9	4	2014	2019	0.309	2.6	1.368	Behavior	Business Strategy	CSR Disclosure Index	BMA-EEF
Critical Perspectives on Accounting	USA	9	7	1996	2019	1.823	5.1	1.936	Accountability	Accounting	Accounting Firms	BMA-DS-EEF-SS
International Journal of Scientific and Technology Research	IN	9	1	2018	2019	0.123	0.2	0.091	Accounting	Accounting Events	Accounting Information Systems	BMA-E-SS
Climatic Change	NL	8	7	2007	2017	1.908	8.3	1.504	Uncertainty Analysis	Economic Analysis	Emission Control	EPS-ES
Issues in Accounting Education	USA	8	5	2010	2016	0.410	1.8	0.811	XBRL	Accounting Principles	Audience Response Systems (ARS)	BMA-SS
Journal of Intellectual Capital	UK	8	5	2002	2019	1.184	8.6	2.290	Intellectual Capital	Business Performance	Management Accounting	BMA-SS

C: country; UK: United Kingdom; USA: United States of America; NL: Netherlands; TU: Turkey; AU: Australia; IN; India; A: number of articles; H: H-index or Hirsch-index; 1A: First article; LA: Last articles; SJR: SCImago Journal and Country Rank (2019); CS: CiteScore (2019); SNIP: Source Normalized Impact per Paper (2019); (*): in this research topic; KW: Keyword; BMA: Business, Management and Accounting; DS: Decision Sciences; EEF: Economics, Econometrics and Finance; CS: Computer Science; SS: Social Sciences; E: Engineering; EPS: Earth and Planetary Sciences; ES: Environmental Science.

Another set of keywords is associated with the main term "business", such as: business performance, business strategy, CSR disclosure index, economic analysis, productivity, uncertainty analysis, and efficiency. Additionally, another group of terms is related to the search terms "digital" and "technology", such as: artificial intelligence, technology acceptance, digital reporting, continuous monitoring, emission control, information technology, XBRL (extensible business reporting language), technology adoption, simulation, IT (information technology) governance, or business value of IT.

In the context of research, XBRL refers to a global and open-access framework for the exchange of business information, that is, it is the open international standard for digital business reports, which allows the expression of the semantic meaning commonly required in the reports business [22,27,97,98].

The high number of keywords that journals associate as topics of the publications indicates the multidisciplinary nature of this topic. It includes the link of a discipline of accounting that includes the study of the evolution of accounting techniques, and organization and business management and control techniques, with technological and digital transformation [19,99,100].

4.3. Productivity by Research Institutions and Countries

The sample of 1126 articles on emerging technologies in corporate accounting has been developed in 1816 international affiliations. Table 3 shows the 10 most prolific research institutions on this topic.

This ranking highlights that 10 are of American origin (Southeast Missouri State University, International Business Machines, The University of Queensland, and University of Southern California), 4 Australian (The University of Sydney, University of Melbourne, RMIT University—Royal Melbourne Institute of Technology and Melbourne Technical College, and Monash University), 1 British (University of Birmingham), and 1 Malaysian (Universiti Utara Malaysia).

The Australian research institution The University of Sydney is the one that has contributed the most to the subject of study, with 11 articles, and it is also the one with the highest h-index (6) together with also the Australian RMIT University. They are followed in the production by the University of Melbourne (9) and a group of institutions with eight contributions (RMIT University, Southeast Missouri State University, Monash University, University of Birmingham, International Business Machines, and The University of Queensland). As for the h-index, they are followed by: University of Melbourne, Monash University, and University of Birmingham.

Business, management, and accounting was the subject area where the articles of the 10 most productive research institutions were ranked the most, as is the case with all the articles in the sample. It is followed in order of importance by economics, econometrics, and finance; social sciences; and computer science. Although with less importance, the articles on this topic are also grouped in the subject areas: mathematics, decision sciences, and engineering.

Likewise, it is noteworthy that 60% of these main research institutions have contributed to the last year analyzed (2019): The University of Sydney, University of Melbourne, RMIT University, Monash University, The University of Queensland, and Universiti Utara Malaysia.

