EVOLUTION OF INTELLECTUAL CAPITAL AS AN INTANGIBLE ASSET IN ACCOUNTING: SYSTEMATIC LITERATURE REVIEW AND BIBLIOMETRIC ANALYSIS

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Abstract: This study presents a systematic literature review and bibliometric analysis focusing on the evolution of intellectual capital as an intangible asset in accounting research. Drawing data from two prominent scientific databases, Web of Science and Scopus, we provide significant insights into key topics, leading countries, authors, and affiliations in this field. Our findings highlight variations across databases in certain areas, emphasizing the nuanced differences in research trends and outputs. Additionally, we identify a time lag in the evolution of topics within Scopus compared to Web of Science. This research contributes original insights by offering a comprehensive overview of past and current relevant topics, serving as a valuable resource for stakeholders interested in intellectual capital research and its implications in accounting.

Keywords: intellectual capital, intangible assets, accounting, bibliometric analysis.

1 Introduction

The accounting for intangible assets and intellectual capital (IC) has seen significant changes in Europe, North America, Australia, and Asia since the year 2000. This has increased the importance of academic research in this field, and the interest in intangible assets and intellectual capital is not limited to academic research alone. Regulatory bodies like the Financial Accounting Standards Board and businesses have also shown a growing interest in this issue from a practical perspective (Garanina et al., 2021).

The issue of intangible assets and intellectual capital's relevance is confirmed by several reasons. Firstly, from a regulatory perspective, the field of intangible assets has significantly developed over the past 30 years (Garanina et al., 2021). Reforms implemented between 1994 and 2004 resulted in the adoption of International Accounting Standards (IAS), expanding accounting options for companies globally. Starting from April 1, 2001, the International Accounting Standards Board (IASB) has embraced International Financial Reporting Standards (IFRS), previously referred to as IAS, as the recognized accounting standards (IFRS, 2018). Since 2005, the European Union has mandated the use of IFRS as the accounting standard for EU countries. Starting in 2007, efforts to align IFRS with the generally accepted accounting principles of the United States (US GAAP) have been initiated. Currently, despite variations in the accounting treatment of intangible assets, the harmonization process is progressing at a higher level (Garanina et al., 2021).

Despite the new regulations on accounting standards, accounting practices related to intangible assets and intellectual capital remain controversial. Some researchers, such as Chalmers et al. (2012) or Baruch Lev (2018), blame IAS 38 (International Accounting Standards) and SFAS 2 (Statements of Financial Accounting Standards) for the way intangible assets are reported, valued, and disclosed. Furthermore, practitioners and researchers often criticize accounting standards for not providing additional guidance on the accurate measurement of intangible assets.

There is a need to merge two distinct approaches in defining, measuring, and managing reported intangible assets and intellectual capital, which are developing simultaneously. One approach is emerging in Europe, Australia, and Asia, while the other is developing in North America. Both approaches tackle the same problem but employ different terminology to define core concepts. For instance, scholars in Europe, Australia, or Asia use the term "intellectual capital," whereas in the USA, the term "intangible assets" or "intangibles" is more commonly utilized (Garanina et al., 2021). Although the terms are used in different areas, intangible assets in accounting literature, knowledge assets in economists' literature, and intellectual capital in managerial and legal literature essentially refer to the same thing – future benefits that are not materially embodied. Therefore, in academic research, definitions of terms such as "intangible assets," "knowledge assets," "intellectual capital," and others are examined and compared (Lev, 2018).

Over the course of twenty-five years, research on intellectual capital has progressed through five distinct stages. The initial phase established the concept as a "good idea," while the second phase developed frameworks for analysing intellectual capital. The subsequent phase delved into understanding how intellectual capital functions in practical applications (Guthrie et al., 2012). From these beginnings, some researchers have progressed to the fourth phase, which they call the ecosystem approach to effective intellectual capital management. The fifth phase of research addresses the question of whether managing intellectual capital is a worthwhile endeavour, considering how intellectual capital can address not only organizational but also societal issues. Understanding the various stages of intellectual capital research helps identify possible future directions for its study (Garanina et al., 2021).

2 Literature review

Historically, intangible assets have been viewed as risky because they are difficult to measure. Intangible assets, unlike tangible ones such as real estate and machinery, have less easily measurable potential future benefits. However, in today's economy, intangible capital is becoming increasingly valuable as it creates value (Eckstein, 2004).

The global impact of information and technological and communication development has transformed our society and prioritized the globalization of the economy and innovation as key factors in global competition. The economic, political, and social environment has recently undergone profound changes, leading to a higher level of globalization and increased competition. As a result, the transition from traditional accounting to modern accounting now requires more information. The evolution from the agricultural age to the industrial age has also changed the approach to intangible assets and their importance. This is evident in published studies: in 1978, intangible assets accounted for 5% of all assets; in 1998, this number increased to 72% of all assets, and currently, intangible assets represent 75-85% of all assets (Gîju et al., 2012).

In several countries, investments in intangible assets are rapidly growing. In some states, these investments exceed those in traditional capital, such as machinery, equipment, or buildings. The significance of intangible assets for companies, industries, and national economies continues to be reinforced by aspects such as intense global competition, information and communication technologies (ICT), new business models, and others. Given such a situation, policymakers in many developing economies are striving to develop intangible assets necessary for success in high-value-added activities (OECD, 2011).

Intangible assets are resources that are used to add value to a business entity. These assets do not have a physical nature and are classified or defined differently by international organizations, researchers, and regulatory bodies. Given the varying definitions of intangible assets and how they are categorized, the following subchapters describe the approach to this issue from the viewpoint of accounting and regulatory bodies, as well as from the perspective of academic researchers.

According to the OECD, intangible assets can be defined as assets that lack physical or financial form. Intangible assets can be grouped into three categories according to OECD classifications (OECD, 2011):

1. computer-based information – this group includes intangible assets such as software and databases;
2. innovative property – this group includes intangible assets such as scientific research, non-scientific research, copyrights, designs, and trademarks;
3. economic competencies – this group includes intangible assets such as brand value, human capital, networks connecting people and institutions, and organizational know-how.

The European Central Bank (ECB) defines intangible assets as non-monetary assets that lack physical or financial substance. This category includes a wide variety of assets like human capital, innovative products, brands, patents, software, consumer relationships, databases, and distribution systems. These assets can help businesses improve productivity and efficiency through the use of new technologies. Specifically, intangible assets cover investments in computational and computer-based information (such as software and databases), innovative company characteristics and competencies (like scientific and non-scientific research and development, copyrights, designs, and trademarks), economic competencies (including brand value, company-specific human capital, networks connecting people and institutions, organizational know-how enhancing efficiency, and advertising and marketing aspects). They are also known as "intellectual assets," "knowledge assets," or "intellectual capital" (ECB, 2018).

As per IFRS/IAS 38, an intangible asset is an identifiable non-monetary property without physical substance. An intangible asset is identifiable when it can be separated (sold, transferred, licensed, etc.) or when it arises from contractual or other legal rights. Expenditures on an intangible asset are recognized as an expense unless the item meets the definition of an intangible asset and it is probable that economic benefits will flow from the asset in the future, and the acquisition cost of the asset can be reliably measured. It's challenging to distinguish between costs to create intangible assets and maintenance costs from an internal perspective. Therefore, internally generated brands, titles, publishing titles, customer lists, and similar items are not recognized as intangible assets. Costs to create other intangible assets generated by own activities are classified based on the phase during which they arose, either in the research phase or in the development phase. Research expenditures are recognized as an expense, and development expenditures are recognized as the acquisition cost of intangible assets (if they meet specified criteria). (IFRS, 2022). In Table 1, we have depicted the recognition rules for intangible assets according to IAS 38.

