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Dynamics of Vertical Integration for Technological Innovation in Business

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ABSTRACT

Enterprises aim to gain optimal benefits and methodologies in a cutting-edge and all-encompassing market to establish a more robust presence. Despite research suggesting a decrease in vertical integration due to information technology (IT), businesses are increasingly adopting this corporate approach. This study aims to illustrate how the scientific literature has evolved over the last 22 years concerning the impact of IT on vertical integration, a key facet of corporate strategies. The results reveal a balanced evolution of vertical integration within a technological landscape. Through cluster analysis, three categories—digital technology, inventive processes, and operational methods—emerged to elucidate this correlation. When making integration decisions, factors such as the direction of operational integration, industry concentration levels, demand variability, and the scope of innovation must all be taken into account.

Keywords: *integration dynamics; digital technology; technological advancement; corporate innovation*

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Dinámica de la Integración Vertical para la Innovación Tecnológica en los Negocios

RESUMEN

Las empresas buscan obtener beneficios óptimos y metodologías en un mercado vanguardista y abarcador para establecer una presencia más sólida. A pesar de que la investigación sugiere una disminución en la integración vertical debido a la tecnología de la información (TI), las empresas adoptan cada vez más este enfoque corporativo. Este estudio tiene como objetivo ilustrar cómo ha evolucionado la literatura científica en los últimos 22 años con respecto al impacto de la TI en la integración vertical, un aspecto clave de las estrategias corporativas. Los resultados revelan una evolución equilibrada de la integración vertical dentro de un panorama tecnológico. A través del análisis de clúster, surgieron tres categorías: tecnología digital, procesos inventivos y métodos operativos, para elucidar esta correlación. Al tomar decisiones de integración, se deben tener en cuenta factores como la dirección de la integración operativa, los niveles de concentración de la industria, la variabilidad de la demanda y el alcance de la innovación.

Palabras clave: *dinámica de integración; tecnología digital; avance tecnológico; innovación corporativa*

INTRODUCTION

The examination of vertical integration has been ongoing since its inception. According to Porter [1], there exist two primary strategic approaches: corporate and competitive. This paper specifically delves into the corporate strategy of vertical integration and its response to technological influences.

Vertical integration is typically executed for financial reasons and involves acquiring one or more components within the value chain, thereby enhancing the company's capabilities both structurally and autonomously. By diversifying, the company expands its capacities and resources, reducing reliance on external entities. The strategy of vertical integration can be comprehensive, covering the entire chain, or partial, focusing on suppliers or retailers.

Comprehensive integration occurs when a company gains control over the entire value chain, from production and transformation to distribution and eventual sale to the consumer. Conversely, vertical integration may concentrate on acquiring only a specific segment of the value chain, termed partial vertical integration. This can manifest upstream when the company absorbs a supplier to secure necessary raw materials, enhancing autonomy and cost control. Consequently, a market supplier is eliminated, solidifying the company's position in its operating sector. The downstream vertical integration strategy, on the other hand, aims to oversee the distribution of its products by assuming the role of distribution companies. This approach allows the company to eliminate expenses associated with outsourcing this function, increasing control and oversight during the distribution phase, sales, and their fluctuations.

Hence, these strategies of vertical integration, whether partial or complete, compel companies to grapple with the decision of "producing their products internally or outsourcing externally" and/or "ensuring the distribution of their products or relying on an external distributor or seller," scrutinizing the necessity or added value of adopting vertical integration strategies [2].

The ongoing evolution of markets has intensified this discourse, particularly with the emergence of technological tools aligned with business strategies. Specifically, the utilization of information technology (IT) can, on one hand, facilitate companies in sharing information swiftly and efficiently,

and on the other hand, decrease coordination costs, either with external suppliers (when utilizing markets) or within the company (in integrated companies) [3], making it an enticing tool for businesses. While the vertical integration strategy has long been a focus in literature, the integration of IT in companies has heightened research in this area. The scientific community endeavors to gather the most robust evidence [4]. To achieve this objective, the application of a methodology is imperative for advancing knowledge, whether through identifying errors, fostering new solutions, or replicating results [5].

Consequently, this article seeks to synthesize the literature research on the subject, examining the evolution of vertical integration over time, considering the impact of IT integration in companies. For this purpose, Section 1 provides contextualization on the addressed theme through the presentation of select studies. Section 2 delineates the research methodology aligned with Cooper's taxonomy of literature reviews [6] and its five research phases for executing a literature review [7]. Utilizing this methodology, Section 3 delves into and analyzes information across five key dimensions deemed relevant for obtaining a comprehensive and contemporary literature review (dispersion of documents per year, most cited authors and prolific publishers, document types, article evaluations, and searches for the terms "vertical integration" and "IT"). The resulting article sample undergoes a concept co-occurrence mapping process, enabling the correlation of vertical integration with other concepts employed in research over the past 22 years. This procedure facilitates an analysis of the evolution of vertical integration research, offering insights into key findings. Finally, Section 4 presents the primary conclusions and acknowledges some limitations of this research.

The research on vertical integration (VI) posits that firms have two contrasting methods of organizing their transactions: through a hierarchy or the market. However, distinct governance structures are employed for each of these methods [8]. The choice of governance structure hinges on aligning the firm's characteristics and environment with the most suitable strategy. According to Dyer and Singh, establishing and sustaining relationships between firms necessitate a governance framework capable of exchanging characteristics [9].

Previous research indicates that emerging industries typically witness a prevalence of vertically integrated firms [10,11]. However, over time, industries tend to undergo disintegration as integrated firms fragment into specialized entities, with new specialized firms entering the scene [12,13]. Many industries have their origins in technological innovations [10]. When such innovations are systematic, as suggested by Teece, they demand the adjustment and alignment of activities and investments at various stages of the vertical chain [14]. Consequently, it can become challenging for buyers and suppliers to rely on market transactions, including contracts, as highlighted by Williamson in 1985 [15].

RESEARCH METHODOLOGY

Given the expanding empirical base, the task of the reviewer has grown more intricate. In the contemporary era, it is increasingly challenging for researchers to stay abreast of developments through primary data alone. Consequently, researchers heavily depend on integrative research reviews to assess the current state of knowledge [7].

Applying Cooper's taxonomy of literature reviews [6] to structure and categorize the study at hand, researchers characterize this integrative review as primarily focusing on accounting for publications and trend analysis. Simultaneously, they conduct a review of the topic's findings with the aim of summarizing the cumulative knowledge regarding essential issues and relationships in the studied domain (vertical integration in a technological context). They use a representative sample and primarily target conferences and scientific articles. Table 1 outlines Cooper's five stages of investigation for conducting a literature review, each of which is elucidated in detail in the subsequent chapter, providing insight into the authors' approach.

Table 1. Cooper's Five Phases of Research Methodology

Problem Formulation	Definition of the study and literature review question
Data Collection	Definition of the criteria that will be the reference for the investigation and data extraction
Data Evaluation	Weighing on the Quality of the data, resulting in the final set of article
Analyzis and Interpretation	The data is synthesized into statements that inform the research problem
Public Presentation	Translation of the authors notes, impressions, and thoughts in public documentation

The review employs bibliometric analysis, a quantitative method for assessing published scientific literature. This approach involves utilizing quantitative metrics such as citation counts and author impact factors to gauge the productivity, visibility, and impact of an article, author, or research field. Bibliometric analysis aids in identifying trends and patterns in scientific literature and is commonly utilized in library and information science, as well as in the evaluation of scientific research and funding decisions [16].

