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Mapping the Scientometric Landscape of Intangible Assets: Trends, Measurements, and Collaborative Dynamics*

Mapeando el Panorama Cienciométrico de los Activos Intangibles: Tendencias, Mediciones y Dinámicas Colaborativas

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Resumen

El propósito de este artículo fue mapear las tendencias y dinámicas en la producción científica en relación con los activos intangibles mediante un análisis cienciométrico y la implementación del algoritmo del Árbol de la Ciencia (Tree of Science). Los datos de Scopus y Web of Science se fusionaron utilizando los paquetes bibliometrix y tosr en R. Los hallazgos revelan un campo maduro y consolidado, evidente tanto en la producción científica como en las colaboraciones entre autores. Además, se identificaron tres tendencias principales: la exploración de la medición de la reputación corporativa y el valor de marca como activos intangibles, la dinámica del capital intelectual en medio de la innovación tecnológica y la regulación de la propiedad intelectual, y el estudio del capital intelectual en contextos latinoamericanos, enfocándose en la creación de valor, la medición y el impacto de los marcos regulatorios.

Palabras clave: Medición de Activos Intangibles, Análisis Cienciométrico, Capital Intelectual, Reputación Corporativa, Innovación Tecnológica en AI; Árbol de la Ciencia.

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*Artículo inédito: "Mapping the Scientometric Landscape of Intangible Assets: Trends, Measurements, and Collaborative Dynamics".

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Abstract

The aim of this article is to chart the trends and dynamics in scientific production regarding intangible assets through scientometric analysis and the implementation of the Tree of Science algorithm. Data from Scopus and Web of Science were merged using the bibliometrix and tosr packages in R. The findings reveal a mature and consolidated field, evident in both scientific output and author collaborations. Additionally, three main trends were identified: the exploration of corporate reputation and brand value measurement as intangible assets, the dynamics of intellectual capital amidst technological innovation and intellectual property regulation, and the study of intellectual capital in Latin American contexts, focusing on value creation, measurement, and the impact of regulatory frameworks.

Keywords: Intangible Assets Measurement, Scientometric Analysis, Intellectual Capital, Corporate Reputation, Technological Innovation in IA; Tree of Science.

1. Introduction

The study of Intangible Assets (IA) is pivotal for organizations as they are resources capable of generating value and enhancing performance [1]. For instance, an IA such as corporate reputation can add value to a firm, even if it is not directly reflected in the financial statements [2]. Moreover, IAs are linked with future returns when considered in the acquisition of new companies [3]. These are merely examples of IAs, which also include intellectual capital, human capital, corporate reputation, adaptability of firms in shifting environments, corporate culture, and networks of suppliers and customers. Hence, IAs represent opportunities for business development.

The academic literature on IAs has expanded in recent years, becoming a well-established field [4]. However, this body of research is dispersed, necessitating a comprehensive study to consolidate the key contributions on IAs. While some reviews on IAs have focused on specific themes, such as science-based innovation from universities [5] or areas like accounting [6], there is a dearth of quantitative research that encompasses IAs in a broad sense [7]. Therefore, the aim of this article is to map out the scientific production dynamics and the main sub-areas of IA with a focus on measurement.

This study conducts a scientometric analysis of the scientific output on IAs and their measurement through queries in Scopus and Web of Science (WoS). The methodology is divided into two parts: the first presents a scientometric study analyzing annual production, countries, journals, and scientific collaboration. The second part employs the Tree of Science (ToS) algorithm to identify the main trends regarding IAs and measurement.

It has been found that the study of intangible assets is a mature field, with a stable number of publications being produced. The most studied intangibles are intellectual capital and

brand reputation. Discovering that research has concentrated largely on just these two intangible assets reveals a gap in the literature, which this study addresses.

Given that the focus on the measurement of intangibles is primarily concentrated on intellectual capital and brand reputation, this invites researchers to explore the measurement of other intangible assets, such as the capacity for collaboration among workers, coordination, learning mechanisms, and relational resources, among others.

2. Methodology

This study features a scientometric review of IA utilizing the Scopus and WoS databases. Data were merged using bibliometric tools such as bibliometrix and the ToS [8]. Table I outlines the parameters employed in the search queries. The merging yielded 523 unique records across both databases, with 53 (9.56%) articles exclusive to WoS. This approach is consistent with current recommendations for scientometric research [9]–[12].