Of this group, International Business Machines (IBM), an American multinational technology company (New York, USA) also stands out, founded in 1911 as the "Computing, Tabulation and Recording Company" and which was renamed "International Business Machines" in 1924. This global technology company develops hardware, software, cloud-based services, and cognitive computing [101,102].

Table 3. Top 10 research institutions (1961–2019).

Research Institution	Country	A	SA	h	1A	LA	KW1	KW2	KW3
The University of Sydney	Australia	11	BMA-SS-CS	6	2009	2019	Accounting	Intellectual Capital	Accounting History
University of Melbourne	Australia	9	BMA-SS-EEF	5	2007	2019	Absorptive Capacity	Accounting History	Administration
RMIT University	Australia	8	BMA-EEF-SS	6	1988	2019	Digital Reporting	XBRL	Administrative Burden
Southeast Missouri State University	USA	8	BMA-SS-CS	0	2011	2015	Acquisition Cycle	Control	Convergence
Monash University	Australia	8	SS-BMA-EEF	5	1996	2019	Access	Accounting Education	Agricultural Policy
University of Birmingham	UK	8	BMA-SS-EEF	5	1995	2018	Digital Reporting	XBRL	Abstractions
International Business Machines (IBM)	USA	8	CS-M-DS	4	1977	2014	Cost Accounting	Accounting Information Systems (AIS)	Administrative Data Processing
The University of Queensland	USA	8	BMA-EEF-CS	4	2011	2019	Extensible Business Reporting Language	XBRL	Business Reporting
University of Southern California	USA	7	BMA-CS-EEF	3	1999	2018	Enterprise Resource Planning Systems	AIS Research	Adoption Curve
Universiti Utara Malaysia	Malaysia	6	EEF-BMA-E	3	2014	2019	Internet Reporting	Accountants	Accounting Information System

A: number of articles; SA: 3 main subject areas by research institution; h: h-index or Hirsch-index; 1A: First article; LA: Last articles; KW: Keyword; SA: Subject area; USA: United States of America; UK: United Kingdom; BMA: Business, Management and Accounting; EEF: Economics, Econometrics and Finance; SS: Social Sciences; CS: Computer Science; M: Mathematics; DS: Decision Sciences; E: Engineering.

On the other hand, Table 3 also shows the main keywords of the 10 most productive research institutions on this topic. The main keywords of the articles published in these 10 journals linked to the main search term "Accounting" are: accountants, accounting education, accounting history, accounting information system, accounting information systems (AIS), cost accounting, and intellectual capital.

The keywords associated with the main term "business" are: acquisition cycle, administrative burden, administrative data processing, agricultural policy, AIS research, business reporting, enterprise resource planning systems, extensible business reporting language—XBRL, adoption curve, and absorptive capacity. In this group, the term "administrative burden" refers to everything that is necessary to demonstrate compliance with a regulatory requirement, including the collection, processing, reporting and retention of information, and the financial and economic costs to do it [22,103].

In this research topic, the 1126 articles were written in 62 different countries. Table 4 shows the top 10 countries in this field. The country with the most articles is the United States (348), which represents 30.91% of the sample, followed by the United Kingdom (104, 9.24%). They are followed by Australia (87, 7.73%), China (53, 4.71%), Germany (38, 3.37%), Russian (37, 3.29%), and Canada (36, 3.20%). The rest of the countries did not exceed 3% of the total articles.

Business, management, and accounting is the thematic area that mostly associates articles associated with the most prolific countries in research on emerging technologies in corporate accounting, during the period 1961–2019. They are followed in order of importance: economics, econometrics, and finance; social sciences; computer science; and engineering.

Likewise, Table 4 also includes the top three keywords for the most productive countries in this research topic. The most used keyword in articles is "Cost Accounting", used as a topic in seven countries. The main keywords used by these 10 countries were associated to three different groups. In this way, a set of keywords were associated with the search term "accounting": cost accounting, accounting information system, cost benefit analysis, costs, mathematical models, and standardization. On the other hand, other terms were associated with the technological and digital aspects of this topic: information technology, digital economy, ICT, industry, innovation, technology, and XBRL (extensible business reporting language). Likewise, another group of terms, although in a minority way, were associated with the term "business", such as: economics and investments.

