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Vertical Integration Dynamics to Innovate in Technology Business

Pedro Nogueira [1], Leandro Pereira [2,*], Ana Simões [2], Alvaro Dias [1] and Renato Lopes da Costa [2]

[1] ISCTE-IUL, 1649-026 Lisbon, Portugal
[2] BRU-Business Research Unit, ISCTE-IUL, 1649-026 Lisbon, Portugal
* Correspondence: leandro.pereira@iscte-iul.pt

Abstract: Companies try to acquire the finest advantages and techniques in a technologically advanced and end-to-end market to have a stronger foothold there. Although empirical research on this topic links IT to a decline in vertical integration, corporations are increasingly using this corporate strategy. The goal of this study is to show how over the past 22 years, scientific literature has changed with regard to how information technology (IT) affects vertical integration, one of the main types of corporate strategies. The findings demonstrated that vertical integration has been evolving in a balanced manner in a technological environment. Three categories—information technology, innovation, and processes—help explain this association and were discovered through cluster analysis. The direction of operational integration, the degree of industry concentration, demand unpredictability, and innovation should all be considered while making integration decisions.

Keywords: vertical integration; information technology; technology innovation; business innovation

Citation: Nogueira, P.; Pereira, L.; Simões, A.; Dias, A.; Lopes da Costa, R. Vertical Integration Dynamics to Innovate in Technology Business. *Informatics* **2023**, *10*, 25. https://doi.org/10.3390/informatics10010025

Academic Editor: Guendalina Capece

Received: 5 December 2022
Revised: 4 February 2023
Accepted: 15 February 2023
Published: 22 February 2023

1. Introduction

The topic of vertical integration has been studied since its inception. According to Porter [1] there are two types of strategies: corporate and competitive. This paper focuses in particular on the corporate strategy of vertical integration and the way it reacts to technological impacts.

Vertical integration is normally carried out on financial grounds and consists of the acquisition of one or more links in the value chain, thus increasing the capacity of the company both in terms of structure and autonomy. The company diversifies and increases its capacities and resources, becoming less dependent on external organizations. The vertical integration strategy can be total (across the whole chain) or partial (targeting suppliers or retailers).

Total integration occurs when a company acquires control of the entire value chain, from the moment of its production, through transformation and distribution, to the moment when the product is sold to the consumer. On the other hand, vertical integration may focus on the acquisition of only one of these factors of the value chain, thus being called partial vertical integration. This can be considered upstream in cases where the absorption is made with the purpose of acquiring the supplier; or on the contrary, downstream in cases where the purpose of the increase in the company is carried out through the purchase of the retailer or wholesaler. The upstream vertical integration strategy is thus characterized by the company taking on the role of supplier with the aim of finding the raw materials it needs internally, enabling an increase in autonomy and control over costs. Consequently, a supplier is eliminated from the market, and with this, the company is more firmly established in the sector where it operates. The strategy of downstream vertical integration, in turn, aims to ensure the distribution of its own products, absorbing the role of the distribution companies. This strategy enables the company to eliminate the expenses it would incur with the other company to perform this function, increasing control and monitoring in the distribution phase, sales, and their oscillations.

Thus, these vertical integration strategies, whether partial or total, lead companies to confront the question of "manufacturing their products internally or buying externally" and/or "ensuring the distribution of their products or resorting to an external distributor or seller", analyzing the need or added value of resorting to vertical integration strategies [2].

The evolution of markets over time has been driving this debate, especially when technological tools allied to business strategies emerge. In particular, the use of IT (information technology) can, on the one hand, effectively enable companies to share information in a faster and more efficient way, and on the other hand, reduce coordination costs either with external suppliers (when using the markets) or within the company (in integrated companies) [3] becoming an attractive tool for companies.

If the vertical integration strategy was already the target of literature attention over time, with the implementation of IT in companies the investigations have been accentuated. The scientific community aims to obtain the best evidence [4]. To this end, the application of a methodology is imperative for the advancement of knowledge, either through the discovery of errors, potentiation of new solutions. or replication of results [5].