Table I. Search Parameters for Scientometric Analysis of Intangible Asset Measurement Literature

Parameters	**Web of Science**	**Scopus**
Range	2000 - 2022	
Date	November 27 del 2023	
Document types	Articles, books, chapters, and conferences	
Words	Title-abs-key: (“intangible asset”) AND Tile-abs-key: (measurement)	
Results	189	473
Total (Wos+Scopus)	523	

Sources: Author.

Figure 1 depicts the flowchart from the data search to the analysis phase. In the preprocessing step, text mining extracted key details like authors, titles, publication years, and journals from Scopus entries. Web scraping supplemented this with information from WoS entries via DOIs. This generated an Excel file with 22 sheets, organizing the data for subsequent analysis. The analysis is bifurcated into two segments: the first entails a scientometric analysis that incorporates state-of-the-art techniques for assessing scientific collaboration among authors [13], shedding light on the network-building strategies for forming research teams [14].

In the second part, the ToS algorithm is applied to identify the most significant contributions, organized into roots, trunk, and branches [15], [16]. This algorithm has been extensively applied in fields such as marketing [17], entrepreneurship [18], management [19], [20], finance [21], engineering [22], and environment [23]. A detailed explanation of its dissemination process can be found in the work of Eggers et al. [24].

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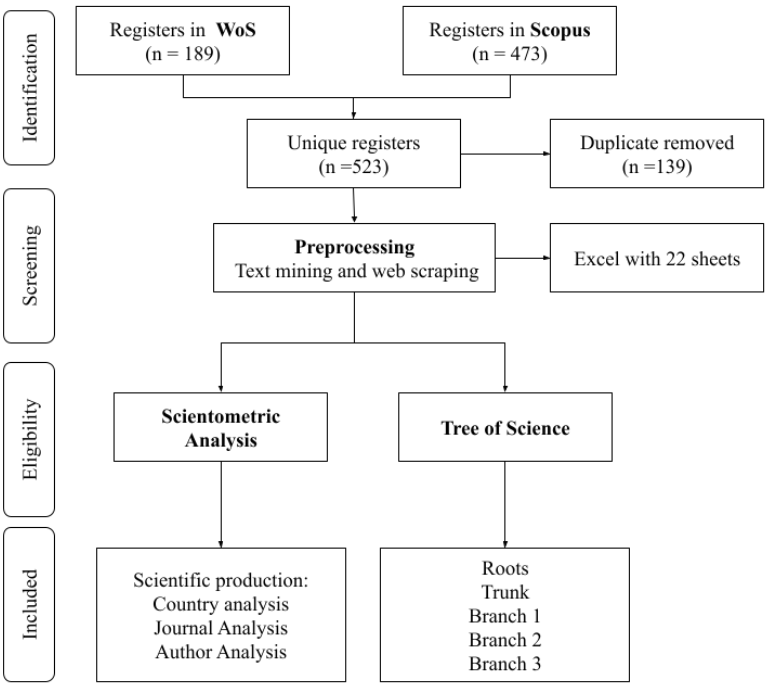

Figure 1. Flowchart of Methodology for Scientometric Review of Intangible Asset Measurement Research
Sources: Author.

3. Results

Scientometric Analysis

Scientific production: the production of articles and citations over time remains stable, as shown in Figure 2, without significant periods of expansion. However, the figure indicates that from 2008 to 2022, the total number of publications consistently exceeds 20 per year. This level of productivity was not observed in the years before 2008, where the output was substantially lower, with the exception of 2004, which also saw 20 publications.

The growth in article production for the second period, 2011-2022, compared to the first period, 2000-2010, is 62.42%. This suggests that the academic community has shown increased interest in the second decade in the field of IA measurement research.