Table 1 Recognition of intangible assets according to IAS 38

Recognition of intangible assets
Recognition criteria for (intangible) assets: • It is probable that future economic benefits will flow to the entity. • The acquisition cost of the asset can be reliably measured.
Additional recognition criteria for intangible assets arising from development: • Technical feasibility • Focus on completion • Usability or saleability • Potential to generate future economic benefits • Availability of adequate technical, financial, and other resources • Ability to reliably measure attributable expenditures
Specific restrictions for the recognition of internally generated intangible assets: • Internally generated goodwill cannot be recognized. • Internally generated brands, publishing titles, customer lists, and similar items cannot be recognized. • Expenditures related to start-up activities, training activities, advertising and promotional activities, relocation, or reorganization are part of the overall entity. • Expenditures on intangible assets initially recognized as expenses cannot be capitalized later.

Source: own proceeding according to IFRS, 2022

The Financial Accounting Standards Board (FASB) categorizes intangible assets into five groups: marketing-related intangible assets, customer-related intangible assets, artistic-related intangible assets, contract-based intangible assets, and technological intangible assets. Table 2 also provides specific examples of these groups of intangible assets (Yallwe & Buscemi, 2014).

Table 2 Classification of intangible assets according to FASB

Group of intangible assets	**Examples of intangible assets**
Intangible assets related to marketing	Trademarks, trade names, service marks, collective marks, certification marks, trade dress (unique colour, shape, or packaging design), newspaper headlines, internet domain names, and non-compete agreements.
Intangible assets related to customers	Customer lists, outstanding orders or production, contracts with customers and related customer relationships, and non-contractual customer relationships.
Intangible assets related to art	Games, opera books, ballet books, magazines, newspapers, other literary works, musical works such as compositions, song lyrics, jingles, images, photographs, video and audiovisual material, including films, music videos, and television programs.
Intangible assets based on contracts	Licenses, licensing agreements, advertising, construction, management, services, or supply contracts, lease agreements, construction permits, franchise agreements, operating and broadcasting rights, utility rights such as drilling, water, air, mineral rights, timber harvesting, and easements, service contracts such as mortgage services contracts, employment contracts.
Technological intangible assets	Patented technology, computer software and mask works, unpatented technology, databases, including plant varieties, trade secrets such as secret formulas, processes, and recipes.

Source: own processing according to Yallwe & Buscemi, 2014

From the above classifications and definitions, we can consider the terms "intellectual asset," "intangible asset," "knowledge asset," and "intellectual capital" as interchangeable. Furthermore, in general, all characteristics of intangible assets can be summarized as (Yallwe & Buscemi, 2014):

- Organizational resources without physical existence;
- Provide future economic benefits;
- Legally protected (i.e., ownership);
- Acquired from past activities (research and development, training, learning by practice, contractual agreement).

3 Methodology

This study involves bibliographic research that provides valuable information about research trends and gaps through a systematic and quantitative analysis of intellectual capital evolution as an intangible in accounting. The analysis of empirical data in published literature guides the bibliometric analysis of the research area and identifies major themes (Leung et al., 2017). The application of mathematical and statistical methods to books and other forms of communication (Pritchard, 1969).

For our study, we utilize the standard science mapping workflow developed by Börner et al.(2003) and further developed by Aria & Cuccurullo (2017) Cobo et al. (2011) and Zupic & Čater (2015). The standard workflow consists of 5 stages: study design, data collection, data analysis, data visualization, and interpretation. For our study design, we formulated the following research questions:

RQ1: What are the emerging trends in publication and citation patterns in the Web of Science and Scopus databases?

RQ2: What are the key trends and themes according to the keywords in publication patterns in the Web of Science and Scopus databases?

RQ3: How have publication trends evolved in the Web of Science and Scopus databases?

RQ4: Which countries are leading in publication counts in the Web of Science and Scopus databases, and what are their key international collaborations?

RQ5: Which journals are the most relevant in terms of publication metrics in the Web of Science and Scopus databases?

RQ6: Which authors are the most relevant in terms of publication metrics in the Web of Science and Scopus databases? How have their publication trends evolved? What do their collaboration networks look like?

RQ7: Which affiliations are the most relevant in terms of publication metrics in the Web of Science and Scopus databases? What do their collaboration networks look like?

In order to address these research questions, we utilized bibliometric techniques as outlined in Table 3.

Table 3 Standard bibliometric techniques

Bibliometric technique		The unit of analysis used	Kind of relation
Bibliographic coupling	Author	Author's oeuvres	Common references among author's oeuvres
	Document	Document	Common references among documents
	Sources	Journal's oeuvres	Common references among the journal's oeuvres
Co-author	Author	Author's name	Authors' co-occurrence
	Country	Country from affiliation	Countries' co-occurrence
	Institution	Institution from affiliation	Institutions' co-occurrence
Co-citation	Author	Author's reference	Co-cited author
	Document	Reference	Co-cited documents
	Journal	Journal's reference	Co-cited journal
Co-word		Keyword, or term extracted from	Terms' co-occurrence title, abstract, or document's body

Source: own proceeding according to the Cobo et al. (2011)

Data was collected on June 3, 2024, from two main research databases: Web of Science and Scopus. The PubMed database was excluded from the selected databases because it only yielded 6 publications and did not provide valuable output for analysis. The inclusion criteria of data filtering are described in Table 4.

Table 4 Inclusion criteria for data collecting

Inclusion Criteria	Web of Science	Scopus
Keywords	"intellectual capital" AND "intangible assets" AND "accounting" OR "IFRS" OR "IAS" OR "US GAAP" Should include "intellectual capital" AND "intellectual capital management" Search within all fields	
Document Type	Article	
Language	English	
Subject Area / Category	Business Finance; Management; Business; Economics; Multidisciplinary Sciences. Exclude all other	Business, Management and Accounting; Economics, Econometrics and Finance. Limited to the mentioned area
Total number of selected documents	**4,767 documents**	**3,369 documents**

Source: own proceeding

To gain a better insight into our research topic's evolution, we collected data from all available years without filtering any specific time period. For Web of Science, we analysed data from 1985 to 2024; for Scopus, we looked at the period from 1997 to 2024. Since the year 2024 is not yet finished, our analyses may be subject to change by the end of the year. However, we do not anticipate any changes in the research area, but only in the number of published documents. We chose not to exclude the year 2024 in order to understand the current trends.

To analyse the collected samples, we use the latest version of RStudio (2024.04.2+ 764) installed on a Windows 11 platform. For bibliometric analysis, we utilize a package called "bibliometrix". Data from both databases are imported as ".bib" files. Using the "biblioshiny" package command, we delete duplicated articles and process the analyses. The Figure 1 illustrates the analysis of features that can be performed by "biblioshiny" using R (Aria & Cuccurullo, 2017; Donthu et al., 2021).

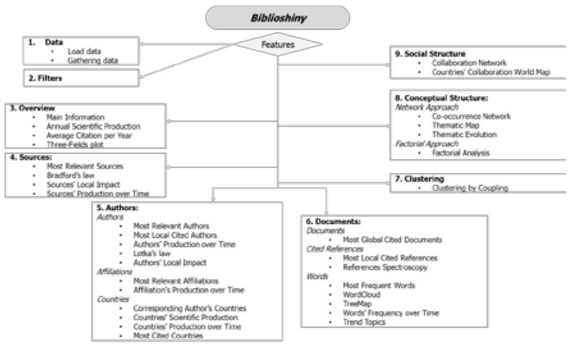

Figure 1 Features of "biblioshiny" in RStudio
Source: own proceeding

4 Results

After making the necessary corrections to the loaded sample (such as deleting duplicated evidence), we have finalized our samples, which are described in Table 5. Based on these samples, all other analyses were proceeded.