As such, this article aims to carry out a synthesis of the literature research on the subject, analyzing the evolution of vertical integration over time, taking into account the impact of IT integration in companies. With this purpose, Section 1, serves to contextualize the readers on the theme addressed, through the presentation of some studies. Section 2 aims to describe the research methodology that was framed in Cooper's taxonomy of literature reviews [6] and its five research phases for conducting a literature review [7]. Through the methodology used, Section 3 explored and analyzed the information obtained through five key dimensions, which were considered relevant to obtain a final sample of a current and scientific literature review (dispersion of documents per year, most cited authors and those who publish the most, types of documents, evaluation of articles, and searches for the terms "vertical integration" and "IT"). The final sample of articles was also submitted to a concept co-occurrence mapping process that allowed one to relate vertical integration to other concepts used in research over the last 22 years. This procedure enabled the analysis of the evolution of vertical integration research, describing some considerations on the main results. Section 4 presents the main conclusions and some limitations of this research.

The studies conducted on vertical integration (IV) consider that there are two opposite ways for firms to organize their transactions: the hierarchy and the market. However, firms use different governance structures for these two ways [8]. It is up to the governance structure to best align the characteristics and surroundings of the firm to the appropriate strategy. According to Dyer and Singh, developing and maintaining relationships between firms requires a governance framework that can exchange characteristics [9].

Much of the previous research suggests that new industries generally have a strong representation of vertically integrated firms [10,11], and over time, industries have tended to disintegrate as integrated firms split into specialized firms and new specialized firms entered [12,13]. Many industries originated from a technological innovation [10]. When such innovation is systematic, according to Teece, it requires adjustment and alignment of activities and investments at different stages of the vertical chain [14]; thus, it can be difficult for buyers and suppliers to use market transactions (including contracts, as pointed out by Williamson in 1985 [15].

2. Research Methodology

As the empirical base has expanded, the reviewer's task has become more complex. In this day and age, it is increasingly difficult for researchers to keep up to date through primary data. That said, researchers truly rely on integrative research reviews to define the state of knowledge [7].

Using Cooper's taxonomy of literature reviews [6] to structure and categorize the study in question, researchers have described this integrative review as having a primary focus on accounting for publications and trend analysis. In parallel, they have resorted to a

review of the findings of the topic, with the aim of summarizing the state of accumulative knowledge regarding the important issues and relationships of the topic under study [7] (vertical integration in a technological world), employing a representative sample, and targeting mainly conferences and scientific articles. Table 1 shows Cooper's five stages of investigation for conducting a literature review. Each stage is described in detail in the following chapter, which is representative of the authors' approach.

Table 1. The 5 stages of research methodology according to Cooper.

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 follows a bibliometric analysis, which is a method used to quantitatively analyze and evaluate published scientific literature. This analysis involves the use of quantitative metrics, such as citation counts and author impact factors, to measure the productivity, visibility, and impact of a particular article, author, or research field. Bibliometric analysis can help identify trends and patterns in the scientific literature, and is commonly used in the fields of library and information science, as well as in scientific research evaluation and funding decisions [16].

2.1. Problem Formulation

Guided by Cooper's taxonomy, which raises the quality of reviews [6], the first stage of the research methodology concerns problem formulation, which consists of formulating the questions of the literature review or of the empirical research. It should be noted that according to Cooper, it is important to make a distinction between these two types of questions.

Literature review questions can be answered through secondary research reviews, while empirical research questions are those that are answered through primary research [17].

That said, the literature review question for this paper is stated: 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?

2.2. Data Collection

In order to obtain a representative sample for this literature review, the reviewer is advised to detail the data collection procedure such that in theory, other reviewers following the same steps would find an identical set of results [17]. Consequently, in the following, the remaining steps that led to the final set are presented.

Firstly, on 12 July 2022, searches were conducted in the Scopus database (designed for searches by author and subject) in order to discover the first range of results that meet the theme. To this end, in the mentioned database, the following keywords were searched in the abstract, title, and keywords fields of the articles (F1): "information technology" (IT) and "vertical integration". The search identified 905 documents, so a second filtering was carried out (F2) excluding documents published up to the year 2000. The database presented 776 results that were in conformity with the search carried out. The third filter (F3) reduced the results to 759 documents, through the inclusion of documents written only in English. Two more document absorption systems were also performed on this database, F4 and F5.

The next filtering, (F4), through the moderation of articles that are in the areas of computer science or business or economics, yielded 361 results. F5 narrowed the sample by confining it to documents that are scientific articles or conferences, resulting in 322 results.