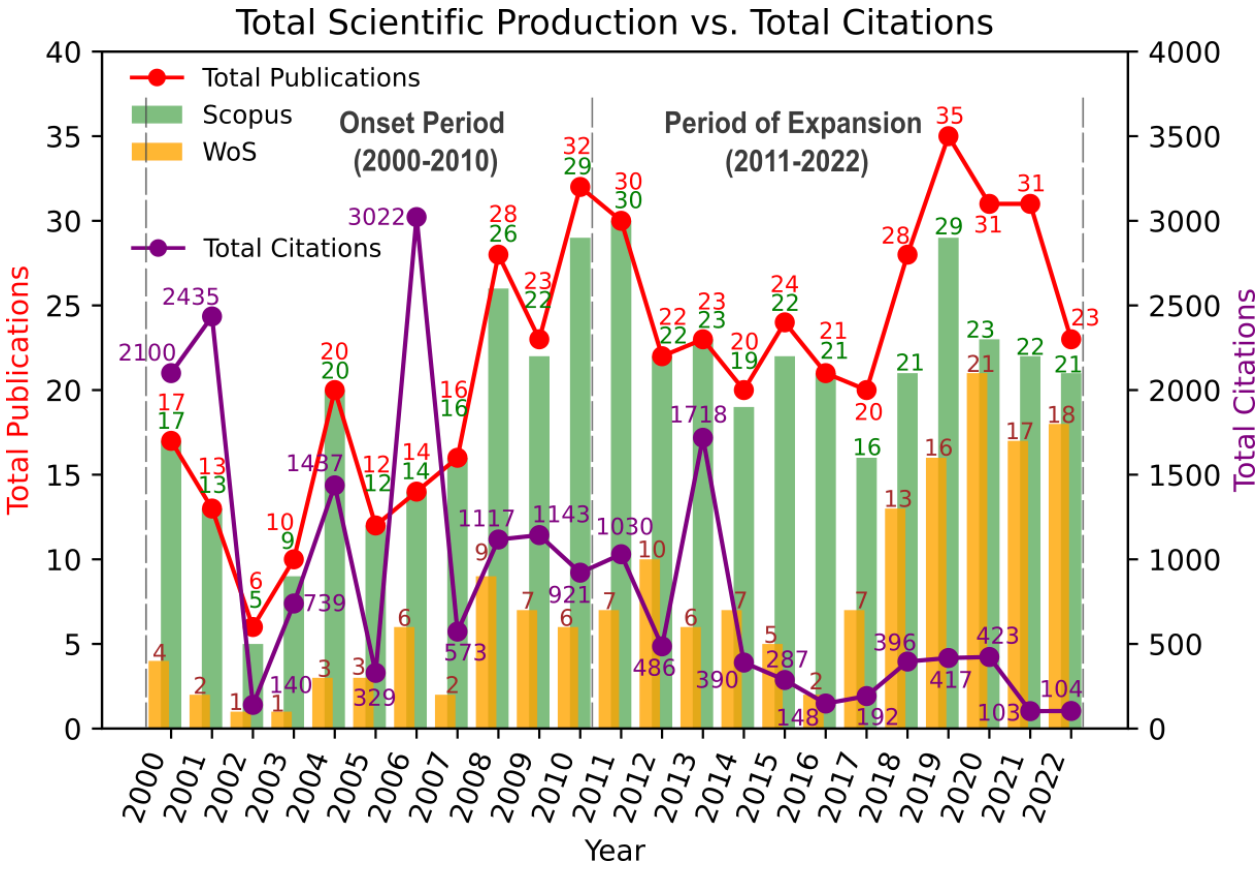

Figure 2. Comparative Trends in Scientific Output and Citation Counts for Intangible Assets Research from 2000 to 2022

Onset Period (2000 - 2010)

During this decade, the average scientific article production was 15.7%. There were two notable peaks in citations, one in 2001 and another in 2006. In 2001, the most cited article

was Bontis [25] literature review on the evaluation of knowledge assets. This article discusses models addressing the measurement of Intellectual Capital (IC) and concludes with directions for future research. In 2006, the paper by Keller and Lehmann [26] propelled citation numbers in the field by examining influential works in brand studies, highlighting key topics such as brand positioning, brand valuation, and brand management.

Maturation Period (2011 - 2022)

The average production of scientific articles in this decade was 26.08%, which represents a 62.42% increase in publications compared to the previous period. A citation peak occurred in 2013, driven by the article from Hernández-Morcillo et al. [27]. This paper sought to determine the benefits provided by recreation, spiritual enrichment, and ecosystems, which the authors term cultural ecosystem services. It concludes that indicators for cultural ecosystem services are still nascent in scientific research.

Country Analysis

Table II displays the leading countries in IA research. The United States tops the list with a total of 74 publications, accounting for 23.9% of the impact. The United Kingdom ranks second with 38 publications and a 10.1% impact. Notably, Australia stands as the sixth in publication volume yet the second in impact, with 12.42%.

Table II. Global Distribution of Scientific Production and Citations in Intangible Assets Research by Country and Quartile Ranking.

Country	Production		Citation		Q1	Q2	Q3	Q4
USA	74	14.71%	3532	23.9%	27	11	5	2
United Kingdom	38	7.55%	1493	10.1%	14	8	4	2
Italy	37	7.36%	947	6.41%	14	4	3	2
Spain	36	7.16%	826	5.59%	9	7	4	2
China	27	5.37%	326	2.21%	4	5	2	2
Australia	22	4.37%	1835	12.42%	9	6	3	0
Portugal	16	3.18%	110	0.74%	3	2	1	0
Brazil	15	2.98%	165	1.12%	4	1	2	2
Germany	12	2.39%	852	5.76%	7	1	0	1
Romania	12	2.39%	83	0.56%	1	1	2	0

Sources: Author.