Figure 4 displays a collaboration map between the main countries based on the co-authorship analysis. Likewise, the different colors corresponded to the different clusters of countries, while the diameter of the circle varied depending on the number of articles published by each country. The software tool grouped them into five components.

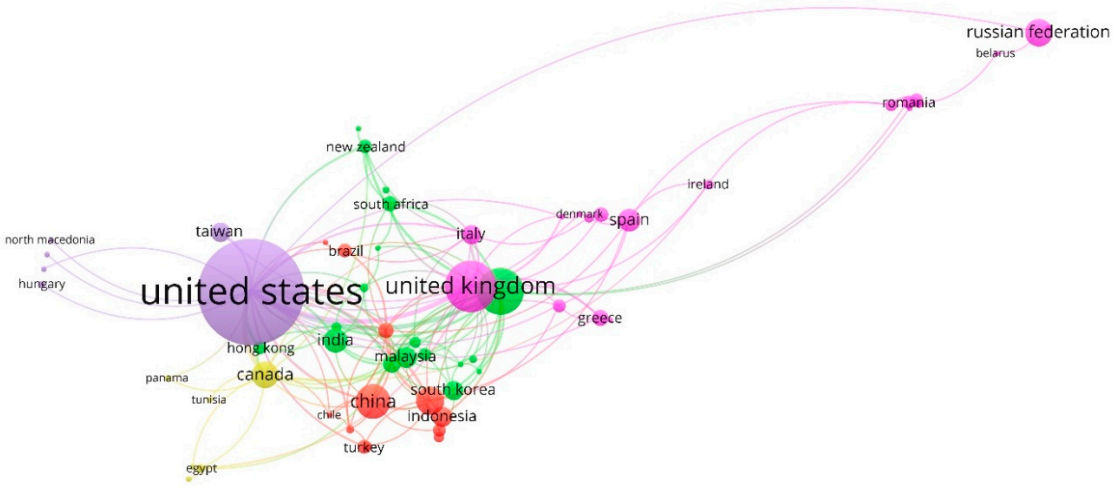

Figure 4. Network of countries based on the co-authorship method (1961–2019).

Table 4. Top 10 countries (1961–2019).

Country	A	%	SA	h	1A	LA	KW1	KW2	KW3
USA	348	30.91	BMA-SS-CS	42	1961	2019	Information Technology	Cost Accounting	Technology
UK	104	9.24	BMA-SS-EEF	20	1970	2019	Information Technology	Cost Accounting	Investments
Australia	87	7.73	BMA-SS-EEF	20	1988	2019	XBRL	Accounting	Economics
China	53	4.71	CS-E-BMA	12	2004	2019	Cost Accounting	Accounting Information System	Emission Control
Germany	38	3.37	BMA-EEF-E	12	1998	2019	Cost Accounting	Cost Benefit Analysis	Information Technology
Russia	37	3.29	EEF-E-BMA	6	2000	2019	Digital Economy	Innovation	Standardization
Canada	36	3.20	BMA-CS-EEF	14	1996	2019	Information Technology	Cost Accounting	Mathematical Models
India	30	2.66	BMA-EEF-SS	6	1996	2019	Information Technology	Cost Accounting	Industry
Spain	27	2.40	BMA-SS-E	9	1997	2019	Costs	Economics	Cost Accounting
Malaysia	23	2.04	EEF-BMA-SS	6	2010	2019	Accounting Information System	ICT	Information Technology

A: number of articles; %: Percentage of articles over the total; SA: 3 main subject areas by country; h: h-index or Hirsch-index; 1A: First article; LA: Last articles; KW: Keyword; SA: Subject area; USA: United States of America; UK: United Kingdom; BMA: Business, Management and Accounting; SS: Social Sciences; CS: Computer Science; EEF: Economics, Econometrics and Finance; E: Engineering.