Problem Formulation

Aligned with Cooper's taxonomy, which enhances the quality of reviews [6], the initial stage of the research methodology involves problem formulation. This phase includes formulating questions for the literature review or empirical research. It's crucial, as per Cooper's distinction, to differentiate between questions for literature review, answerable through secondary research reviews, and questions for empirical research, answerable through primary research [17].

For this paper, the literature review question is stated as follows: What is the current state of the scientific literature on the topic of vertical integration in a technological world, and how has it evolved over the last 22 years?

Data Collection

To obtain a representative sample for this literature review, the reviewer is advised to detail the data collection procedure to ensure that other reviewers following the same steps would yield identical results [17]. Consequently, the remaining steps leading to the final set of results are presented.

Initially, on July 12, 2022, searches were conducted in the Scopus database (designed for author and subject searches) to discover the initial set of results aligning with the theme. Keywords "information technology" (IT) and "vertical integration" were searched in the abstract, title, and keywords fields of articles (F1). The search identified 905 documents, and a second filter (F2) was applied, excluding documents published before the year 2000. The database presented 776 results in line with the search. The third filter (F3) narrowed the results to 759 documents, including only those written in English. Two additional document absorption systems were also performed on this database, labeled as F4 and F5.

The subsequent filtration, labeled as F4, focused on refining articles within the domains of computer science, business, or economics, resulting in 361 outcomes. F5 further narrowed down the sample by restricting it to documents classified as scientific articles or conference papers, yielding 322 results. Additionally, a manual filter (F6) was applied to the documents from F5, involving the classification of articles and conferences with the assistance of the Scimago Journal & Country Rank and Conference Ranks tools, respectively. Documents not found in these tools were excluded from the final selection, except for those recently written in 2022, for which the classification from the preceding year was assumed, resulting in 240 articles included in our ultimate sample.

Table 2. Overview of the Filtering Process in this Study

Filters	Description	Inserted Querry	Number of Articles
F1	Keywords in the title, the abstract, and keywords in the document	(TITLE-ABS-KEY ({vertical integration}) AND TITLE-ABS-KEY ({technology})	905
F2	Articles from 2000 to the current date	(TITLE-ABS-KEY ({vertical integration}) ANDTITLE-ABS-KEY ({technology}) AND PUBYEAR > 1999	776
F3	Only articles written in English	(TITLE-ABS-KEY ({vertical integration}) ANDTITLE-ABS-KEY ({technology})) AND PUBYEAR > 1999 AND (LIMIT-TO (LANGUAGE, "English"))	759
F4	Articles with the themes of business or economics or computer science	(TITLE-ABS-KEY ({vertical integration}) AND TITLE-ABS-KEY ({technology})) ANDPUBYEAR > 1999 AND (LIMIT-TO (LANGUAGE, "English")) AND(LIMIT-TO (SUBJAREA, "COMP") OR LIMIT-TO (SUBJAREA, "BUSI") OR LIMIT-TO (SUBJAREA, "ECON"))	361
F5	Conferences and articles only	(TITLE-ABS-KEY ({vertical integration}) ANDTITLE-ABS-KEY ({technology}) ANDPUBYEAR > 1999 AND (LIMIT-TO (SUBJAREA, "COMP") OR LIMIT-TO (SUBJAREA, "BUSI") OR LIMIT-TO (SUBJAREA, "ECON")) AND (LIMIT-TO (LANGUAGE, "English")) AND (LIMIT-TO (DOCTYPE, "ar") OR LIMIT-TO (DOCTYPE, "cp"))	322
F6	Conferences [A1, B4] and articles [Q1, Q4].		240

Data Analysis

Following Cooper's recommendation, at this point, the reviewer systematically assesses the extracted data to verify whether they align with the inclusion and exclusion criteria established in the preceding stage [17].

In this investigation, the documents underwent a thorough review, revealing that among the anticipated outcomes, two documents (Workshops) did not adhere to the defined parameters of "type of document" (F5). Consequently, both were excluded from the final sample due to their document type falling outside the established limits, resulting in a total of 238 documents. A summary of this process is presented in Table 3.

Table 3. Recent Filtering Actions

F6	Manual Filtration	Final Sample
240	238	238

Additionally, in this phase, to enhance the data's validity, an external researcher, unrelated to the current research, was enlisted to thoroughly examine the methodology and validate the established criteria [17]. By validating the process, the external researcher affirmed the reliability of the results obtained in this study.

Data Interpretation

Similarly, to Cooper's emphasis on detailed steps in the data collection stage to safeguard validity, the suggestion persists in this stage, despite this type of study being less prone to validity threats [17].

With that in mind, a detailed presentation of the analyses conducted on the set of 238 documents was provided. These documents underwent statistical analysis and synthesis into graphics, illustrating six dimensions (dispersion of documents per year, authors, sources, types of documents, article evaluations, and trends in keywords).

Subsequently, using the final sample, key concepts of the theme under study were identified, and a mapping of these concepts across the entire sample (238 articles) was executed. An analysis was conducted using the VosViewer tool to summarize the insights drawn from each data grouping and present the most relevant articles, along with pertinent information on these documents. The VosViewer tool is software that constructs and displays bibliometric networks, depicting the network of key terms, clustering them, and highlighting relationships between concepts. The outcome of this concept occurrence mapping reveals the terms most interconnected with vertical integration in the literature over the last 22 years.

Finally, a concept map was generated to showcase the research trends of key concepts, again utilizing the VosViewer tool.

Public Presentation

This research aims to present a document on the evolution of vertical integration over the past 22 years, accessible to jurors and anyone seeking additional information about the observations and analysis on

the investigated subject of vertical integration. The authors are available to address requests for the content of the research conducted.

DATA ANALYSIS AND DISCUSSION

This section of the research fulfills the objective mentioned at the end of Section 2 by summarizing and evaluating the obtained data. This phase is divided into the analysis and exploration of three major subpoints: the first encompasses data collected through the listed dimensions; the second includes key concepts and the detailed structure of each cluster, revealing the most relevant articles and authors in each; and finally, mapping the trends of the key concepts collected in the sample.

Data Analysis and Exploration

Dispersion of Documents per Year

Figure 1 illustrates the dispersion of documents present in the scientific literature, extracted from the Scopus database and meeting the inclusion criteria we defined.

Upon brief analysis, it is evident that the theme remains current, and although it is not at its investigative peak, the number of works developed in the last three years surpasses the average of the last 22 years. Another potential hypothesis from the analysis of data from Figures 1 and 2 (from page 10) is that a sharp rise is observed in both figures from 2008 to 2009, indicating a connection between the publication of works by authors and the increased interest in the term IT.

Authors

In this subpoint, the top 10 authors publishing the most on the subject are presented (Figure 3), along with the top 10 authors obtaining the most citations (Figure 4). Figure 3 reveals that the researcher with the most extensive body of work on the subject is Gautam Ray, contributing a total of four articles. Ray boasts a highly relevant and impactful career in the field, earning prestige for his research contributions.