Table 5 Summarize of selected samples

Description	Web of Science	Scopus
Timespan	1985 - 2024	1997 - 2024
Sources (Journals, Books, etc)	624	827
Documents	4,763	3,333
Annual Growth Rate %	14.58	16
Document Average Age	7.38	7.66
Average citations per	22.74	33.41

doc		
Author's Keywords (DE)	8,003	6,641
Authors	8,628	6,505

Source: own proceeding

4.1 Descriptive statistics

Between 1985 and June 3rd, 2024, a total of 8,628 authors produced 4,763 documents across 624 sources listed in the Web of Science database. In the case of 827 Scopus-listed sources, 6,505 authors produced 3,333 documents during the period from 1997 to June 3rd, 2024. The publication trend for both scientific databases is illustrated in Figure 2. We observe that both databases show a consistent increasing trend in publications related to intellectual capital in accounting.

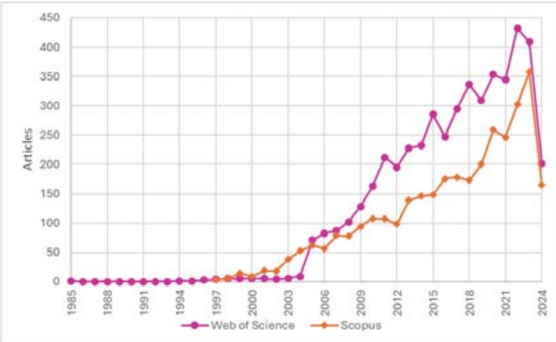

Figure 2 The publication trend
Source: own proceeding

Not less important are citations. Table 6 compares two databases based on the average citations per article and citation years.

Table 6 Citation comparison of Web of Science and Scopus

	Web of Science			Scopus		
Year	Average citations per article	Number of articles	Citable Years	Average citations per article	Number of articles	Citable Years
1985	2	1	40			
1994	128	1	31			
1995	0	1	30			
1996	13	3	29			
1997	151	4	28	105.67	3	28
1998	315.8	5	27	239.83	6	27
1999	305.6	5	26	267.93	14	26
2000	347.17	6	25	58.11	9	25
2001	147.6	5	24	192.95	19	24
2002	181.75	4	23	83.06	18	23
2003	258.17	6	22	95.32	38	22
2004	239	9	21	83.02	53	21
2005	83.8	71	20	86.06	62	20
2006	46.92	83	19	72.14	57	19
2007	54.57	87	18	68.96	79	18
2008	58.86	102	17	62.78	78	17
2009	33.98	128	16	38.6	94	16
2010	44.6	163	15	58.55	108	15
2011	33.88	212	14	50.69	107	14
2012	36.38	195	13	48.32	98	13
2013	31.39	228	12	37.58	139	12
2014	26.75	232	11	28.84	146	11
2015	25.07	285	10	40.35	148	10
2016	24.75	247	9	30.5	176	9
2017	19.17	295	8	42.14	178	8
2018	14.77	336	7	32.65	173	7
2019	12.61	309	6	22.72	200	6
2020	11.69	353	5	21.05	259	5
2021	7.12	344	4	14.41	246	4
2022	4.71	432	3	10.85	302	3
2023	1.96	409	2	3.71	358	2
2024	0.73	202	1	1.02	165	1

Source: own proceeding

For a better understanding of the citation trend for both databases, we have illustrated the average citations per year in Figure 3.

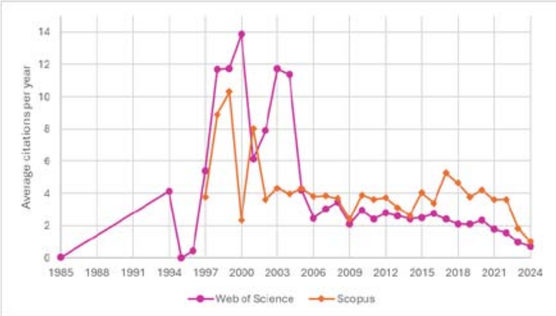

Figure 3 Citation trends in Web of Science and Scopus
Source: own proceeding

4.2 Keywords bibliometric analyses

The Web of Science sample contains 8,003 authors' keywords, which will be analysed in subsequent parts of this chapter. The Scopus sample includes 6,641 keywords. The top 20 most frequent keywords for both samples are listed in Table 7.

Table 7 The most frequent keywords for Web of Science and Scopus

Web of Science		Scopus	
Words	Occurrences	Words	Occurrences
Intellectual capital	1238	Intellectual capital	1162
IFRS	812	Intangible assets	314
Disclosure	217	Human capital	274
Human capital	188	Knowledge management	177
Corporate governance	162	Innovation	152
Earnings management	160	Financial performance	149
Value relevance	160	Disclosure	148
Financial reporting	153	Performance	119
Capital	130	Structural capital	102
Performance	127	Relational capital	100
Intangible assets	125	Corporate governance	97
Innovation	124	Intangibles	92
Accounting	118	Content analysis	82
Knowledge management	117	Firm performance	81
IFRS adoption	109	Corporate social responsibility	67
Financial performance	99	Competitive advantage	66
International financial reporting standards	98	Balanced scorecard	60
Accounting standards	89	Integrated reporting	59
Fair value	88	Value creation	55
Structural capital	84	India	54

Source: own proceeding

We used a word cloud to visualise the top 100 keywords for both samples. To account for keyword frequency variations and enhance visualisation clarity, we utilized square roots of keyword occurrences. The word cloud for Web of Science is illustrated in Figure 4 and for Scopus in Figure 5.

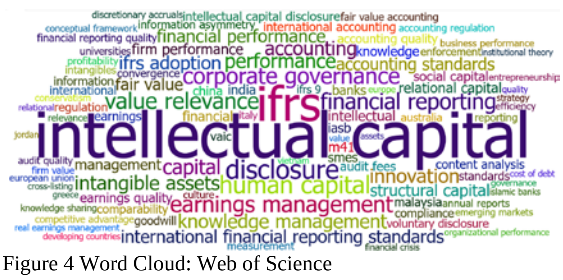

Figure 4 Word Cloud: Web of Science
Source: own proceeding

Figure 5 Word Cloud: Scopus
Source: own proceeding

The Web of Science keywords were categorised into three clusters using co-word net analysis. The first cluster (red) is linked to intellectual capital as an intangible asset in corporations. The second cluster (blue) is associated with accounting standards and reporting. The final cluster (green) pertains to intellectual capital, its components, and calculations related to firm performance and innovation. The node network is depicted in Figure 6.

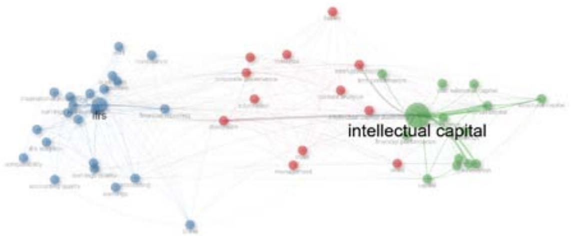

Figure 6 Co-word net: Web of Science
Source: own proceeding

The Scopus keywords were categorised into six clusters using co-word net analysis. The first cluster (red) is related to the innovation perspective, including R&D, patents, and intellectual property. The second cluster (blue) is related to intellectual capital as intangible, which provides a competitive advantage and has an impact on firm performance. The third cluster (green) combines words related to corporate finance and accounting. The fourth cluster (purple) is related to reporting and measurement. The fifth cluster (orange) is related to performance measurement, and the final cluster (brown) is related to intellectual capital components. The node network is depicted in Figure 7.