Finally, a manual filter (F6) was also applied to the documents from F5, which consisted in the classification of articles and conferences, with the help of the Scimago Journal & Country Rank and Conference Ranks tools, respectively. The documents that were not found in these tools were no longer part of the final range, with the exception of those that were recently written (2022), which as they had not yet been assessed, the classification of the previous year was assumed. This resulted in 240 articles counted, which form part of our final sample. Table 2 summarizes the filtering system.

Table 2. Summary of filtering for this research.

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

2.3. Data Analysis

As suggested by Cooper, at this stage, the reviewer, after extracting the data, methodically evaluates them to confirm whether the inclusion and exclusion criteria were complied with those defined in the previous stage [17].

In this study the documents were reviewed, and it was observed that within the expected results, there were two documents (Workshops) that did not fit the defined parameters of "type of document" (F5). Therefore, both were removed from the final sample (document type outside the limits imposed), giving rise to 238 documents. Table 3 presents a summary of the above.

Table 3. Latest filters.

F6	Manual Filtration	Final Sample
240	238	238

Also in this phase, to better protect the validity of the data, another external researcher, unconnected with the research in question, was asked to carefully examine the methodology followed and confirm the established criteria [17]. By validating the process implemented, the external researcher confirmed the reliability of the results obtained in this study.

2.4. Data Interpretation

In the same way that Cooper suggested great detail in the steps of the data collection stage so that validity is protected, in this stage the suggestion remains, despite this type of study being less susceptible to validity threats [17].

Having said this, the analyses performed on the set of 238 documents were presented in detail. These documents were statistically analyzed and synthesized in graphics, reflecting six dimensions (dispersion of documents per year, authors, sources, types of documents, evaluation of articles, trends in keywords).

Subsequently, through the final sample, the key concepts of the theme under study were identified and a mapping of these concepts to the entire sample (238 articles) was performed. With this in mind, an analysis was performed using the VosViewer tool that summarized the learning drawn from each data grouping, as well as the presentation of the most relevant articles and some relevant information on these documents. The VosViewer tool is a software that builds and presents bibliometric networks, which is expressed by drawing the network of the main key words, grouping them into clusters and giving relevance to the existing relationships between the concepts. The result of this concept occurrence mapping will unveil the terms present in the literature over the last 22 years that are most interconnected with vertical integration.

Finally, a concept map was constructed with the research trends of the key concepts, again using the VosViewer tool.

2.5. Public Presentation

This research is intended to present a document on the evolution of vertical integration in the last 22 years, with the jurors and all those who wish to obtain more information about the observations and analysis on the subject investigated, vertical integration. The authors are available to receive requests for the content of the research carried out.

3. Data Analysis and Discussion

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

3.1. Data Analysis and Exploration

3.1.1. Dispersion of Documents per Year

Figure 1 represents the dispersion of documents present in the scientific literature, extracted from the Scopus database and which are contained in the inclusion criteria we determined.

After a brief analysis, we can verify that the theme is still considered current, and that although it is not at the peak of its investigation, in the last three years, the number of works developed is above the average of the last 22 years. Another possible hypothesis concerning the analysis of data from Figures 1 and 2 (from page 10), is that in both figures, from the year 2008 to 2009, a sharp rise is observed, which refers to a connection between the moment when the publications were launched by the authors and the increase in people's interest for the term IT.

3.1.2. Authors

In this subpoint, the 10 authors who publish the most on the subject are exposed (Figure 3), as well as the 10 authors who obtained the most citations (Figure 4).

Figure 3 shows that the researcher who has developed the most work on the subject is Gautam Ray, with a total of four articles, who has an enormously relevant and impactful career in the area and is highly prestigious in his field of research.

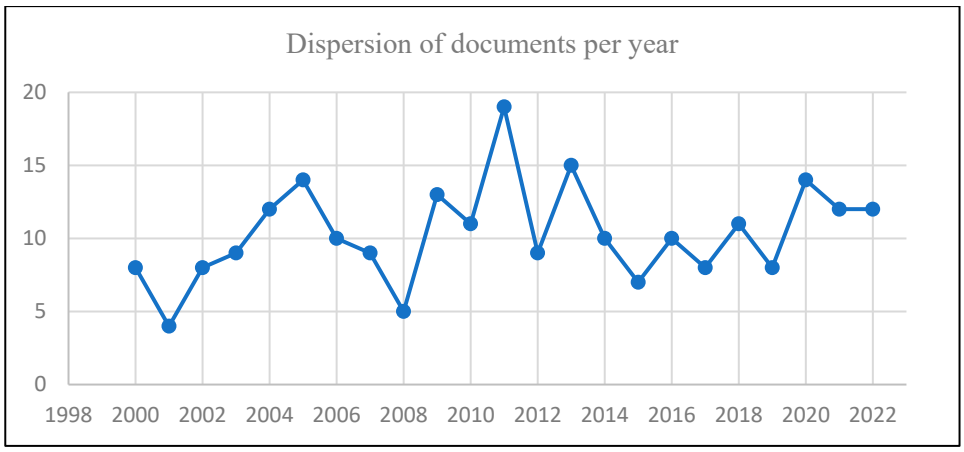

Figure 1. Number of documents per year.