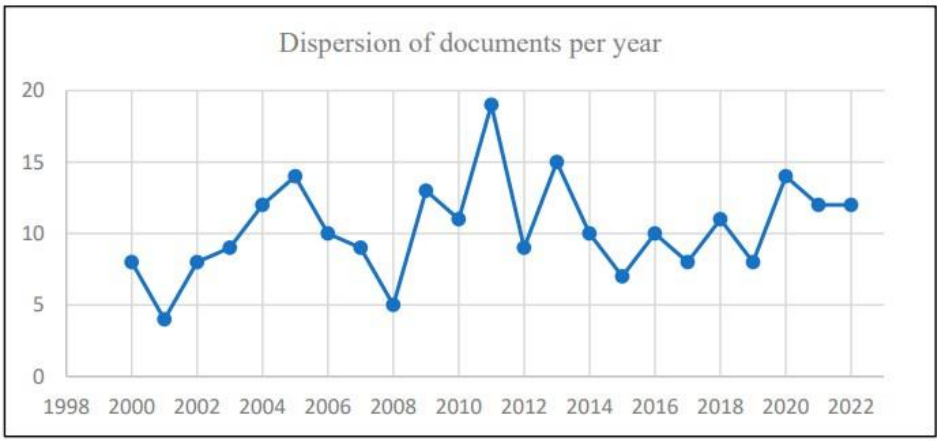

Figure 1. Document Count Over the Years

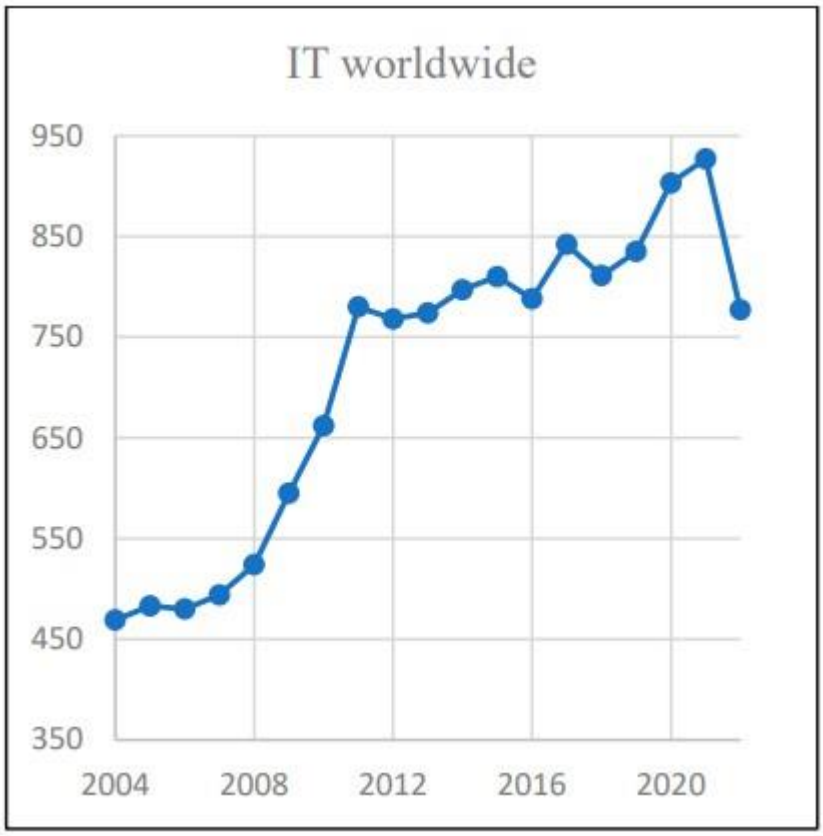

Figure 2. Global Searches for the IT Keyword

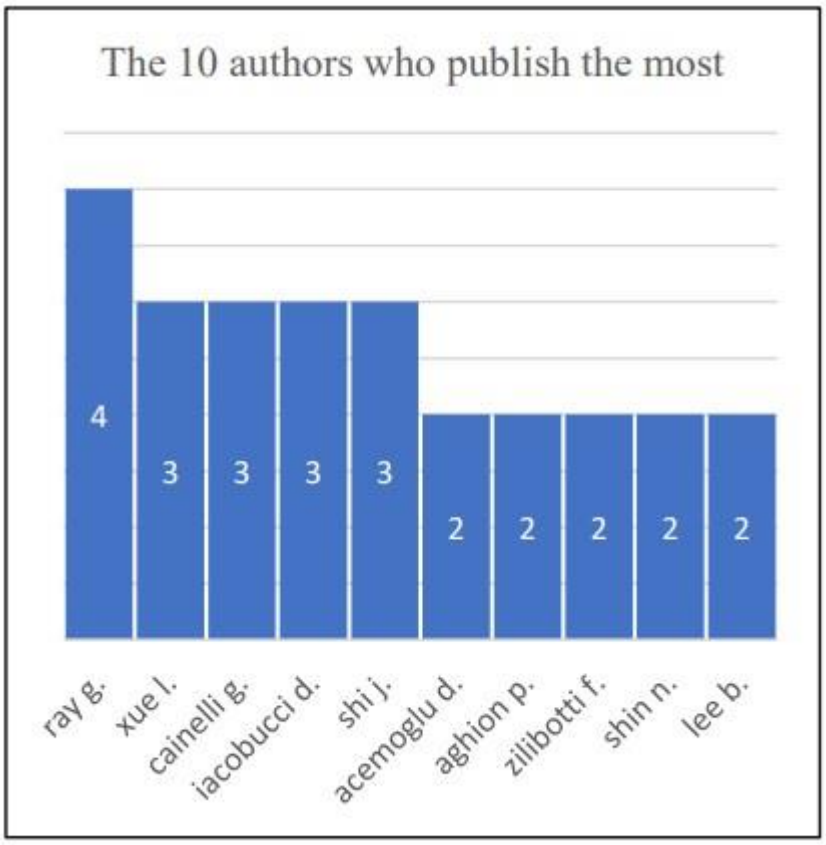

Figure 3. Article Count by Highly Cited Authors

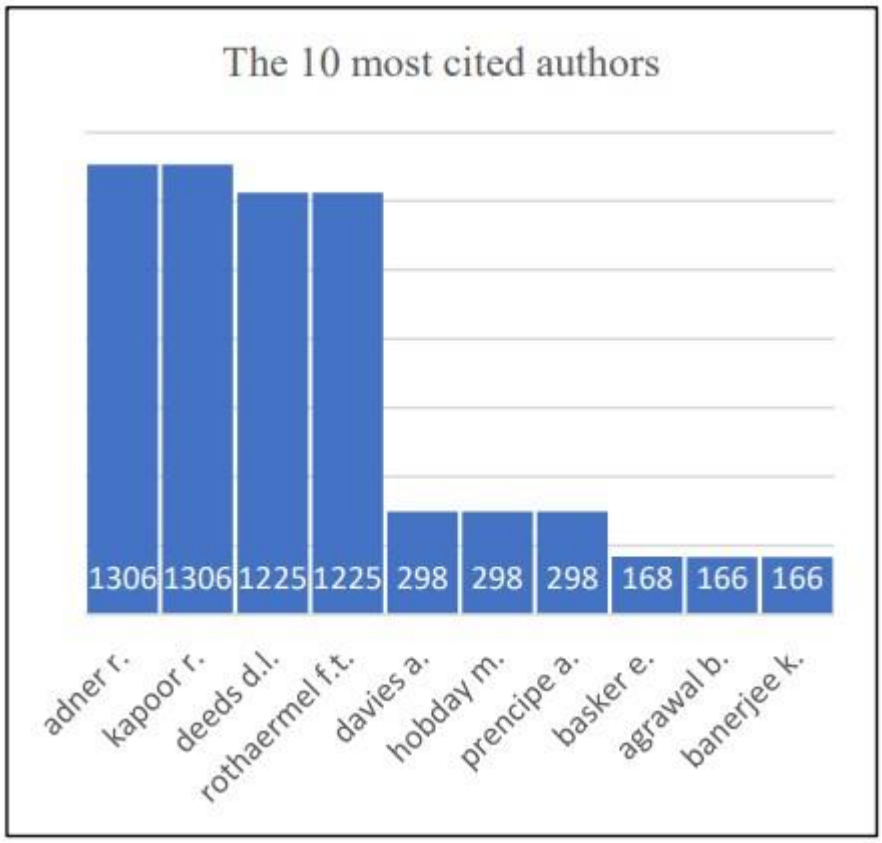

Figure 4. Citations Count by Highly Cited Authors.

Similarly, in Figure 4, the presence of pairs of names with an identical number of citations is evident. This occurrence arises because the authors of the articles are the same. Notably, Adner and Kapoor stand out in this regard, jointly authoring the scientific article titled "Value creation in innovation ecosystems: How the structure of technological interdependence affects firm performance in new technology generations," which has garnered 1306 citations.

Sources

The following two figures illustrate the top 10 sources that publish the most papers (Figure 5) and those that receive the most citations from other authors (Figure 6).

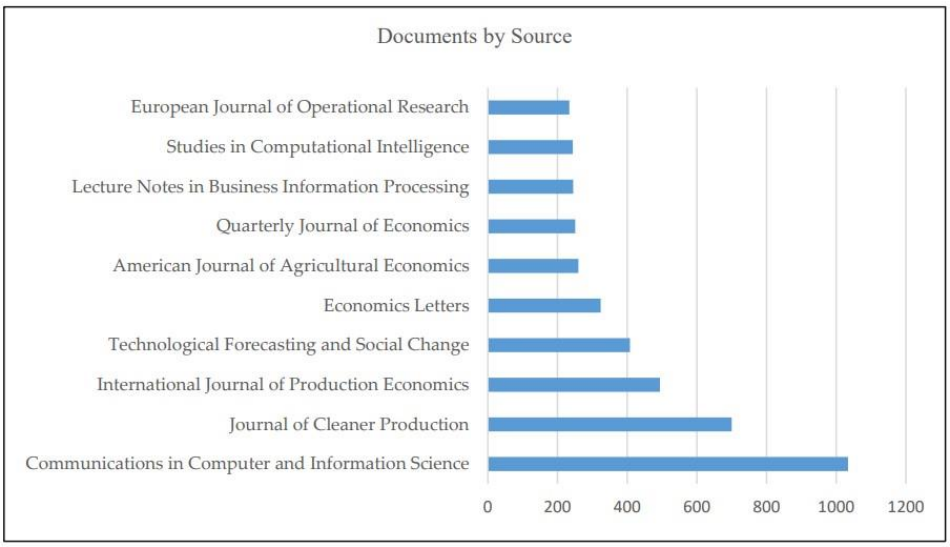

Figure 5. Document Count from the Most Prolific Sources

Figure 6. Citation Count from the Highly Cited Sources

Through the examination of Figure 5, it is notable to emphasize the Journal Communications in Computer and Information Science, which has been the most prolific publisher over the past 22 years, contributing to a total of over 1000 documents on the subject under consideration. The absence of conferences in the top sources suggests a strong inclination towards written literature in addressing this theme.

In Figure 6, it is noteworthy that both journals and a conference are relevant to the subject, with one source standing out significantly with the highest number of citations, totaling 2632.