Figure 7 Co-word net: Scopus
Source: own proceeding

We have analysed the themes based on keywords, considering their relevance and level of development. The themes have been divided into four categories:

1. Niche themes (high development, low relevance);
2. Motor themes (high development, high relevance);
3. Emerging or declining themes (low development, low relevance);
4. Basic themes (low development, high relevance).

A thematic map for the Web of Science is shown in Figure 8. The map encompasses niche themes such as entrepreneurship, competitive advantage, governance, and efficiency. Additionally, it covers motor themes like IFRS disclosure and corporate governance. Emerging topics include themes related to annual reports, profitability, and IFRS 9. The largest group consists of basic themes, which touch upon topics like intellectual capital and its components, disclosure and measurement of intellectual capital, universities, and innovations.

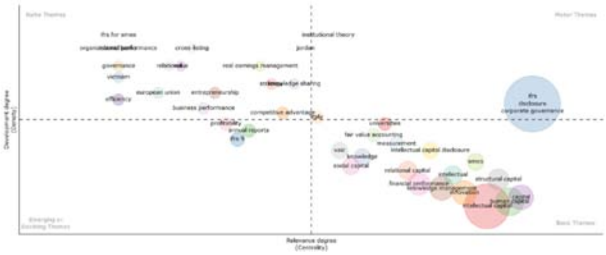
Figure 8 Thematic map: Web of Science
Source: own proceeding

In the case of Scopus, niche themes include topics such as panel data, open innovation, and human resources. Organizational learning is identified as a motor theme. Additionally, topics like intellectual capital, intangible assets, and human capital are shifting from basic themes to motor themes. Emerging themes include agency theory. Within the group of basic themes, we can find systematic literature review, value relevance, knowledge sharing, and information asymmetry, among others. Figure 9 shows a thematic map for Scopus.

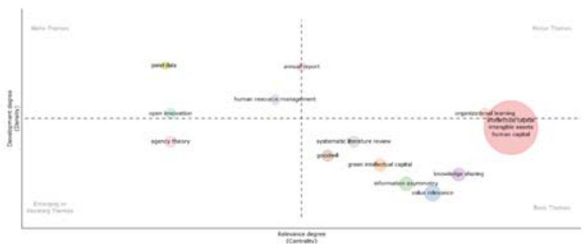
Figure 9 Thematic map: Scopus
Source: own proceeding

It's widely known that trends and topics change over time. To illustrate how these topics have evolved, we've conducted a thematic evolution analysis. We divided the period into smaller intervals with four time points. These time points were chosen based on the evolution of intellectual capital in literature. The first time cut was in the year 2000 when the concept and empirical confirmations of intellectual capital gained attention from international accounting organisations amid reforms about standards for intangibles in accounting and reporting systems. The second time point is in the year 2010 when all accounting standards were harmonized, and researchers began focusing not only on organisational intellectual capital but also on national and regional intellectual capital, while countries were recovering from the global crisis. The next time point was set for the year 2015, and the last for 2020.

In our analysis of the Web of Science sample, we divided the data into five time intervals: 1985 – 2000, 2001 – 2010, 2011 – 2015, 2016 – 2020, and 2021 – 2024. In the first interval, the focus was on "capital markets" and "international accounting standards." The second interval covered a wider range of topics, including intellectual capital, performance, and annual reports. The third interval emphasized social aspects and the impact of intangibles and innovations on information asymmetry in capital markets (referred to as "agency theory"). After 2015, attention shifted towards sustainable economics. The most recent interval, from 2021 to the present, reflects contemporary global events such as the COVID-19 pandemic, the war in Ukraine, and energy crises. Therefore, we are now focusing on topics such as innovations, knowledge management and sharing, competitive advantage, intellectual capital efficiency, development, and others. The results for Web of Science listed documents are illustrated in Figure 10.

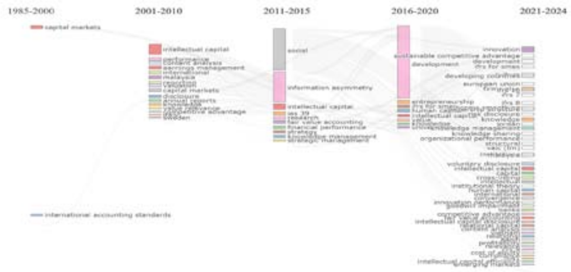

Figure 10 Thematic evolution: Web of Science
Source: own proceeding

In our analysis of the Scopus sample, we divided the data into five time intervals: 1997-2000, 2001-2010, 2011-2015, 2016-2020, and 2021-2024. The results for each interval vary. Starting in 1997, the first interval is characterised by intellectual capital, intangible assets, knowledge management, and measurements. The second period focuses on intellectual capital, intangibles, and financial reporting. The third interval adds innovations and risk management to the previous topics. In contrast to the Web of Science, agency theory and information asymmetry have been addressed since 2016. The last interval emphasises intellectual capital, SMEs, and measurements. The results Scopus listed documents are illustrated in Figure 11.

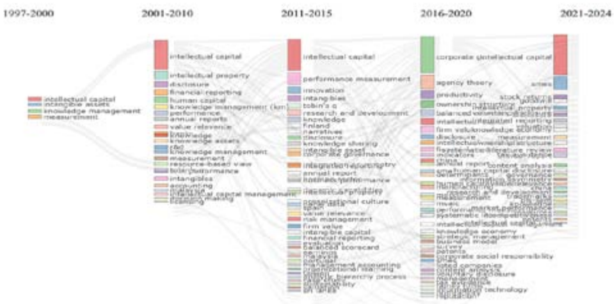

Figure 11 Thematic evolution: Scopus
Source: own proceeding

4.3 Countries bibliometric analyses

The scientific output from both databases is on the rise. In the case of Web of Science, for the year 2024, 109 countries contributed to scientific content (published in articles, books, etc.). The United States of America leads in this type of production with 2,014 publications, followed by the United Kingdom with 1,146 publications. China closes the top 3 scientific producers list with 1,010 publications. Scientific production for all countries is illustrated in Figure 12.

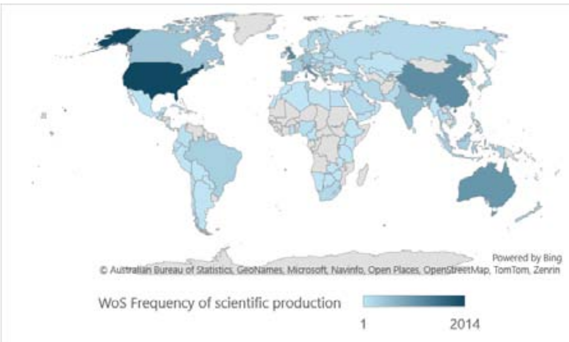

Figure 12 Country scientific production: Web of Science
Source: own proceeding

In contrast to the previous database, scientific content listed in Scopus in the year 2024 is contributed by 100 countries. In this case, Italy leads with 669 publications, followed by the United States of America with 581 publications. The top 3 are closed by China, as in the previous case, with 535 publications. Scientific production for all countries is illustrated in Figure 13.