Cluster 1 (pink), the most numerous, included 32.26% of the countries, and was headed by the United Kingdom. This was associated, among others, with Russian, Spain, Italy, Greece, Finland, Romania, Switzerland, Ukraine, Poland, or Ireland. Cluster 2 (green) included 29.03% of the countries and was led by Australia and shared work with India, Malaysia, South Korea, France, South Africa, New Zealand, Hong Kong, Iran, Belgium, or Singapore. Cluster 3 (network) included 19.35% of the countries and was led by China, and included countries such as Germany, Indonesia, the Netherlands, Brazil, Turkey, Japan, Thailand, Sweden, Norway, or Chile. Cluster 4 (yellow) included 9.08% of the countries and was headed by Canada, and included Egypt, Qatar, Bahrain, Panama, and Tunisia. Finally, cluster 5 (violet) included 9.08% of the countries and was led by the United States, includes Taiwan, Hungary, Slovenia, North Macedonia, and Venezuela.

Worldwide research on emerging technologies applied to business accounting was mainly led by the United States, the United Kingdom, and Australia. Therefore, research in these reference countries is mainly focused on aspects related to the accounting cost and the information provided by technology. That is, the impact of technology on the accounting discipline is analyzed from how information technologies operate as an engine of change that allows responding to new information needs, which leads to a new post-industrial era that involves making all the data obsolete with business structures without the ability to adapt [104,105].

4.4. Keyword Analysis

In this analysis, 6384 keywords were identified in the 1126 scientific articles that made up the study sample. The analysis of the keywords that appeared with more frequency and relevance provided the identification of a set of research topics, which suggest the lines of interest carried out by academics and researchers during the period 1961–2019, in addition to assuming the basis for the detection of future directions of research at the international level on emerging technologies in corporate accounting.

4.4.1. Current Lines of Research

An analysis of co-occurrences of the keywords of the total articles of the selected sample from the Scopus database was carried out. Figure 5 shows the six clusters in which the keywords and their links were grouped, identifying each group with a color. The size of each group refers to the importance of the keywords that make up the group, while the thickness of the lines connecting two groups refers to the number of interactions established between two different groups.

This analysis, based on the method of co-occurrences, allowed us to group the publications into groups of functions of the keywords used, in addition to recognizing the lines of research developed in this field of research, during the period 1961–2019, based on the use of keywords in articles.

Table 5 shows the six clusters of keywords made up by VOSviewer. The color with which each cluster is identified and the weight that each group represents in the total sample is indicated. In addition to the main keyword of each of them, which also defines the name of the cluster, the three main keywords with which it is linked within each group, based on the occurrences, the links, and the total link strength, were included.

The six clusters identified from the co-occurrence analysis represent the lines of research developed during the analyzed period (1961–2019) by the different driving agents of this research field, that is, authors, research institutions, countries, and financing centers. These lines and a brief description of the scope of each of them are presented below.

- Technology: The publications during this period have analyzed the technologies related to accounting, both as improvements in speed, which only affect quantitative aspects, and in the changes in the design of information systems that cause changes in the way companies work [17]. During these decades, the actors have dedicated their efforts to verify the new technologies, which they have incorporated more speed, interconnectivity, data processing capacity, and self-learning

capacity, and it has not always been perceived as a positive aspect because it is a discipline very anchored to tradition [106].