Type of Documents

Figure 7 reveals that, out of the total of 238 documents constituting the final sample, more than two-thirds represent scientific articles (78%). This underscores the notion that the scientific literature places substantial value on this theme. Additionally, 22% of the documents correspond to conferences, encompassing a total of 53 conferences included in this study.

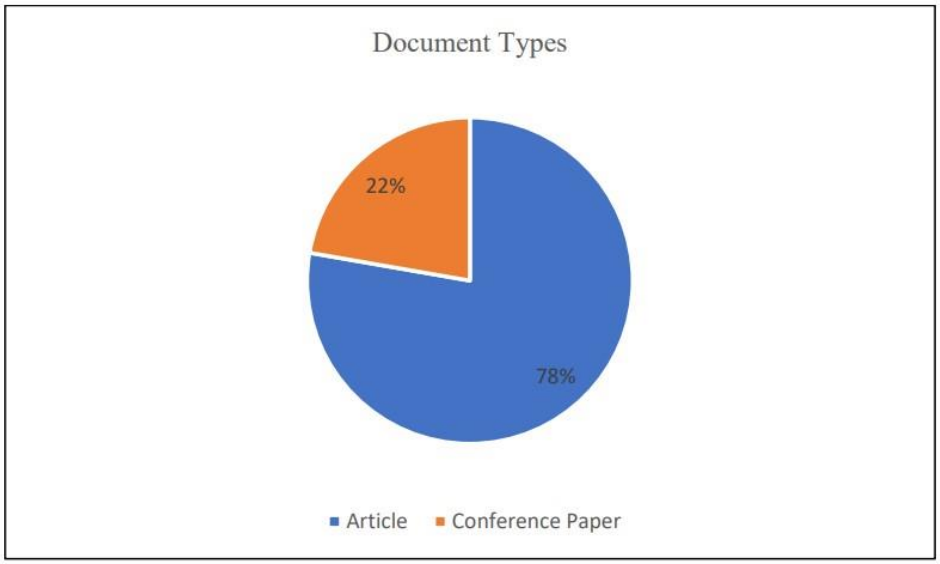

Figure 7. Distribution of Document Types in the Sample

Article Evaluation

Regarding the assessment of article quality, the Scimago tool was utilized to determine the ranking of scientific articles based on their impact factor (IF), with the results presented in quartiles. The first quartile (Q1) signifies higher relevance, encompassing the top 25% of articles with the highest IF. The second quartile (Q2) denotes great relevance, representing an average position between the top 50%

and 75%. The third quartile (Q3) indicates lower thematic relevance, securing a lower average position between 25% and 50%. Finally, the fourth quartile (Q4) implies even less thematic relevance, corresponding to a lower position among the 25% of articles with the lowest impact in the IF distribution. Additionally, considering that our final sample included conferences, which cannot be analyzed through the Scimago tool, we turned to the Conference Ranks website. This platform classifies conferences from A to C based on their criteria (A—excellent, conferences of major relevance; B—good to very good, conferences with significant consideration; C—satisfactory and solid). Figure 8 illustrates the distribution of the quality assessment of articles in our final sample.