Collaborative networks between countries highlight the collective efforts to address scientific inquiries through research. Figure 3 depicts the most prominent groups in scientific collaboration. The United States leads the first group, followed by Australia and then Sweden. The United States and the United Kingdom have collaborated on a study proposing accounting strategies for measuring IA [28].

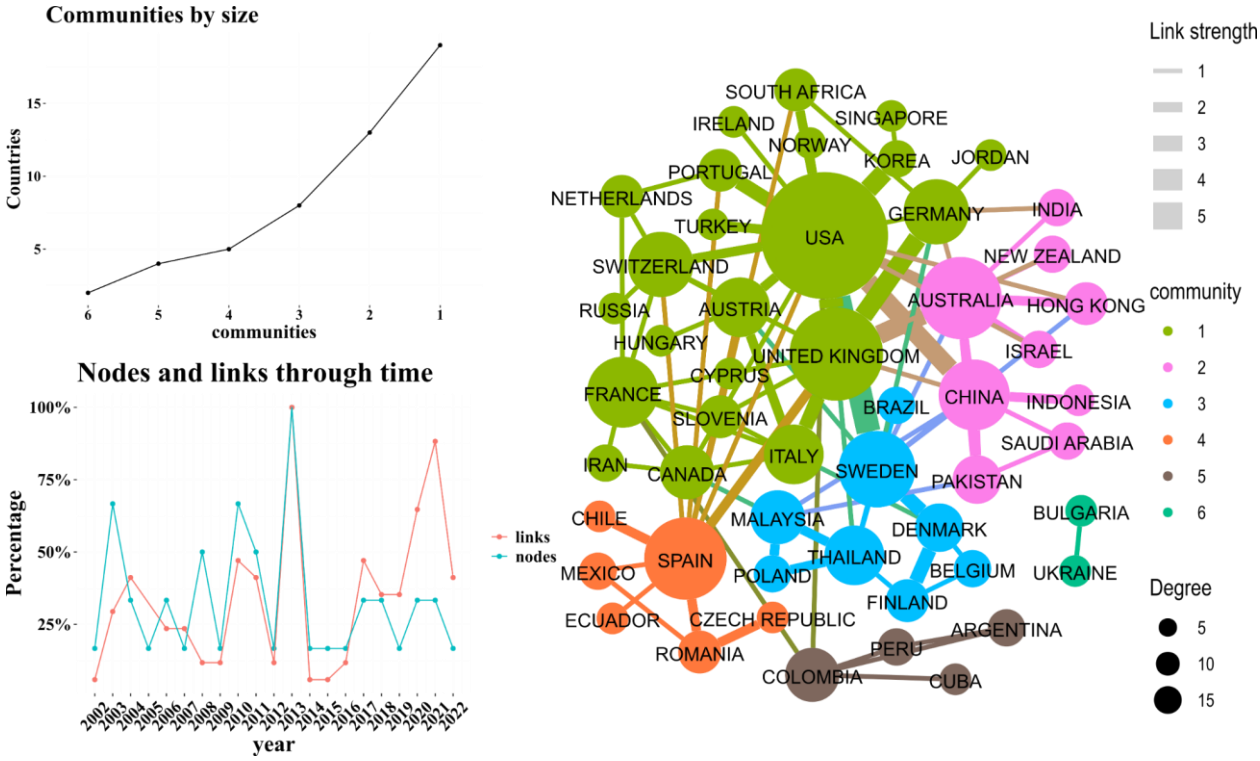

Figure 3. International Collaboration Network in Intangible Assets Research

Journal Analysis

According to the data presented in Table III, the journal with the highest number of publications is the Journal of Intellectual Capital, featuring 11 articles in WoS and 53 in Scopus. Three of the journals with the most substantial output in IA research are ranked in the highest quartiles (Q1), with the journal Sustainability boasting the highest h-index. Most journals are indexed in Scopus but not in WoS.