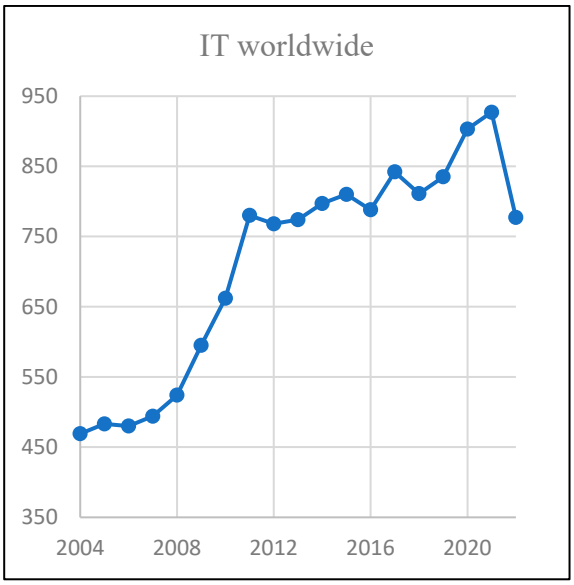

Figure 2. Number of searches worldwide for the keyword IT.

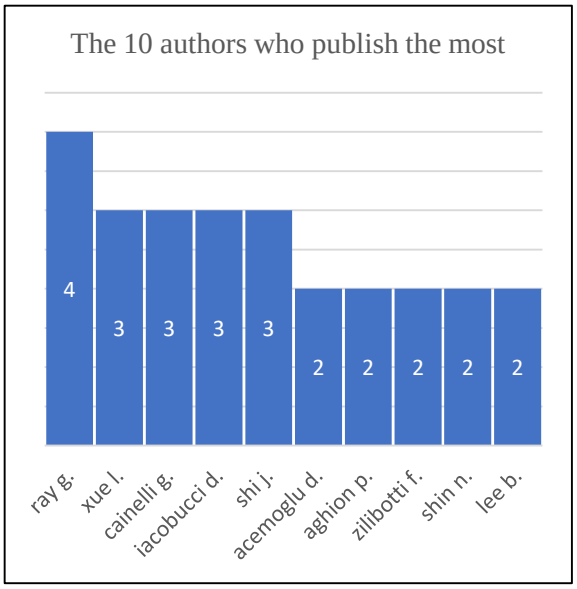

Figure 3. Number of articles by authors most cited.

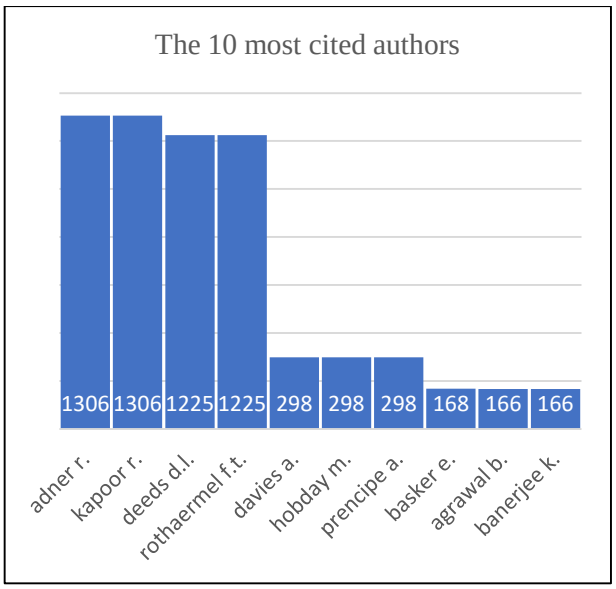

Figure 4. Number of citations by authors most cited.