The results obtained were satisfactory, with approximately 73% of the final sample falling between Q1 and Q2 (Scimago criteria) and, in the case of conferences, between A1 and A2 (conference ranks). The remaining 27% represents documents in the boundaries of Q3 and Q4 (Scimago criteria) and B1 to B4 (conference ranks). The limited percentage of documents in the lower positions of the respective rankings suggests a high impact of quality in the documents obtained in the final sample. Notably, no conference evaluated in B2 was obtained, as indicated in the legend of Figure 8.

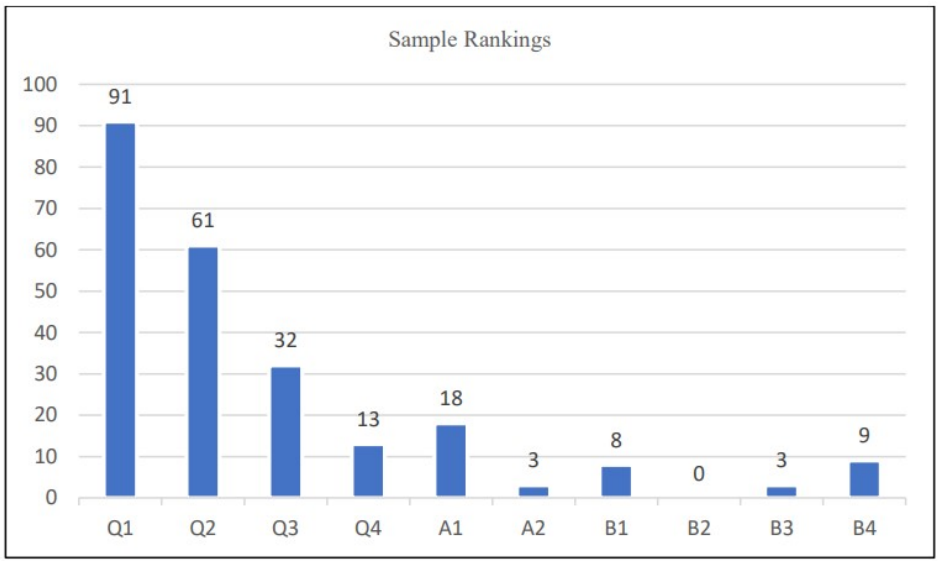

Figure 8. Article Count in Each Ranking.

Keyword Trends

Figures 2 and 9 depict the frequency of searches for the acronym IT (information technology) and the term vertical integration (VI) on Google worldwide in recent years. These data were retrieved using the

Google Trends tool, which has been recording results since 2004. It is noteworthy that from January 2004 to July 2021, the acronym IT exhibited nearly uniform growth, while the interest in the topic of vertical integration declined, indicating a decrease in searches and interest in this concept. As mentioned in the initial subpoint of this section, referring to the correlation between Figures 1 and 2, there was indeed an uptick in the publication of articles related to IT (Figure 1) and the number of studies on this concept (Figure 2) between 2008 and 2009. Hypothetically, these data may be linked to the increasing integration of IT into people's daily lives. This integration may have spurred a greater exploration of the use of information technology within companies, thereby necessitating research on the integration of IT with vertical integration. This justifies the subsequent surge in publications and research related to both concepts in the following years.

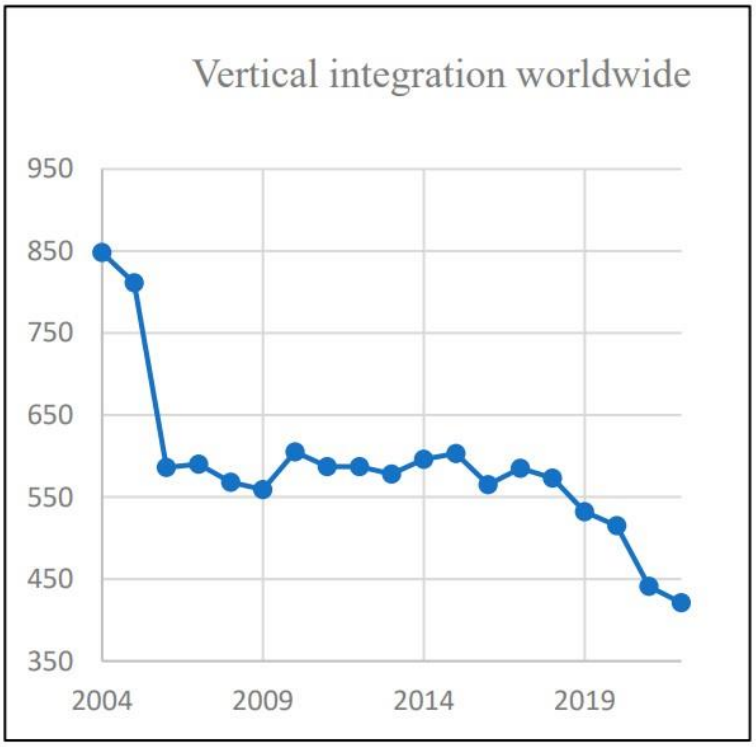

Figure 9. Global Search Volume for the Term "Vertical Integration."

Analysis and Exploration of Key Concepts and Cluster Structures

The utilization of bibliometric tools has experienced a notable increase and is presently a common method for interpreting literature and research trends [18]. In this section, the key concepts most relevant to the theme in the last 22 years are pinpointed. Employing the VosViewer tool, these concepts

were mapped across the entirety of the sample data. The outcome of this mapping was translated into a visualization of a bibliometric network, offering a comprehensible map of the most frequently occurring keywords associated with the term "vertical integration" and the connections between them. This tool facilitates distance-based maps, where the space between two points/terms signifies the relationship between them—greater distance indicating a weaker relationship, and proximity indicating a stronger relationship (i.e., frequently linked terms). The analysis is illustrated in the ensuing figure.

Upon examining the concept occurrence map in Figure 10, it became possible to identify the most closely related concepts (distance between terms) and the primary data clusters, distinguished by colors. These clusters facilitate the extraction of categories or themes underlying each concept cluster. Table 4 succinctly outlines the clusters identified through concept mapping.

Table 4. Structure of Clusters and Primary Keywords.

Cluster 1: Focused on Information Technology	Cluster 2: Focused on Innovation	Cluster 3: Focused on the Process
information technology, technological development, technology transfer, ecosystems	vertical integration, industry 4.0, information management, network architecture	economics, strategic planning, industry, commerce

The thorough examination of each cluster facilitated the gathering of information from the top five documents in each cluster based on the concepts most intricately connected to the researched theme. This information is presented in Table 5 for the cluster concentrating on IT, Table 6 for the cluster emphasizing Innovation, and Table 7 for the cluster centered on Processes. It's worth noting that, given the nature of the study, certain works appeared in more than one cluster. Consequently, these documents were placed within the data grouping most closely aligned with the category delineated for the respective cluster. Subsequently, we proceeded with the analysis of the study occupying the subsequent position, adhering to the defined criterion.