- Information Technology: During this period, the linkage of information technologies as an engine of change that leads to a new post-industrial era has been studied and that, during this period, has been making obsolete all business structures that have failed to adapt [16]. Thereby, this line associated with information technology has been developed as an application of telecommunication equipment to store, retrieve, transmit, and manipulate data, in the context of business or other companies [107,108].
- Cost Accounting: This school of thought has examined the study of cost accounting as an information system for recording, determining, distributing, accumulating, analyzing, interpreting, controlling, and reporting the costs of production, distribution, administration, and financing [109].
- Investments: During this period, research in this line has sought to identify investments in research and development activities as a measure that will reduce capital requirements, operating costs, and the generation of innovative products in accordance with market requirements. This line has examined improving productivity, to help companies to be more efficient and economically viable by increasing the productive apparatus of the countries [110].
- Optimization: Since the beginning of the analyzed period, research in this line has studied inefficiency in internal accounting processes that have a negative impact on business flow. So, this line has contributed to the analysis of the management of the processes as a continuous activity of the financial inputs and outputs in the company that guarantees a correct operation. Accounting and financial reporting continue to play a leading and regulatory role among models and information on economic phenomena that help understand how companies produce value [111].
- Employment: This line of research has examined how technology and digitization has transformed the area of business accounting due, among other causes, to regulatory regulations and the need that has been imposed on the speed in the transmission of information [17,21,112].

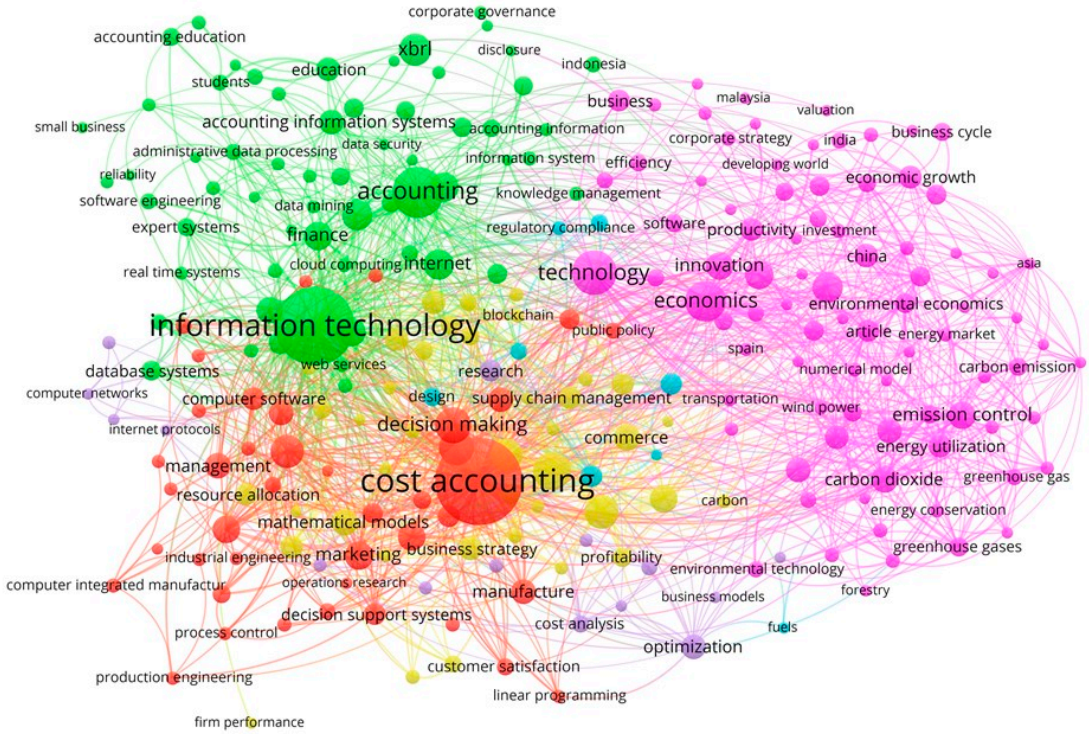

Figure 5. Network of keywords based on the co-occurrence method (1961–2019).

Table 5. Clusters of keywords (1961-2019).