Tabla III. Comparative Analysis of Journal Impact in Intangible Assets Research

Journal	WOS	Scopus	Impact Factor	H Index	Quantile
Journal Of Intellectual Capital	11	53	1.58	105	Q1
Proceedings Of The European Conference On Knowledge Management, Eckm	0	17	0	12	-
Sustainability	0	7	0.66	136	Q1
Measuring Business Excellence	0	6	0.56	49	Q2
Review Of Accounting Studies	6	5	4.21	88	Q1
International Journal Of Learning And Intellectual Capital	0	5	0.31	24	Q3
Journal Of Information And Knowledge Management	0	5	0.23	25	Q3
Acm International Conference Proceeding Series	0	4	0.21	137	-
Australian Accounting Review	1	4	0.76	43	Q2
International Journal Of Business Performance Management	0	4	0.18	23	Q4

Sources: Author.

Figure IV, illustrates the citation network of the journals, highlighting three significant thematic clusters. The first cluster (green) is led by the journal ABACUS, with its most recent publication being a commentary on whether internally generated IAs should be recognized [29]. The second cluster is spearheaded by the Journal of Intellectual Capital, with its latest article examining the impact of green Intellectual Capital on employee behavior [30].

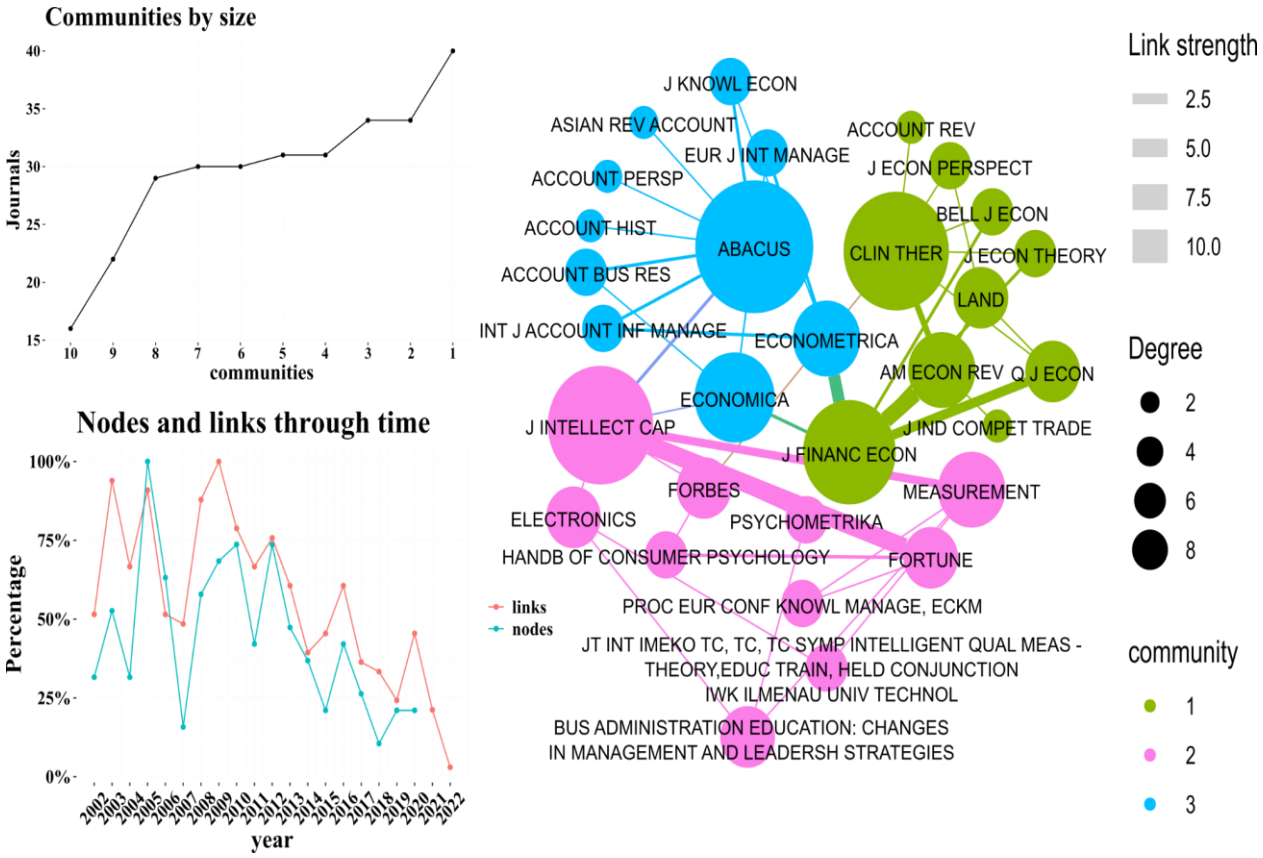

Figure IV. Temporal and Network Analysis of Citation Patterns in Intangible Assets Journals

Author Collaboration Network

Table IV lists the ten most prolific authors in the field of IA. Leading the chart is Professor Bernard Marr with seven publications and an h-index of 22. His key publication presents a framework for measuring a company's IC [31]. The author with the highest h-index is Dr. James Guthrie, whose seminal work includes a review of existing measures for IC [32]. The h-index scores of these researchers indicate that IA is a mature and established area within the academic community.