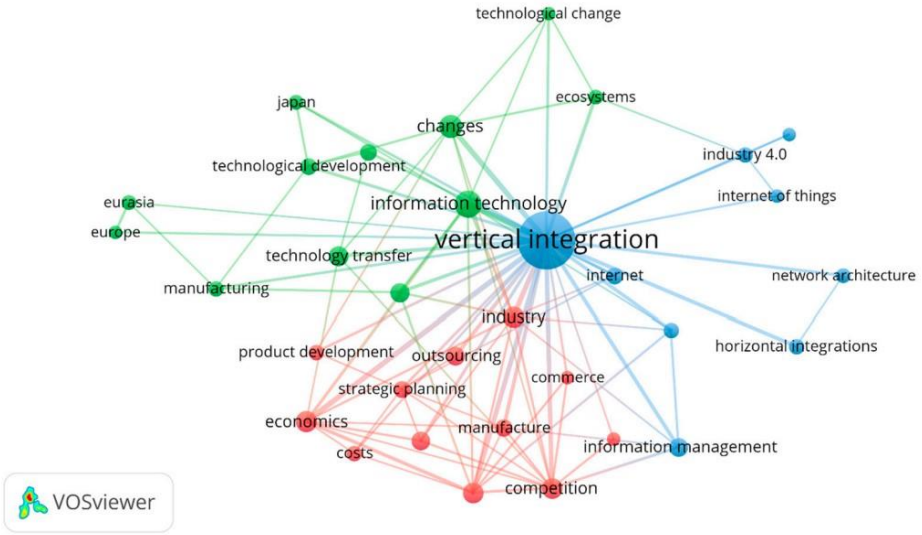

Figure 10. Visualization of Keyword Occurrence

Table 5. Highly Cited Documents in the Cluster Emphasizing Information Technology (IT)

Title	Author	Year	Source Title	Cited by
Leveraging the impact of supply chain integration through information technology	Vanpoucke E., Vereecke A., Muylle S.	2017	*International Journal of Operations and Production Management*	134
Information technology and firm boundaries: Impact on firm risk and return performance	Dewan S., Ren F.	2011	*Information Systems Research*	95
Competitive environment and the relationship between IT and vertical integration	Ray G., Wu D., Konana P.	2009	*Information SystemsResearch*	57
Cost control and production performance enhancement by IT investment and regulation changes: Evidence from the healthcare industry	Menon N.M., Lee B.	2000	*Decision Support Systems*	44
The impacts of country characteristics upon the value of information technology as measured by productive efficiency	Lin W.T., Chiang C.-Y.	2011	*International Journal of Production Economics*	38

Table 6. Highly Cited Documents in the Cluster Emphasizing Innovation.

Title	Author	Year	Source Title	Cited by
Value creation in innovation ecosystems: How the structure of technological interdependence affects firm performance in new technology generations	Adner R., Kapoor R.	2010	*Strategic Management Journal*	1306
Job creation or destruction? Labor market effects of Wal-Mart expansion	Basker E.	2005	*Review of Economics and Statistics*	168
The growth of alliances in the knowledge-based economy	Contractor F.J., Lorange P.	2002	*International Business Review*	147
Can the SME survive the supply chain challenges?	Vaaland T.I., Heide M.	2007	*Supply Chain Management*	109
Integrative capabilities, vertical integration, and innovation over successive technologylifecycles	Helfat C.E., Campo-Rembado M.A.	2016	*Organization Science*	69

Table 7. Highly Cited Documents in the Cluster Emphasizing Processes

Title	Author	Year	Source Title	Cited by
Mutual commitment to support exchange: Relation-specific IT system as a substitute for managerial hierarchy	Kim S.M., Mahoney J.T.	2006	*Strategic Management Journal*	101
Testing foreconomies of scope in European railways	Growitsch C., Wetzel H.	2009	*Journal of Transport Economics and Policy*	72
Technological transfers from the European space programs: A dynamic view and comparison with other R&D projects	Bach L., Cohendet P., Schenk E.	2002	*Journal of Technology Transfer*	40
A price theory of vertical and lateral integration	Legros P., Newman A.F.	2013	*Quarterly Journal of Economics*	27
Determinants of organizational form: Transaction costs and institutions in the European trucking industry	Arruñada B., González-Díaz M., Fernández A.	2004	*Industrial and Corporate Change*	26

Cluster Emphasizing Information Technologies (IT)

While the significance of supply chain integration is widely acknowledged, previous studies focused on comprehending the operational impact on the supply chain have not adequately considered the interrelationships and complexities between supply chain tactics [19]. These studies also failed to differentiate the benefits associated with the direction of integration. As articulated by Frohlich and Westbrook in 2001 and Sahin and Robinson in 2002, supply chain integration involves coordinating flows among partners, encompassing material movements, procedures, optimization processes, and transactions, all while considering the information derived from these flows [20]. At the tactical level,

the literature proposes two interconnected forms of integration: information exchange and operational integration tactics (e.g., Kulp et al., 2004 [21]; Leuschner et al., 2013 [22]; Frohlich and Westbrook, 2001 [23]). Information exchange pertains to coordinating information transfers and communication, whereas operational integration involves developing joint activities, collaborative work processes, and coordinated decision-making among supply chain partners [20,24].

To achieve operational advantages on both the supplier and customer sides in terms of cost-efficiency and delivery criteria, it is demonstrated that companies benefit from engaging in both information exchange tactics and integration tactics, such as operational integration. These two should function complementarily rather than as substitutes, as it is asserted that information exchange alone is insufficient to achieve the intended aims. This aligns with the assertion by Vereeck and Muylle [25] that operational integration plays a significant role in governing the relationship between information exchange and operational performance. This finding is also consistent with Kulp's [21] assertion that while information exchange is necessary for achieving above-average profit margins, it is not the sole determinant. Another notable observation is the creation of operational benefits in both directions of supply chain partners, with a greater impact seen in integration initiatives with upstream partners (left). This observation aligns with the argument presented by Kembro and Näslund [26], suggesting that the performance associated with information exchange depends on the position within the supply chain.

Specifically, it is suggested that using IT for integration with suppliers has a more pronounced impact on operational performance than integration with customers. Cheng [27] supports this idea, finding that buyers derive greater benefits from exchanging information with suppliers than with customers. An explanation proposed is the incentive for suppliers to adopt the same technologies, driven by the desire to maintain the business relationship. For instance, multinational companies like Wal-Mart have requested their main suppliers to adopt the same information systems and technologies, with suppliers passing on the same requirement to their own suppliers. While this approach involves investments for suppliers, the benefits for the buyer appear to be more pronounced in the short and medium term. In the long term, these costs may be balanced by the multinational company's willingness to increase purchases, establish new contracts, and/or pay more for the services provided.

In supplier operational integration, IT has been found to impact cost efficiency and delivery performance for the buyer. In customer operational integration, it positively affects delivery efficiency for the buyer but does not contribute to cost reduction for the focal company. The significant improvement in delivery performance for both can be attributed to information exchange supported by robust procedures shared and analyzed in the supply chain, consequently reducing the bullwhip effect. With this in mind, the utilization of IT in cross-organizational tactics is seen to enhance the speed and accuracy of the supply chain.