Similarly, in Figure 4, the existence of pairs of names with the same number of citations is observable. This is due to the fact that the authors of the articles are the same: standing out in this matter are the authors Adner and Kapoor, who with the writing of the scientific article "Value creation in innovation ecosystems: How the structure of technological interdependence affects firm performance in new technology generations", reached 1306 citations.

3.1.3. Sources

The next two figures represent the 10 sources that publish the most papers (Figure 5), and those with the most citations from other authors (Figure 6).

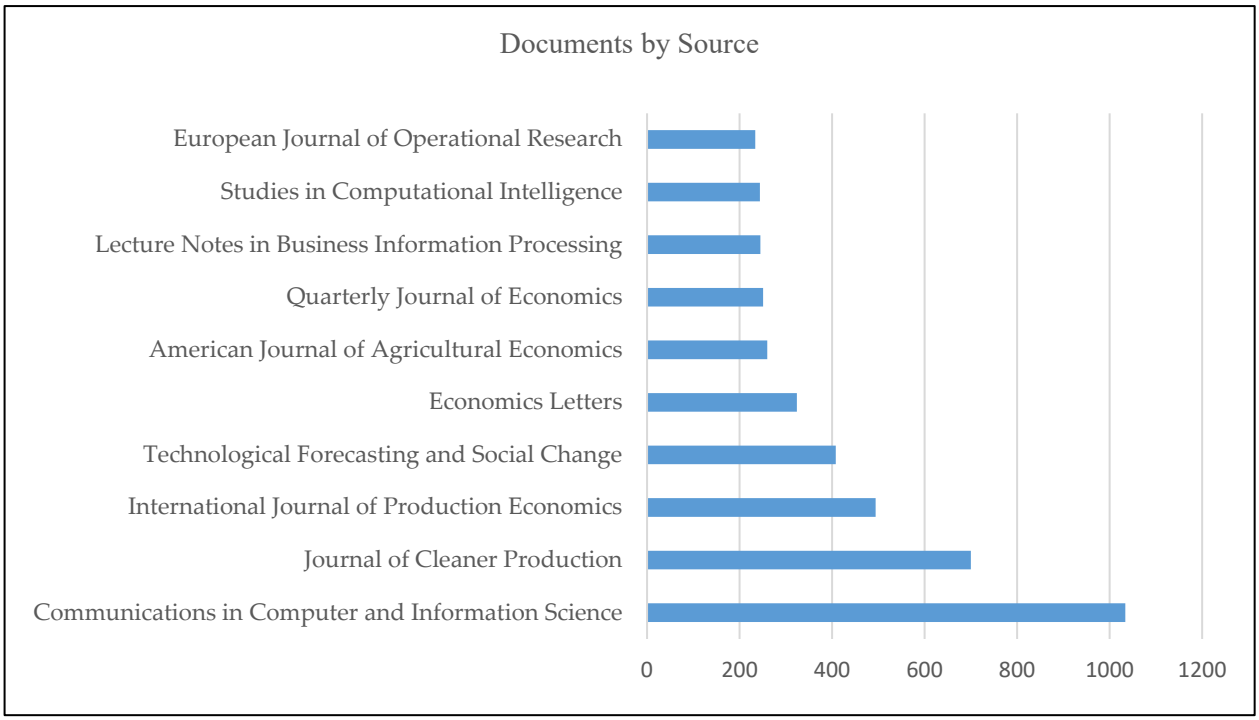

Figure 5. Number of documents from the sources that publish the most.

Figure 6. Number of citations from most cited sources.

Through the analysis of Figure 5, it is possible to highlight the Journal *Communications in Computer and Information Science*, which over the last 22 years has published the most articles, accounting in total for over 1000 documents on the subject we have portrayed. It is also possible to note the absence of conferences in the top of the sources, which suggests a great inclination for the written literature to portray this theme.

In Figure 6, of note is the presence of both journals and a conference pertinent to the subject, as well as one source overwhelmingly showing the highest number of citations, 2632.

3.1.4. Type of Documents

Figure 7 shows that of the total of 238 documents (representing the final sample), more than 2/3 represent scientific articles (78%), which reinforces the idea that the scientific literature values this theme. A total of 22% of the documents correspond to conferences, accounting for a total of 53 conferences present in this study.