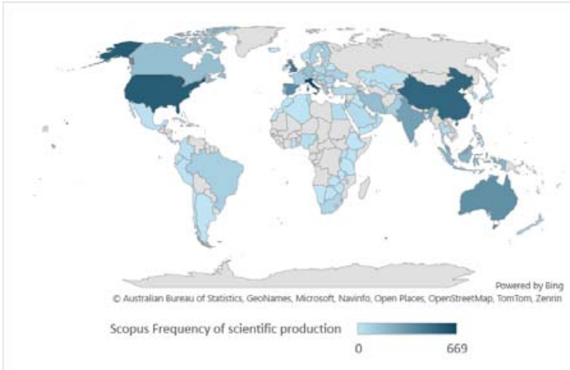

Figure 13 Country scientific production: Scopus
Source: own proceeding

To enhance the relevance of research in the field of intangible intellectual capital in accounting, we present the number of publications for 2013 and 2023 for the top 10 countries of each database, thus interpreting the trends over the past 10 years. These results are illustrated in Figure 14 for Web of Science and Figure 15 for Scopus.

In the case of Web of Science, the top 10 producers of research content are the USA, the UK, China, Australia, Italy, Spain, India, Canada, Germany, and Malaysia. For the top 3 countries, the scientific output from 2013 to 2023 increased as follows: USA from 714 to 1,939, UK from 347 to 1,110, and China from 249 to 1,012. Nearly all of the top 10 countries at least doubled their scientific production.

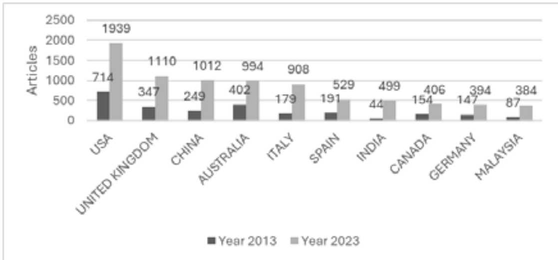

Figure 14 The top 10 countries production in the years 2013 and 2023: Web of Science
Source: own proceeding

In the case of Scopus, the top 10 producers of research content are Italy, the USA, China, the UK, Spain, Australia, India, Malaysia, Indonesia, and Portugal. The scientific output from 2013 to 2023 for the top 3 countries increased as follows: Italy from 102 to 644, the USA from 228 to 552, and China from 157 to 483. Nearly all of the top 10 countries more than doubled their scientific production

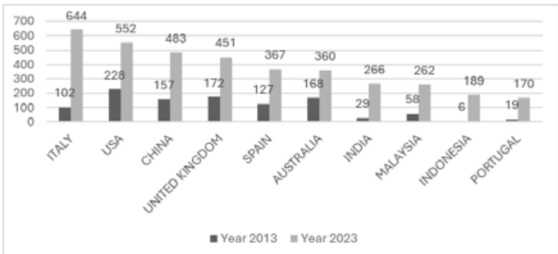

Figure 15 The top 10 countries production in the years 2013 and 2023: Scopus
Source: own proceeding

Next, we examined the collaborative patterns among countries to determine whether they had solely domestic publications or if they engaged in international co-authorship. We identified corresponding authors and country collaboration maps to better understand these connections. The corresponding author's countries are illustrated in Figure 16 for Web of Science and in Figure 18 for Scopus.

The top 20 countries in Web of Science primarily produce publications within their borders.

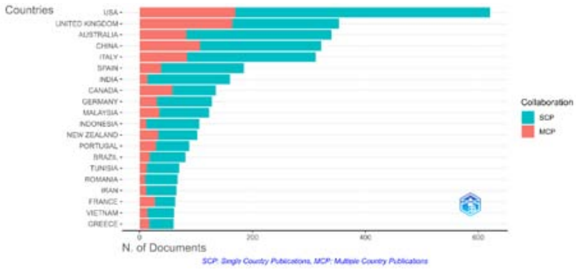

Figure 16 Corresponding author's countries: Web of Science
Source: own proceeding

The USA collaborates most frequently with China (87 collaborations), the UK (67 collaborations), and Canada (44 collaborations). On the other hand, the USA has the lowest collaborations with South Africa, Serbia, Poland, Pakistan, Nigeria, Mexico, Malta, Lithuania, Iran, Hungary, Ghana, Czech Republic, Chile, Bahrain, and Argentina, with only one collaboration with each of these countries. In the case of the United Kingdom, their top three collaborations are with Australia (47 collaborations), Italy (38 collaborations), and China (28 collaborations). Conversely, the UK has very minimal collaboration with Ukraine, Tanzania, Montenegro, Monaco, Mexico, Malta, Lithuania, Liechtenstein, Latvia, Kenya, Kazakhstan, Hungary, Ecuador, and the Czech Republic, with only one collaboration with each of these countries. Australia's most frequent collaborations are with New Zealand (29 collaborations), Italy (28 collaborations), and Malaysia (10 collaborations), while their least frequent collaborations are with Ukraine, Turkey, Tanzania, Romania, Pakistan, Norway, Nigeria, Mauritius, Libya, Lebanon, Korea, Israel, Ireland, Finland, Fiji, Egypt, Brazil, Austria, and Albania, with only one collaboration with each of these countries. The collaboration links map is illustrated in Figure 17. It is important to note, that we are explaining countries, with whom mentioned countries collaborate at least 1 time. Countries with which they do not collaborate may be dedicated from Figure 17.

Figure 17 Collaboration world map: Web of Science
Source: own proceeding

The top 20 Scopus countries are all single-country producers, with the exception of Pakistan.

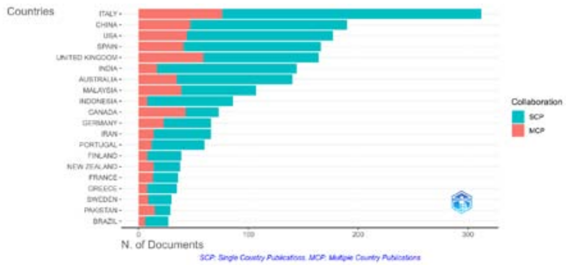

Figure 18 Corresponding author's countries: Scopus
Source: own proceeding

Italy most frequently collaborates with the United Kingdom (38 collaborations), Australia (23 collaborations), and the USA (15 collaborations). On the other hand, Italy has only one collaboration each with Turkey, Tunisia, Switzerland, Serbia, Romania, Qatar, Morocco, Mexico, Kazakhstan, Jordan, Indonesia, and Estonia. China frequently collaborates with the United Kingdom (13 collaborations), Malaysia (12 collaborations), and Australia (10 collaborations). Conversely, China has only one collaboration with each of the following: Ukraine, Turkey, Thailand, Romania, Philippines, Oman, Latvia, Japan, Iran, Indonesia, Greece, Denmark, and Croatia. The USA's most frequent collaborations are with China (32 collaborations), the United Kingdom (27 collaborations), and Canada (18 collaborations). The USA has only one collaboration with each of the following countries: Ukraine, Uganda, Slovenia, Oman, Nigeria, New Zealand, Namibia, Malta, Kuwait, Japan, Ireland, Indonesia, Ghana, Georgia, Egypt, Czech Republic, Croatia, Chile, Brazil, and Bahrain. The collaboration links map is illustrated in Figure 19. It is important to note that we are referring to countries with which the mentioned countries have collaborated at least once. Countries with which they do not collaborate are not described.