Cluster Number	Cluster Color (See in Figure 5)	%	Keyword	O	L	TLS
1	Pink	34.00%	Technology (*)	44	112	183
			Economics	38	121	228
			Sustainable Development	23	74	104
			Emission Control	21	57	75
2	Green	24.40%	Information Technology (*)	112	163	450
			Accounting	54	80	122
			XBRL	26	18	21
			Information Systems	23	47	76
3	Red	16.40%	Cost Accounting (*)	131	179	625
			Decision Making	30	100	175
			Industrial Economics	29	74	132
			Strategic Planning	27	75	145
4	Yellow	16.00%	Investments (*)	33	102	191
			Cost Benefit Analysis	28	96	183
			Industry	25	88	141
			Economic Analysis	20	88	135
5	Violet	6.00%	Optimization (*)	16	53	84
			Cost Analysis	9	33	56
			E-Commerce	8	21	26
			Standardization	8	18	21
6	Blue	3.20%	Employment (*)	13	48	73
			Laws and Legislation	9	37	47
			Standards	9	36	47
			Regulatory Compliance	7	27	31

%: percentage of total keywords; O: occurrences; L: links; TLS: total link strength; (*): leading keyword.

4.4.2. Evolution of Keywords

This section presents the evolution that keywords have followed in the research on emerging technologies in corporate accounting during the period examined (1961–2019). Therefore, the pioneering terms associated with this research are identified and have been incorporated from the increase in published articles. For this reason, Figure 6 shows the evolution and maturity of each cluster of keywords, since it differentiates the period in which they have been studied and associated with the articles examined. In this way, it is verified that there has been progress in the terminology of the study topic.

In this evolution of the keywords associated with the research topic, Figure 6 shows the group of pioneering keywords that has allowed one to establish the basis of the study of data processing business, computer aided manufacturing, production engineering, computers, operations research, production control, computer networks, computer software, information science, telecommunication, database systems, quality assurance, computer aided design, and international trade, and search terms (accounting, business, digital, and technology).

Likewise, among the keywords that have been associated more recently with this topic are business process, internal controls, higher education, digital storage, business development, artificial intelligence, big data, social media, and blockchain.

In recent years, terms related to new technologies and digitalization related to accounting development are emerging. Hence, concepts have emerged such as: (1) big data, which refers to the massive analysis of data by data processing applications, and which allows the company to be analyzed beyond the historical data of the business in order to observe trends in the market [23,113]; (2) blockchain, a decentralized, peer-to-peer network that allows the reliability and immutability of the records that are kept open and visible to everyone [18,114]; (3) social media, in relation to

a multiplatform business strategy, sharing accounting content on LinkedIn, Facebook, and Twitter, in order to empower the accounting industry [115,116]; or (4) artificial intelligence (AI), which allows changing accounting books by computer systems, using Electronic Data Interchange (EDI) solutions to connect different sources of information, implemented, for example, Enterprise Resource Planning (ERP) systems. Hence, AI allows, among other aspects: to work on purchases and accounts payable, collecting received invoices, and accounting for them against order orders; in the scrutiny of supplier information, so that the results of various supplier information sources are counted in order to complete their file in the process of creating new suppliers [20,26,117]

The different subperiods in which emerging technologies in corporate accounting scientific activity takes place represent an abundant collection of keywords. This allows one to verify the six axes of study in the identified research activity. Figure 6 visualizes the importance of key terms based on when they have been associated with this research. Therefore, as indicated, the older ones have been a reference for the later ones.