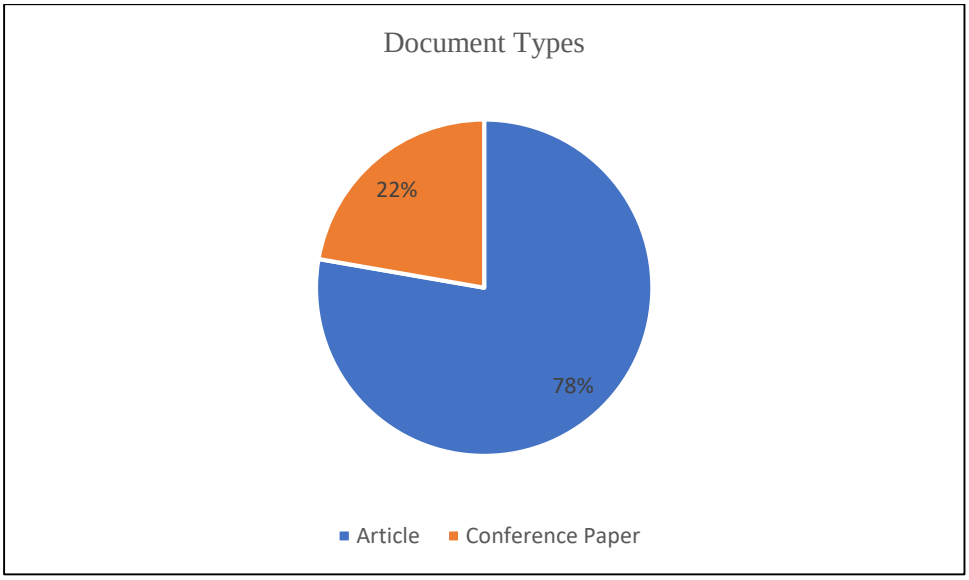

Figure 7. Percentage of the types of documents in the sample.

3.1.5. Evaluation of Articles

With regard to the analysis of the quality of the articles, we used the Scimago tool, which allowed us to find the ranking of the scientific articles, based on the impact factor (IF) data, and the results are presented in quartiles. The first (Q1) assumes greater relevance (top 25% of the IF); the second (Q2) assumes great relevance corresponding to an average position, between the top 50% and 75%; the third (Q3) assumes less thematic relevance, obtaining a low average position, between 25% and 50%; and finally, the fourth (Q4) assumes even less thematic relevance, corresponding to a lower position, among the 25% of articles with lower impact of the IF distribution. Complementarily, taking into account that our final sample included conferences, which are not possible to analyze the ranking through the Scimago tool, we resorted to exploring the Conference Ranks website, which through its criteria classifies the conferences from A to C (A—excellent, conference of major relevance in the area; B—good to very good, conferences with great consideration in the area; C—satisfactory and solid). Figure 8 shows the distribution of the quality assessment of the articles in our final sample. The results obtained were satisfactory. It should be noted that approximately 73% of the final sample is between Q1 and Q2 (Scimago criteria), and in the case of conferences, between A1 and A2 (conference ranks). The remaining 27% represent the documents in the boundaries Q3 and Q4 (Scimago criteria), B1 to B4 (conference ranks). A reduced percentage of documents in the lower positions of the respective rankings leads to the conclusion that there is a high impact of quality in the documents of the final sample obtained. No conference evaluated in B2 was obtained, as can be seen in the legend of Figure 8.