Figure 19 Collaboration world map: Scopus
Source: own proceeding

4.4 Sources bibliometric analyses

The main bibliometric analysis tool for journals is Bradford's law. Bradford's law is a pattern first described by Samuel C. Bradford in 1934 that estimates the exponentially diminishing returns of searching for references in science journals. According to the law, if the number of articles sorts journals in a field into three groups, each with about one-third of all articles, then the number of journals in each group will be proportional: 1:n:n^2 (Naranan, 1970). In many disciplines, this pattern is called a Pareto distribution. Core Sources by Bradford's law for Web of Science and Scopus are illustrated in Figure 20 and Figure 21.

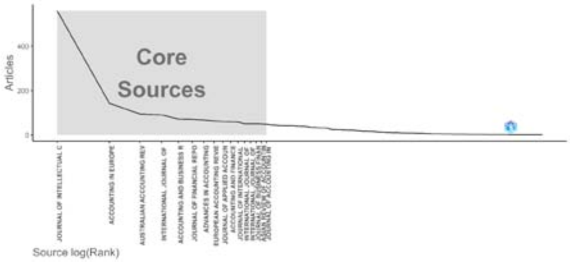

Figure 20 Core sources by Bradford's law: Web of Science
Source: own proceeding

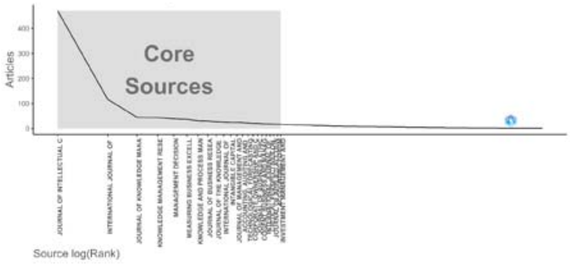

Figure 21 Core sources by Bradford's law: Scopus
Source: own proceeding

We thoroughly analysed these journals to better understand the core sources' structure according to Bradford's Law. First, we examined the most relevant sources of production for both databases. The results for Web of Science are illustrated in Figure 22 and for Scopus in Figure 23.

The Journal of Intellectual Capital is the most prominent journal in the Web of Science database, having published 561 articles. Accounting in Europe follows with 143 articles, making it the second most significant journal. The Australian Accounting Review rounds out the top 3. Lastly, the top 10 includes Accounting and Finance, which has published 60 articles.

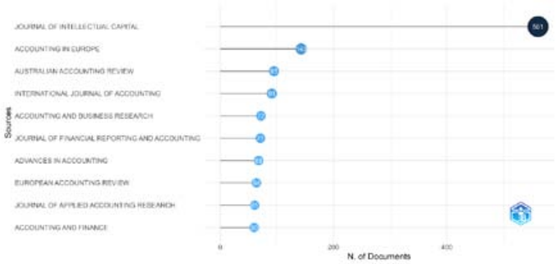

Figure 22 Most relevant sources: Web of Science
Source: own proceeding

In addition to the previous case, the Journal of Intellectual Capital is also highly relevant in Scopus. It has a significant lead with the second place being taken by the International Journal of Learning and Intellectual Capital with 117 articles. The top 3 is rounded out by the Journal of Knowledge Management with 45 articles. The top 10 is completed by the International Journal of Productivity and Performance Management.

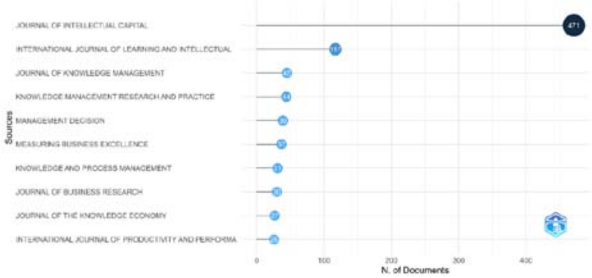

Figure 23 Most relevant sources: Scopus
Source: own proceeding

4.5 Authors bibliometric analyses

Lotka's law is a basic infometrics law for analysing the authors (similar to Bradford's law for sources). Lotka's law, named after Alfred J. Lotka, is a special application of Zipf's law that describes the frequency of publication by authors in any given field. Let's define X as the number of publications, Y as the number of authors with X publications, and k as a constant that depends on the specific field. Lotka's law states that Y ∝X^(-k). Lotka initially claimed that k = 2, but subsequent research has shown that k varies depending on the discipline. Alternatively, Lotka's law can be expressed as Y^'∝X^(-(k-1)), where Y' is the number of authors with at least X publications. These two expressions can be proven equivalent by taking the derivative (Qiu et al., 2017). Lotka's law for the Web of Science sample is illustrated in Figure 24 and for Scopus – Figure 25.

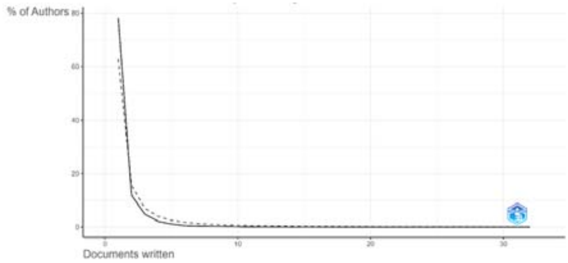

Figure 24 Lotka's law: Web of Science
Source: own proceeding

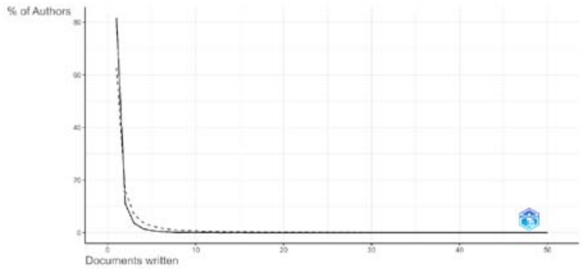

Figure 25 Lotka's law: Scopus
Source: own proceeding

In our analysis, we examined the top 10 most relevant authors from both samples and analysed their individual production and fractionalized articles. Fractional authorship measures an author's contributions to a set of published papers, assuming uniform contributions from all co-authors for each document. We calculated fractional frequency as follows (Demaine, 2022):

$$FracFreq\,(AU_j) = \sum_{h \in AU_j} \frac{1}{number\ of\ co-authors\ (h)},$$

where AUj is the set of documents co-authored by the author j, and h is a document included in AUj.

The most relevant authors according to Web of Science are N. Bontis, J. Dumay, C. Nobes, H. Gupta, V. A. Nageswaran, T. V. Somanathan, A. Krimpmann, M. Salehi, K. Wennberg, and P. Chand. In the case of Scopus, the top 10 authors are N. Bontis, J. Dumay, J. Guthrie, I. Abeysekera, G. Roos, M. Grimaldi, L. Cricelli, J. Mouritsen, P. Paoloni, and S. Veltri. We provide information about articles and fractionalized articles for both samples in Table 8.

Table 8 Most relevant authors from Web of Science and Scopus

Web of Science			Scopus		
Author	Articles	Articles Fractionalized	Author	Articles	Articles Fractionalized

BONTIS, N.	32	11,16666667	BONTIS, N.	50	17,96666667
DUMAY, J.	30	12,45	DUMAY, J.	31	12,28333333
NOBES, C.	26	20,33333333	GUTHRIE, J.	22	8,616666667
GUPTA, H.	18	6	ABEYSEKERA, I.	19	15,5
NAGESWARAN, V. A.	17	5,666666667	ROOS, G.	17	7,283333333
SOMANATHAN, T. V.	17	5,666666667	GRIMALDI, M.	16	5,116666667
KRIMPMANN, A.	16	16	CRICELLI, L.	15	4,616666667
SALEHI, M.	16	4,883333333	MOURITSEN, J.	15	6,683333333
WENNBERG, K.	16	5,45	PAOLONI, P.	15	5,25
CHAND, P.	15	6,333333333	VELTRI, S.	15	7,5

Source: own proceeding

Additionally, we also provide analysis of the author's production and citations per year for both samples. The results are illustrated in Figure 26 for Web of Science and in Figure 27 for Scopus.