Table IV. Scholarly Contributions in Intangible Asset Research: Authorship and Institutional Affiliations

No	Researcher	Total Articles	Scopus h-Index	Affiliation
1	Marr B	7	22	Universidad De Cambridge., Cambridge, Reino Unido
2	Edvinsson L	4	17	Compañía De Seguros Sueca Skandia , Suecia
3	Guthrie J	4	49	Universidad Macquarie., Sydney, Australia
4	Pike S	4	13	Intellectual Capital Services Ltd , Londres, Reino Unido
5	Popescu C	4	11	Universidad De Estudios Económicos De Bucarest., Bucarest, Rou
6	Wyatt A	4	13	La Universidad De Queensland., Brisbane, Australia
7	Chatzkel J	3	9	Práctica Progresiva , Estados Unidos
8	Costa R	3	21	Universidad Degli Studi Di Roma "Tor Vergata"., Roma, Italia
9	Demartini P	3	11	Università Degli Studi Roma Tre., Roma, Italia
10	Gomes J	3	17	Universidad De Lisboa., Lisboa, Portugal

Sources: Author.

Figure V depicts the scientific collaboration network among the most productive researchers in IA. The network is divided into three components, with the first being the most significant. The primary component (green) indicates a highly cohesive network due to the connections among common acquaintances. Notably, the sole collaborative work among these authors involves Professor Bernard Marr and Professor Jay Chatzkel, proposing measures for IC [33].