Another study has proposed that the influence of IT, under specific conditions of industry concentration and demand uncertainty, can alter firm boundaries [28]. Specifically, when demand uncertainty is high or industry concentration is low, IT is linked to a reduction in vertical integration. In these scenarios, an increase in vertical integration may lead to higher coordination and production costs, prompting less integrated firms to invest more in IT to coordinate with specialized firms. Conversely, in situations where industry concentration is high or demand uncertainty is low, IT is associated with an increase in vertical integration. This is because vertical integration can potentially decrease coordination and production costs, leading integrated firms to invest more in IT. Another argument posits that in conditions of demand uncertainty and unstable competitive environments, IT is connected to a decrease in vertical integration. In such cases, companies aiming to maintain flexibility reduce commitments to specialized assets. IT, in this context, facilitates coordination with different external partners [29]. Conversely, in concentrated environments with predictable demand, IT might be associated with increased vertical integration. Firms in such environments use IT to coordinate activities within the organization, aiming to boost revenue and capture added value. These insights also contribute to understanding the varied behaviors of B2B (business-to-business) exchanges, influenced by industry environments [28]. In situations with high demand uncertainty, firms are more likely to adopt B2B electronic exchanges to coordinate with suppliers and customers, a concept supported by Hoffman [30]. In contrast, more concentrated environments, such as the chemical industry, see the use of B2B exchanges for coordinating activities with business partners with established relationships [31].

Another analysis investigated the use of IT as a means to complement or replace vertical integration in the hospital sector and at the national level. In the hospital sector, where there is no competitive pressure from the private sector, nonprofit organizations tend to exhibit inefficient operations. In this context, IT has been shown to enhance production efficiency by serving as a substitute for various factors, including medical capital and labor in IT [32]. This shift towards computational distribution involves each department taking responsibility for data entry and some IT processing tasks. In essence, doctors are now involved in data entry and have a more participatory role in utilizing IT tools. At the national level, based on production theory, it was analyzed that vertical integration has positive impacts on production and, consequently, on production efficiency. The relationship between vertical integration and IT was observed to be complementary or substitutable [33].

Within the red cluster, studies on IT performance and IT investments were observed. Leveraging contingency theory, which speculates on the alignment of "patterns of contextual, structural, and strategic relevant factors" [34] leading to superior performance, it was predicted that the administrative and labor productivity of companies with a higher degree of vertical integration is positively associated with IT spending. These findings align with Dewan's [35] work, indicating that firms with greater coordination intensity, such as vertically integrated ones, exhibit a higher demand for IT. This is also in harmony with Barney's [36] research, suggesting that IT may yield positive effects on performance [37] Shifting focus to the impact of IT investment on a firm's return and financial performance risk, our findings indicate that IT investment heightens the firm's risk. However, the interaction of IT with frontier strategies enhances the return and diminishes the risk margin. In essence, a company making an IT investment can increase its risk, but by aligning this investment with the integration or disintegration of its processes, the company's risk can be minimized. Specifically, managers should align their IT investment with the costs of internal versus external coordination to assess whether integration or disintegration is more rewarding [38].

Cluster Focused on Innovation

Within this cluster, the examination revolves around the impact of innovations. A primary question addresses how challenges faced by external innovators influence the outcomes for the focal firm. This

involves distinguishing between components and complements, where components are inputs received from suppliers, and complements are offerings bundled with the focal firm's product. For example, a firm producing computers and printers receives chips as a component, while the printer serves as a complement. The focus is on the impact of challenges related to components and complements during technology transitions when a vertical integration strategy is in place.

When contracting suppliers for component innovation, the focal company encounters two types of uncertainty: technological uncertainty, which pertains to not knowing if and when suppliers will discover appropriate solutions to innovation problems, and behavioral uncertainty, which involves uncertainty about if and when suppliers will behave opportunistically to renegotiate agreements in their favor. It was observed that as technology cycles progress, technological uncertainty diminishes; however, the same does not necessarily occur with behavioral uncertainty. The balance between these two uncertainties tends to be established towards the end of the technology cycle.

The argument is made that the benefits of vertical integration should increase throughout the technology life cycle, a notion supported by studies in the automobile industry [40, 41]. The challenges in upstream components prevent the firm from offering its innovation to the market, while downstream complementary challenges impede the focal firm's customers from using the innovation to its full potential. These challenges create bottlenecks to value creation, with distinct effects on the firm's ability to capture value and create a competitive advantage [39]. This finding aligns with calls in the literature to understand the dynamics of value creation [42, 43].

In a subsequent aspect, the examination of innovation within the context of companies of varying sizes was conducted, revealing a notable contrast between Small and Medium Enterprises (SMEs) and Large Enterprises (LEs). There exists a significant divergence in the adoption of current and future supply chain methods by SMEs compared to their larger counterparts. This discrepancy may result in a loss of transactional efficiency for SMEs, indicating a resistance to evolution and change, ultimately leading to a competitiveness lag due to supply chain inefficiency. The reluctance of SMEs to embrace technological advancements creates a substantial gap between these company types, as the majority of planning and control methods are electronic. This technological indifference provides a competitive

advantage to LEs, enabling them to reduce transaction costs and introduce novel and improved process and material methods. Despite the potential advantage of SMEs in being more flexible due to their smaller size, technology can overcome certain barriers and create new opportunities. LEs are leveraging technological methods to shift their business processes towards online and electronic shopping in the market. Another noteworthy point concerning technology in SMEs is that they may not necessarily need to own the technology outright, as networking and resource sharing can minimize the cost of technology acquisition [44].

A third consideration explores the impact of innovation in the context of a complex, interdependent, and communicative global society, where cooperation and coalitions among companies inevitably play a crucial role. It has been demonstrated that in environments characterized by technological change and uncertainty, firms tend to disintegrate and form alliances [46].

Finally, an examination was conducted to understand why specialized and industry-integrated firms persist in the face of innovations within their industries. In contrast to existing literature suggesting cyclical patterns of integration and disintegration, this study explains that firms often opt to remain vertically integrated even when facing profitability losses due to low-cost firms producing similar products. This is particularly prevalent in industries marked by successive innovations. Integrated firms anticipate compensating profits from subsequent innovations and are willing to endure losses to maintain their integrative capabilities, resisting the pressure to lower prices set by specialized firms. The analysis also suggests that the coexistence of these two firm types (integrated and specialized) is more likely in industries characterized by repeated innovations than in those with fewer innovations. However, there are instances of integrated firms in both high and low innovation intensity industries. Notably, integrated firms, having developed extensive integrative capabilities, are more likely to drive innovations than their specialized counterparts in industries associated with frequent technological advancements. When sunk costs of developing integrative capabilities are high, and innovations occur regularly, firms tend to persist in their integrated structure over time [15, 47, 48].