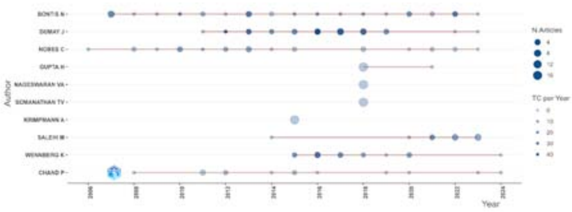

Figure 26 Author's production and citations over time: Web of Science
Source: own proceeding

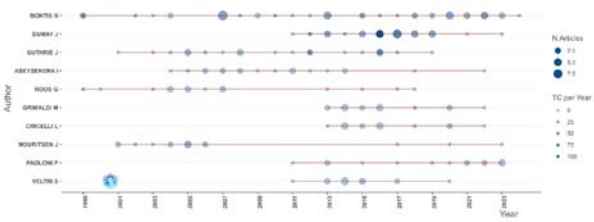

Figure 27 Author's production and citations over time: Scopus
Source: own proceeding

We provide a network of authors for collaboration, normalized by associations. The collaboration network for Web of Science is shown in Figure 28 and for Scopus in Figure 29.

In the Web of Science sample, we have identified 11 clusters of authors. The first collaboration cluster includes N. Bontis, J. Dumay, J. Guthrie, M. Khalique, G. Secundo, I. Abeysekera, S. Abhayawansa, and M. Massaro. The second cluster consists of authors such as S. J. Gray, M. Joshi, N. Hellman, and J. Birt. In the third cluster, we have M. Grimaldi and L. Cricelli. The fourth cluster contains two authors, I. W. K. Ting and Q. L. Kweh. The fifth cluster is represented by L. L. Rodrigues and J. Craig. The sixth cluster includes M. Walker, E. Lee, and J. Xu. The seventh cluster consists of authors P. Chand and C. Patel. The eighth cluster includes two authors, A. Kianto and J. Saenz. In the ninth cluster, we have H. Gupta, V. A. Nageswaran, and T. V. Somanathan. The tenth cluster includes R. Barker and M. E. Barth. The last cluster is represented by I. Tsalavoutas and K. Hussainey.

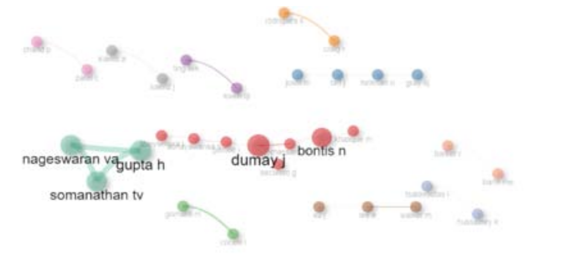

Figure 28 Author collaboration network: Web of Science
Source: own proceeding

In the case of Scopus, we identify as well 11 clusters. The first collaboration cluster includes M. Grimaldi and L. Cricelli. The second cluster consists of authors such as N. Soewarno and B. Tjahjadi. In the third cluster, we have E. Shakina and A. Barajas. The fourth cluster contains two authors, V. O. Dh and N. P. Tran. The fifth cluster is represented by N. Bontis and K. Asiaei. The sixth cluster includes J. Dumay, J. Guthrie, I. Abeysekera, G. Roos, S. Veltri, S. Abhayawansa, G. Secundo and S. Cuganesan. The seventh cluster consists of authors N. Raimo and F. Vitolla.. The eighth cluster includes four authors, G. Schiuma, B. Marr, A. Lönnqvist and D. Carlucci. In the ninth cluster, we have U. Johanson, J. Holland, M. Giuliani and M. Skoog. The tenth cluster includes J. Mouritsen, R. Roslender and C. Nielsen.. The last cluster is represented by Q. L. Kweh, W. M. Lu and I. W. K. Ting.

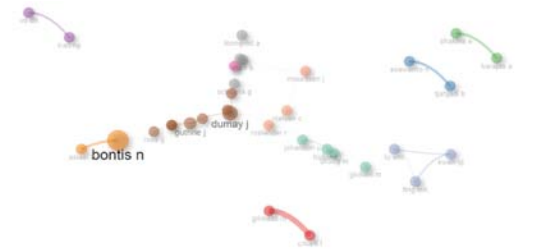

Figure 29 Author collaboration network: Scopus
Source: own proceeding

4.6 Affiliations bibliometric analyses

The top 10 most relevant affiliations in Web of Science are Macquarie University, University of Sydney, Massey University of New Zealand, McMaster University, Universidad de Castilla – La Mancha, Islamic Azad University, University Kebangsaan Malaysia, Hong Kong Polytechnic University, Auckland University of Technology, and Makerere University. The number of articles produced by these affiliations is illustrated in Figure 30.

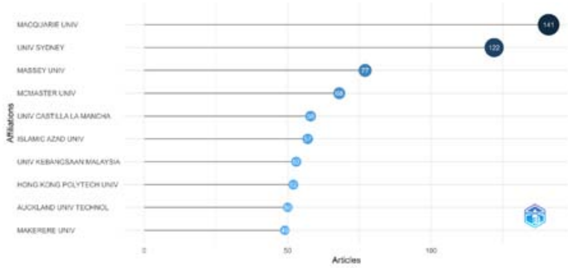

Figure 30 Most relevant affiliations: Web of Science
Source: own proceeding

The top 10 most relevant affiliations in Scopus are Macquarie University, McMaster University, National Research University Higher School of Economics, Islamic Azad University, Universiti Teknologi MARA, University of Cassino and Southern Lazio, University of Salerno, University of Calabria, Universidad de Castilla – La Mancha, and Universiti Teknologi Malaysia. The number of articles produced by these affiliations is illustrated in Figure 31.

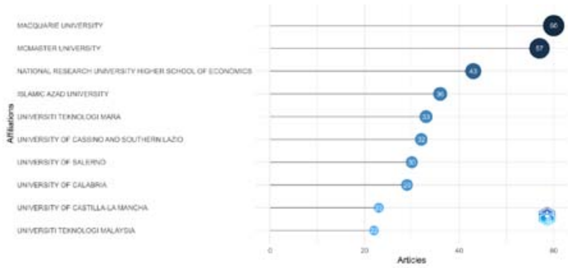

Figure 31 Most relevant affiliations: Scopus
Source: own proceeding

Similarly, we create collaboration networks for affiliations for both Web of Science and Scopus, as illustrated in Figures 32 and 33.