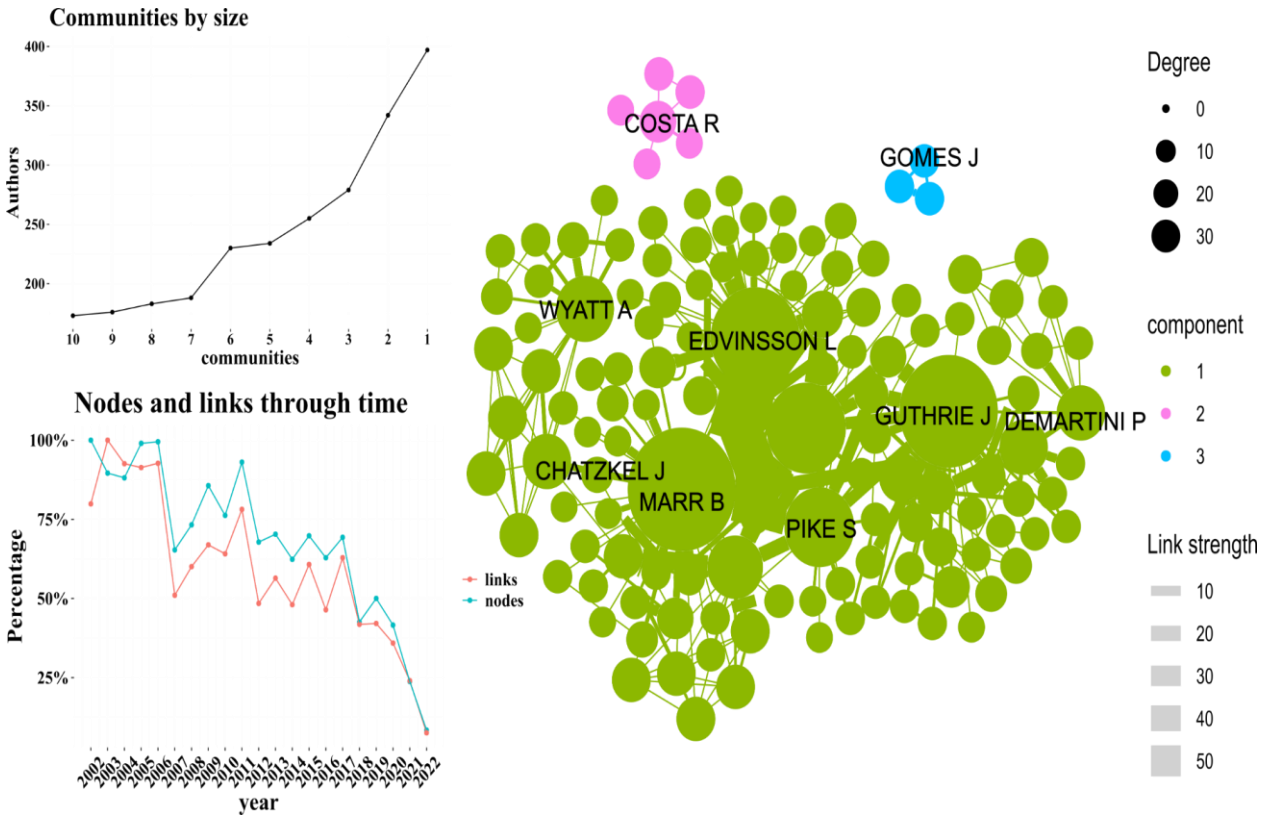

Figure V. Analyzing the Dynamics of Collaborative Networks in Intangible Asset Research: A Node and Link Composition Study

Tree of Science

Root

The genesis of IA study emerged from the problem that financial indicators could not measure the value of these assets, yet they are crucial for corporate success. This challenge led to the development of the Balanced Scorecard (BSC) as a tool that communicates a company's strategy, encompassing both tangible assets and IAs. The BSC is instrumental as it reflects the value of IAs and the factors key to long-term success. According to Kaplan [34], over 75% of the value-adding assets in organizations are IAs. The significance of IAs is such that a robust strategy must establish the direction and alignment of IAs beforehand. The BSC is structured around four perspectives: customer, financial, internal processes, learning and growth, which leads to the coherent setting of strategic objectives.

In line with IAs, Archer et al. [35] presents an approach to measure and manage IC. IC comprises various intangible assets such as intellectual property, human-centered intangible

assets, and market-driven IC potential. This measurement method aids organizations in making more informed corporate decisions. Furthering the measurement methods for IAs, Karl [36] introduces a non-financial measurement approach. The article suggests a monitoring matrix to track the growth and stability of IAs and classifies them into three categories: employee competence, internal structure like a company's internal cultural systems, and external structure including suppliers and customers. In another approach to measuring IC, Bontis [37] initially defines IC as intellectual material that can be used to create wealth, categorizing it into three components: human capital, structural capital, and customer capital. A pilot study is proposed to ascertain the impact of capital on business performance.

It is important to conclude that at the inception of the IA measurement field, the primary focus of the seminal articles was related to IC.

Trunk

According to Mayo [38], IC represents the sum of a company's intangible assets, which, collectively, could surpass the value of its tangible assets. His article delves into an analysis of IC, with a particular focus on human capital. Central to human capital is knowledge. Bontis [25] conducts a literature review on the evaluation of knowledge assets, defining IC as the entirety of knowledge, information, intellectual property, and experience that can be leveraged to generate profits. However, his study underscores the challenges of measuring IC, a difficulty confirmed by Kannan & Aulbur [39]. Among the proposed methodologies for these measurements is Leitner & Warden [40] study, which presents an IC model distinguishing between goals, processes, and outcomes for organizations engaged in research and development activities. Additionally, Andriessen [41] suggests ten methods for measuring IC using a matrix of strengths and weaknesses. Therefore, one of the elements beginning to solidify within the trunk of IA is IC, demonstrating a maturation in measurement strategies.