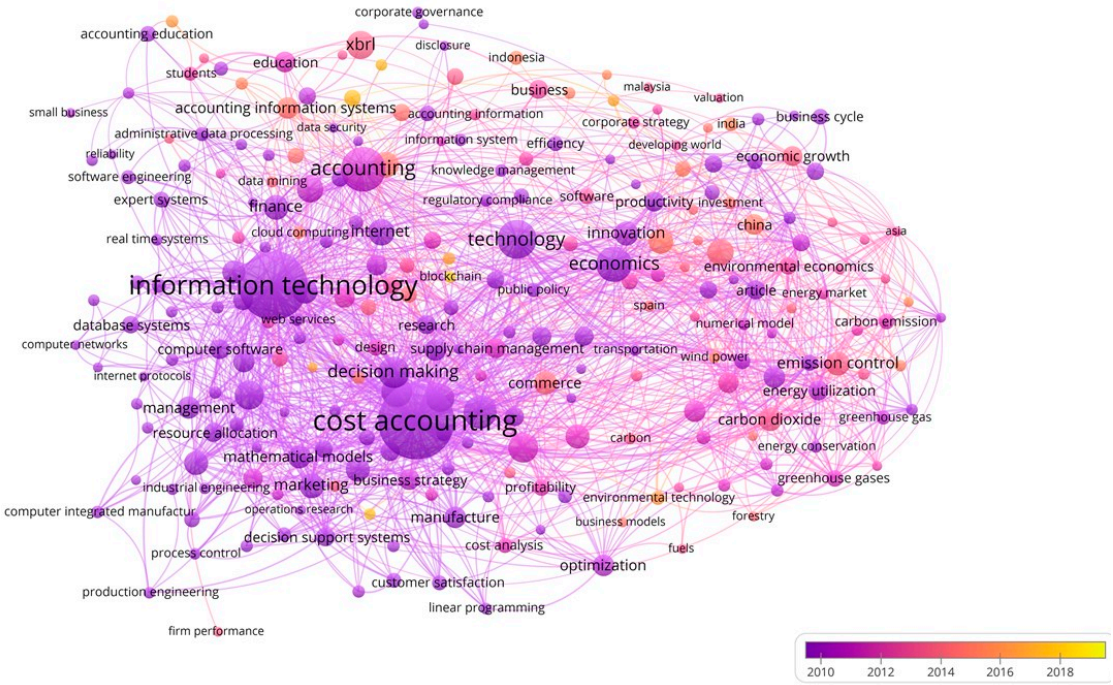

Figure 6. Evolution of the network of keywords based on the co-occurrence method (1961–2019).

4.4.3. Future Directions of Research

Table 6 presents the main future directions for international research on emerging technologies in corporate accounting, based on the score relevance attribute calculated by VOSviewer (see Section 3.3), which has made it possible to identify the 10 most important future lines of research. A brief description of each of the future lines of research in this field is highlighted below.

Table 6. Future directions of research based on score relevance.

Future Direction of Research	Score Relevance	Main Associated Terms	Description
Blockchain Ontology	19.631	• Blockchain Privacy Protection Methodology • Blockchain Integration • Accounting for Cryptocurrencies	This line will examine Blockchain as the technology that unites the philosophy of technology and the ethics of information. This will allow companies the decentralization, transparency, and privacy that the current internet has lost, building a quasi-metaphysical system where everything would be noted, linked, and individualized by cryptographically perfect hashing processes and ensured by ethical managers [118].
Involuntary Unemployment	19.279	• Remote Working • Employees Willingness • Independent Own Account Worker	Analysis of the disadvantages and advantages of how emerging technologies in the accounting field increase involuntary unemployment. This direction should examine how to take advantage of technological change to improve corporate performance through workers, customers, technology, and innovation [119].
Cybersecurity Risk	16.642	• Fraudulent Account • Phishing Technique • Cybersecurity Negative Externality	Cybersecurity risk management is key to safeguarding the confidentiality, availability, and integrity of information assets, critical infrastructure, and personal data in cyberspace. To successfully manage risk, you must follow the reference framework for the study, identification, and mitigation of cybersecurity risks of standards such as ISO 31000: 2018 or ISO/IEC 27005: 2001. Its importance lies in protecting a company's most valuable assets and its reputation [15,120].
Big Data Technology	11.945	• Key Accounting Data • Online Accounting Data • Exogenous Data	Analysis of the multiple options that big data offers to reorganize data structures, to allow the entry of different data sources, and a single transformation of data and homogenization of results. This line will examine how data analysis enables data manipulation and provides tools to create reports and data sets for financial and risk management purposes. In addition, the implementation of big data solutions will be assessed in relation to the challenges (implement new principles of data governance and transform data quality processes) and benefits (improved operational risk mitigation by reducing human intervention) [121,122].
Cloud Accounting	11.807	• Breakthrough Technology • Digitization • COFRIS Accounting Ontology	Examine how cloud accounting can be the most efficient way to maintain a business's accounting records, offering greater flexibility and security. The information is kept in large data centers with more redundant and backup systems than the company's own installation. The digital transformation, in this sense, will allow one to structure all the available information. Moreover, this line should study if the ontology engineering methods work in the development of the regulatory function established by the required International Financial Information Standards [123].
AI exposure	10.684	• AI Challenge • Business Intellectual • Intelligent Virtual Assistant	Analysis of the combination of artificial intelligence and automation in relation to the ability to take on tasks in the accounting area of an organization based on transactions, with little or no human participation. This direction will have to analyze the challenge of the economic survival of a company that consists of capitalizing on the changes in the way of developing the accounting functions [124].