In the case of Web of Science, there are 9 collaboration clusters. The first cluster includes affiliations such as the University of Sfax, the University of Naples Federico II, the Athens University of Economics and Business, the University of Valencia, and the University of Salerno. The second cluster consists of McMaster University, Islamic Azad University, and Ferdowsi University of Mashhad. The third cluster is the largest, containing 17 affiliations: Macquarie University, the University of Sydney, Massey University of New Zealand, The Hong Kong Polytechnic University, Auckland University of Technology, The University of Western Australia, The University of Glasgow, Lancaster University, University of Wollongong, University of Technology Sydney, Swinburne University of Technology, The University of Adelaide, University of Calabria, University of Cassino and Southern Lazio, University Of Salento, Royal Holloway University of London, and the University of Otago. The fourth cluster includes the University Kebangsaan Malaysia, University of Technology MARA, University Utara Malaysia, and International Islamic University Malaysia. The fifth cluster contains two affiliations: University of São Paulo and University of Genoa. The sixth cluster includes the Royal Melbourne Institute of Technology, La Trobe University, Monash University, The University of Queensland, and Griffith University. The seventh cluster consists of the University of Pretoria and The University of Auckland. The eighth cluster includes the Bucharest University of Economic Studies and the University of Birmingham. The last cluster includes National Chengchi University and National Taiwan University.

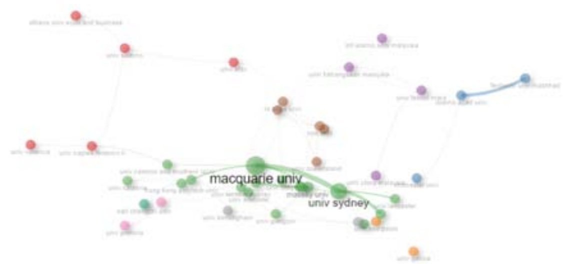

Figure 32 Affiliation collaboration network: Web of Science
Source: own proceeding

When looking at Scopus, there are 10 collaboration clusters. The first cluster consists of the University of Castilla-La Mancha, the University of Technology Malaysia, and the International Islamic University Malaysia. The second cluster includes the University of Salerno, the University of Turin, Tampere University of Technology, the University of Salento, and the University of Basilicata. The third cluster comprises three affiliations: the University of Glasgow, the University of Ferrara, and the University of Florence. The fourth cluster includes the National Research University Higher School of Economics, Lappeenranta University of Technology, the University of Vaasa, and the University of Deusto. The fifth cluster contains National Chengchi University, Chinese Culture University, National Taiwan University, and National Cheng Kung University. The sixth cluster consists of Ahlia University and the University of Johannesburg. The seventh cluster includes two affiliations: Universitas Airlangga and the University of Wollongong. The largest affiliation cluster contains 12 organizations: Macquarie University, the University of Cassino and Southern Lazio, the University of Calabria, Copenhagen Business School, the University of Sydney, RMIT University, Swinburne University of Technology, Monash University, the University of Bologna, the University of Waikato, Sapienza University of Rome, and the University of New South Wales. The ninth cluster includes McMaster University, Islamic Azad University, the University of Malaya, Ferdowsi University of Mashhad, and the University of Isfahan. The last cluster contains the University of Technology MARA, University Utara Malaysia, and Universiti Kebangsaan Malaysia.

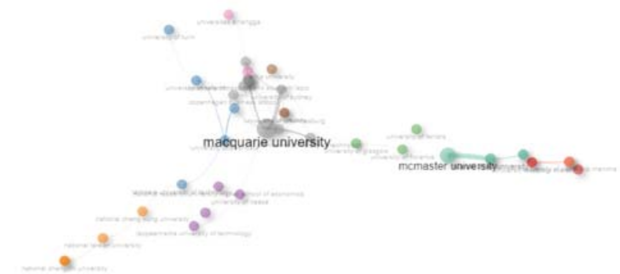

Figure 33 Affiliation collaboration network: Scopus
Source: own proceeding

5 Conclusion

The existing literature contains a significant amount of research on intellectual capital and the accounting of intangibles. In this study, we combine both sides, as intellectual capital is an intangible asset for firms, regions, and countries. We provide a systematic literature review on the accounting of intangibles, as well as systematic bibliometric analyses on the research of intellectual capital as a part of intangible assets in accounting. For our research we use Web of Science and Scopus database as the hugest scientific sources. The PubMed database was excluded because of non-relevant amount of available documents.

We used bibliometric analysis to answer our research questions. Our first question focused on publication and citation patterns. The publication pattern in both samples is increasing, confirming the relevance of the chosen topic. Unfortunately, citation patterns in both databases are decreasing.

The second research question pertained to trend topics and themes. In the Web of Science database, the trending topics are intellectual capital, innovations, and accounting standards. These themes were divided into 4 groups: niche, motor, emerging, and basic. Niche themes include entrepreneurship, competitive advantage, governance, and efficiency. Motor themes cover IFRS disclosure and corporate governance. Emerging topics involve annual reports, profitability, and IFRS 9. The largest group consists of basic themes, which cover intellectual capital and its components, disclosure and measurement of intellectual capital, universities, and innovations. In the case of Scopus, the focus is on innovations, intellectual capital as intangible, and the measurement and reporting of intangibles. Niche themes include panel data, open innovation, and human resources. Organizational learning is classified as a motor theme. Additionally, topics such as intellectual capital, intangible assets, and human capital are transitioning from basic themes to motor themes. Emerging themes include agency theory. Within the basic themes group, we find systematic literature review, value relevance, knowledge sharing, and information asymmetry, among others.

The third research question solving the topics' evolution. The research in the area of intellectual capital as an intangible asset is divided into 5 time intervals. In the Web of Science sample, the data is divided into intervals from 1985 to 2024, with a shift in focus over time. Themes evolved from capital markets to knowledge management, intellectual capital, innovations, etc. In contrast, the Scopus sample, divided into intervals from 1997 to 2024, displays varying results across each interval. Topics evolved from intellectual capital and intangible assets to intellectual property and intellectual capital components. Also we can see that Scopus topics are evolving with a small lags.

The fourth research question focuses on the perspective of country-level research output. In the case of Web of Science, the USA stands out as the leading country, with a significant gap in the number of publications compared to other countries. The top three is rounded out by the UK and China. Over the past 10 years, the top 10 countries have at least doubled their scientific production. We also examined the corresponding author's country, finding that most analysed countries primarily have single-country publications. To better understand collaboration networks, we analysed these networks in detail for all the countries. In the case of Scopus, the leading country is Italy, followed closely by the USA, with China completing the top three. The patterns in scientific publications, corresponding authors, and collaboration networks are quite similar to those observed in the Web of Science data.

The fifth research question focuses on the sources of scientific publications. Using Bradford's law, we identified the core journals for both samples. We also analysed the top 10 journals by their scientific production. In both databases, the leading journal is the Journal of Intellectual Capital.

The sixth research question addresses identifying the most relevant authors, their scientific production, and their collaboration networks. To describe the frequency of authors' publications, we applied Lotka's law, which showed similar patterns for both samples. The top two authors in both databases are N. Bontis and J. Dumay. However, the frequency of their publications varies between Web of Science and Scopus, likely due to the differing criteria these databases use to list sources. Additionally, we mapped out the collaboration networks for both samples to provide a comprehensive view of author collaborations.

The final research question focuses on identifying the most relevant affiliations and their collaboration networks. It was observed that in the Web of Science database, the relevant affiliations tend to publish more scientific production compared to those in Scopus.

Our research also has several limitations that need to be acknowledged. Firstly, there is a data lag issue. We opted not to exclude the year 2024 to ensure we have the most current information available. However, it's important to note that while the basic information might not change significantly, the number of publications could still vary. Secondly, there is a coverage bias due to the databases not uniformly covering all languages. We focused primarily on English, the dominant scientific language. However, results for minor languages may not be as reliably represented in our analysis. These limitations underscore the need for cautious interpretation of our findings, particularly regarding the currency of data and the language bias inherent in our database selection.

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