Cluster Focused on Processes

In the context of processes, studies have underscored the significance of effective cooperative relationships, emphasizing that both suppliers and buyers should make mutual sunk cost commitments to foster long-term, win–win partnerships [49]. Empirical evidence indicates that adopting a general IT system does not necessarily lead to increased performance. Instead of developing an electronic platform for an "electronic marketplace," it is suggested that an "electronic partnership" should be realized, wherein the implemented IT system is relationship-specific, tailored to the practices of the relationship. Such a system supports exchange with partners as if it were a mutual commitment, contributing to a long-term partnership achieved through superior governance of electronic integration. This governance reduces transaction costs and earns relational rents through mutual commitments of sunk costs, aligning with the concept of partnerships generating relational rents as relationships move away from markets [49].

Another analysis focused on processes explored a model in a perfect competitiveness scenario. This model hypothesized that internal organizational effects could have significant consequences at the industry level, unlike strategic and collusive interactions between firms dominating the global economy literature. The model explains the heterogeneity in firm performance and illustrates the industry response to demand or technology shocks. The study indicates that integration becomes more advantageous due to market trade-offs in the presence of positive technological shocks and increased elastic demand. Conversely, if supply increases and prices fall too low, firms may disintegrate as reorganization may absorb the aggregate benefit of technological improvements. The equilibrium model demonstrates how market forces can be determinants in organizational design, with a major trade-off between non-integration and integration. Non-integration excels in internalizing private costs but is weak in coordinating decisions, while integration exhibits the opposite strengths and weaknesses. The profitability of integration is also discussed concerning high and low prices. At high prices, the tendency to integrate increases due to the high costs of failure to work, whereas at low prices, specialization becomes more profitable [50]. Considering welfare, the study suggests that consumers prefer

organizations that make and sell their products, supporting the notion that competition in the product market should ensure efficiency of results [50].

The nature of the participants' network is crucial for studying processes. Observations reveal that the nature of participants' networks significantly shapes the outcomes of technology transfer. The way participants share knowledge and information, the choice of coordination devices, and the degree of trust within the network influence the volume of technological flows. The collective construction of knowledge within a network emerges as a vital factor in the diffusion of innovative ideas and project principles. This collaborative construction accelerates the validation and testing of novelties and the discovery of new fields of application. The success of this process relies on participants having a substantial level of absorption of the network's knowledge and a considerable capacity to analyze, interpret, and transmit new knowledge. The intensity of knowledge transferred in the network is influenced by the cognitive capacity of network elements and the properties of the organizational structure of each element in a project. These properties include the existence of vertical links, the degree of decentralization of decision-making, and specific incentives to favor technological transfer. The contractor's flexibility to modify its organization and deal with new technical resources is crucial for a successful transfer. A successful transfer must align with commercial characteristics in terms of quantity, price, and deadline, enabling companies to transition from maximizing technical capability to maintaining costs in the realm of economic transfer [51].

Within this collection of articles, an examination was conducted on processes applied to railways and haulers in Europe. The focus was on assessing the efficiency of European railways, testing for gamma economies, which result in enhanced efficiency through joint production compared to separate production. Gamma economies manifest when total production costs decline with the addition of product variety. Integrated firms were found to be relatively more efficient than virtually integrated firms due to the presence of a capable manager generating productivity advantages, exemplified as gamma economies [52].

For instance, in the European carrier sector, it is proposed that many carriers in Europe opt for vertical integration as they don't achieve economies of scale. Efficiency in this context is suggested to be

achieved through contractual means and hybrid forms, with firms integrating due to the adoption of public policies promoting integration [53].

Trends in Key Concepts in Recent Years

The study delves into the temporal evolution of key concepts from 2000 to the present, employing the VosViewer tool to map all concepts in the sample. The analysis reveals a dynamic shift in the literature's interest over time. Concepts related to processes, particularly strategic planning and product development, have been a longstanding focus. Subsequently, attention shifted to information technology around 2008, gaining increasing popularity. In a more recent phase, the literature has prominently featured innovation, underscoring its substantial relevance in the subject matter after the exploration of the other two themes.

In summary, the study identifies three overarching themes with implications for theory and practice in vertical integration in technology: IT integration, business innovation, and process innovation. These themes are interconnected, aligning with Helfat's perspective that IT integration creates new business opportunities through innovative models and embedded technology. From a practical standpoint, companies face significant challenges and opportunities, including the integration of cloud services for enhanced efficiency and scalability, the incorporation of IoT devices for data collection and analysis, the utilization of AI and ML for automation and data-driven decisions, integration of 5G networks for faster and more reliable connectivity, and the incorporation of blockchain technology for secure and transparent data management and supply chain tracking.

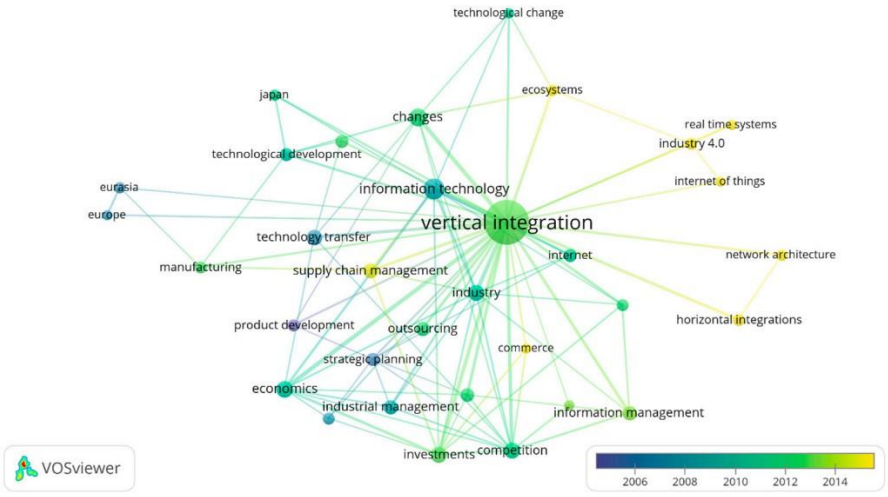

Figure 11. Temporal Visualization of Keyword Occurrence

These implications underscore the growing significance of vertical integration in technology and its pivotal role in propelling business expansion and competitiveness.

CONCLUSIONS

The examination of vertical integration concerning technologies has been a focal point in scholarly literature, as evidenced by this comprehensive review, revealing a consistent and growing interest in this subject over the past 22 years. The study covered diverse aspects, including information technology, innovation, and processes, in a longitudinal exploration. This review proved to be a robust approach, facilitating the aggregation, selection, and synthesis of a body of evidence aligned with the defined objective.

In summary, companies derive advantages from participating in information exchange, enhancing delivery performance, and engaging in operational integration, with these elements acting as complementary facets. Nevertheless, the study identified that operational integration with suppliers tends to yield more benefits compared to integration with buyers, where cost reduction for the focal firm is evident in the former but not the latter. Additionally, industry concentration and demand uncertainty emerged as pivotal considerations for managers when contemplating integration strategies and assessing the impact of IT investments. The study discerned that while IT investments elevate a company's risk, strategic alignment with internal versus external coordination costs mitigates this risk and enhances the company's returns. Another key determinant of vertical integration is innovation cycles, revealing that integrated companies tend to lead in product innovation when innovation cycles are recurrent. Moreover, contrary to conventional literature, companies with well-established integrative capabilities often prefer remaining integrated, even at the cost of profitability losses when competing with specialized firms, rather than opting for disintegration.

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