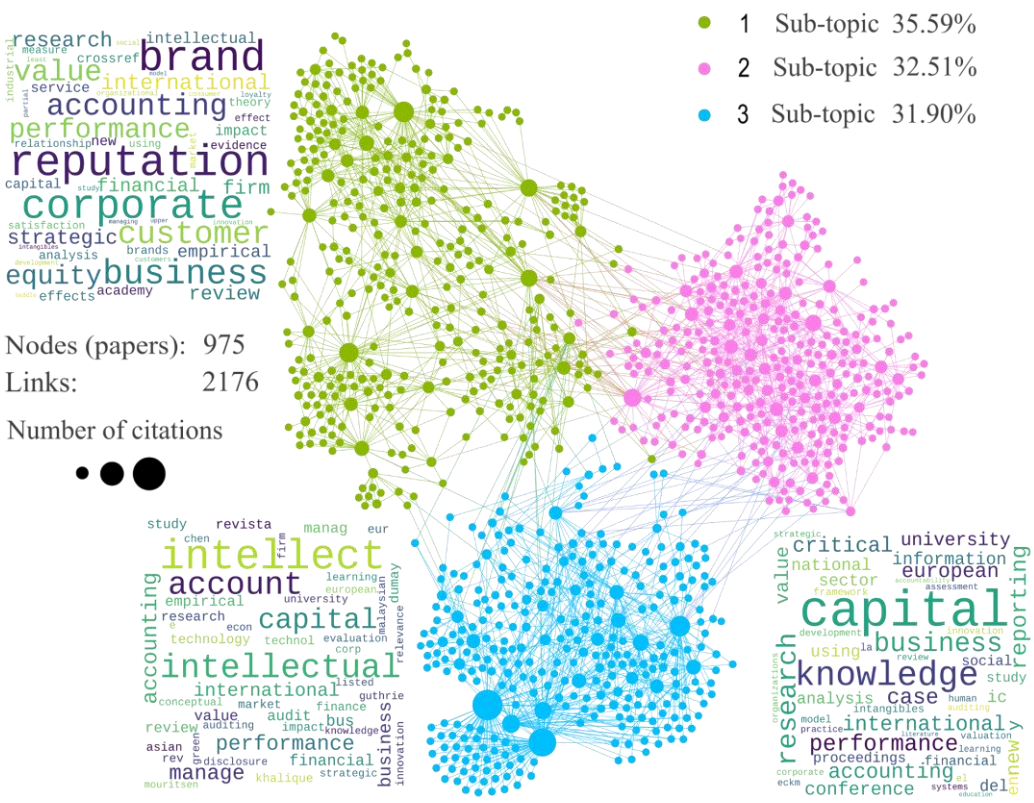

Figure 6. Citation Network Distribution across Three Key Sub-topics of Intangible Assets

Branch 1 - Exploring the Measurement of Corporate Reputation and Brand Value as Intangible Assets

This branch focuses on research pertaining to the measurement of corporate reputation or branding as an intangible asset. For instance, Ghosh & Haque [30] explored the link between green Intellectual Capital and employees' green behavior. Their findings suggest that investment in green Intellectual Capital positively affects employees' green behavior. Xiao et al. [42] examined how servitization influences customer satisfaction. Servitization refers to the enhancement of service offerings surrounding traditional products. The results indicated that innovation has a favorable impact on customers by enhancing the perceived value of the brand. Kim et al. [43] offer another perspective by applying blockchain technology to various issues in digital advertising. The authors demonstrate that this enhances transparency and trust between businesses and customers. In summary, this branch underscores the significance of brand value and the customers' perception of the company as an intangible asset.

Branch 2 - Intellectual Capital Dynamics in the Context of Technological Innovation and Intellectual Property Regulation

Branch 2 encompasses studies related to IC. Vega Falcón et al. [44] define IC as the intangible value of assets that drive innovation and corporate responsibility, focusing on firms reliant on intellectual property rights. They examine the impact of technological innovations and intellectual property regulations on companies that are dependent on intellectual property rights. Similarly, Trequattrini et al. [45] discuss the influence of digital technologies on the management of intangible assets. They analyze how intellectual property regulation and technological innovations affect organizations that are heavily invested in intellectual capital rights.

Branch 3 - Branch 3: Intellectual Capital in Latin American Contexts: Value Creation, Measurement, and Regulatory Perspectives

Branch 3 presents research on IC in Latin American countries. Marsal [46] explored Cuban theoretical models of intangible assets for value generation in organizations, demonstrating increased efficiency in a Cuban bank. Peñaloza López et al.[47] examined the contribution of private universities to the identification and measurement of intellectual capital in agricultural food companies. Their study indicated that IC accounts for an increase in company value ranging from 1.65% to 12.75%, with the companies based in Ecuador and using the Skandia model. Additionally, Vega Falcón et al. [44] conducted a case study that measures the IC of a hotel in Cuba using the Vega-Rivero model, finding that the measurement of IC resulted in an increase of 299.8 USD for the hotel. There is a legal and regulatory aspect in Cuba for measuring IC. These studies highlight the renewed interest in IC across Latin America.

Conclusions

The aim of this article was to conduct a scientometric study on IAs and their measurement. To achieve this, scientometric techniques and the ToS algorithm were applied. The findings confirm that IA is a mature and established topic within the academic community. For instance, the total articles produced between 2000 and 2011 accounted for 62.42% of all articles up to 2022. The Journal of Intellectual Capital, rated as high quality (Q1), had the most significant output, indicating a trend in IA research towards Intellectual Capital, as identified in subsequent analyses.

It is concluded that the field of IA measurement is mature and primarily centralized in two areas: corporate reputation and intellectual capital.

It is emphasized that these two intangible assets positively impact corporate performance and innovation. The field of IA has the potential to broaden its scope to more such assets, where the challenge of how to measure these intangibles has been a consistent theme throughout research endeavors.

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