COFRIS: Core Ontology for Financial Reporting Information Systems.

In this way, mainly, the main advances for the management of external reporting should be based on optimizing efficiency as well as maintaining precision and control. The technologies and techniques implemented by organizations in their financial teams should stimulate the configuration of intelligent reports, based on AI, machine learning, cognitive computing, and natural language tools [24]. Furthermore, the reports must be interactive, from tablets and smartphones to navigate the information, and even through a digital assistant or a chatbot to manage queries. Current technological barriers must be overcome, so that reports are in real time, with the horizon of automation to streamline and simplify data management. In this sense, various digital technologies develop external reporting, such as: (1) RPA (Robotic Process Automation), to shorten the time that companies spend on data management by automating routine tasks; (2) predictive analytics, based on the use of algorithms to perform prospective analysis; (3) chatbots, to allow users to interact directly with the data through voice or text inquiries; and (4) AI, which will include natural language and machine learning tools [125–128].

5. Conclusions

The aim of this study was to analyze the evolution of scientific production and research trends worldwide, during the last 59 years (1961–2019), on emerging technologies in corporate accounting. For this, bibliometric techniques were applied to a sample of 1126 scientific articles obtained from the Scopus database, to study the evolution of the number of articles, the subject areas where they are classified, and the most productive journals, research institutions, and countries. Moreover, the main current and future lines of research were detected.

Scientific production has increased especially in the last decade (2010–2019), where 683 articles have been published, which represents 60.66% of the total on the subject of emerging technologies in corporate accounting, which confirms the global relevance and impact of this research topic in the academic and scientific community.

On the other hand, this study also identified the most influential schools of thought where publications are classified: business, management, and accounting; social sciences; and economics, econometrics, and finance. Likewise, the *International Journal of Accounting Information Systems*, *Journal of Information Systems*, and *Journal of Accounting Education* are the main journals that have contributed the most to the development of this field of research.

The lines of research identified that develop the field of study during the period 1961–2019 have generated contributions on: (1) technology; (2) information technology; (3) cost accounting; (4) investments; (5) optimization; and (6) employment.

Internationally, research on emerging technologies in corporate accounting continues to evolve, so this study identified six new directions in this field: (1) blockchain ontology; (2) cybersecurity risk; (3) big data technology; (4) cloud accounting; (5) AI exposure; and (6) involuntary unemployment.

This research involved an analysis of scientific production (number of articles per year, production trend, thematic areas, journals, research institutions, and countries), besides the identification of the main current lines of research, in the period 1961–2019, and future directions of research on emerging technologies in corporate accounting. Furthermore, the findings obtained are a complement to the knowledge on this subject and allow one to establish the relationship between new technologies and digitization with business accounting, to favor data processing and decision-making. In this way, an optimized management of both research resources and their applications would be achieved.

Even so, this study has a set of limitations, which have conditioned the results obtained, and these could be considered as the basis for future research articles on this topic. Among these limitations, we can highlight the Scopus database chosen to apply the methodology; the keywords selected to extract the sample of scientific articles; the study period; the bibliometric techniques used; and even the variables examined. It is also necessary to recognize that, using data mining, you can explore large databases and find repetitive patterns that explain the behavior of this data.

Lastly, it should be noted that global research on emerging technologies in corporate accounting shows an upward trend, derived from both the number of articles and current and future lines of

research. This indicates the interest that is increasingly accentuated by the academic and scientific community, mainly due to the multidisciplinary nature of this field of research.

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