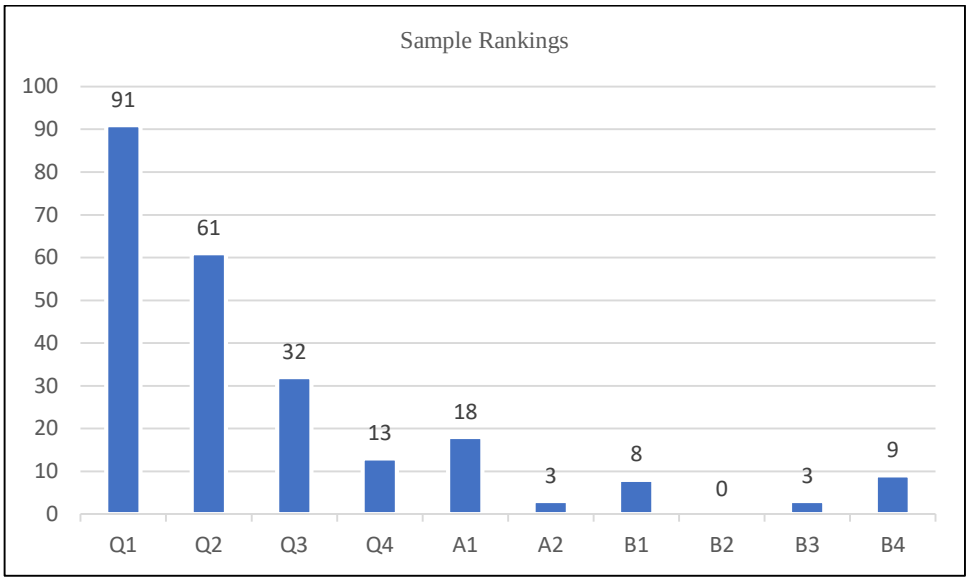

Figure 8. Number of articles in each ranking.

3.1.6. Trends in Keywords

Figures 2 and 9 show the number of times the acronym IT (information technology) and the words vertical integration (VI) were searched for on Google worldwide in recent years. To obtain these data, the Google Trends tool was used, which registers results since 2004. Note that in the periods between January 2004 and July 2021, the acronym IT seemed to be having very close to uniform growth, while the topic of vertical integration had fallen into disuse, pointing to a decrease in the search and search for this concept. As indicated in the first subpoint of this chapter, alluding to the connection between Figures 1 and 2, between the year 2008 and 2009, there was indeed a growth in the publication of articles related to TI (Figure 1), as well as the number of studies on this concept (Figure 2). These data, hypothetically, may be related to the dissemination of IT in people's daily lives. This may have led to a greater exploration of the use of information technology in the companies

themselves, and consequently the need to develop research on how to combine IT with vertical integration, thus justifying the increase in publications and research related to both concepts in the following year.

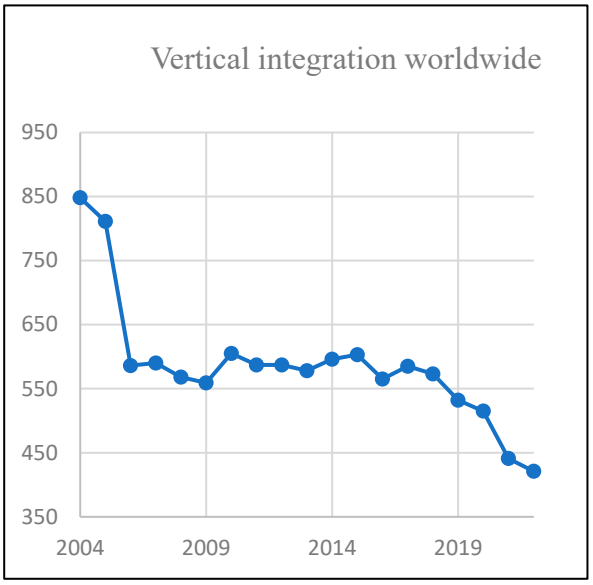

Figure 9. Global number of searches for the term "vertical integration".

3.2. Analysis and Exploration of Key Concepts and Cluster Structures

The use of bibliometric tools has increased significantly and is now a current way of interpreting the literature and research trends [18]. In this section, the key concepts that most relate to the theme in the last 22 years are identified. Using the VosViewer tool, the concepts were mapped to the totality of the sample data. The result of this mapping was translated into a visualization of a bibliometric network, which presents an easy-to-understand map of the most frequently occurring key-words related to the term vertical integration and the relationship between them. This tool supports distance-based maps, where the distance between two points/terms identifies the relationship between them, i.e., distant concepts point to a weak relationship and close concepts point to a strong relationship (i.e., frequently linked terms). This analysis is presented in the following figure.

By analyzing the concept occurrence map in Figure 10, it was possible to identify the most relatable concepts (distance between terms) and the main data clusters, identified by colors. The clusters enable the extraction of the categories or themes underlying each concept cluster. Table 4 summarizes the clusters identified from concept mapping.

Table 4. Cluster structure and main 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 detailed analysis of each of the clusters allowed for the collection of information from the five main documents in each cluster based on the concepts that were most interconnected with those of the researched theme, as can be seen in the Table 5 for the cluster focused on IT, Table 6 for the cluster focused on Innovation and Table 7 for the cluster focused on the Process. It should be noted that due to the characteristics of the study, some works appeared in more than one cluster, so these documents were fitted into the data grouping that was most related to the category described for the cluster. Next,

we proceeded to the analysis of the study that occupied the next position, in view of the defined criterion.

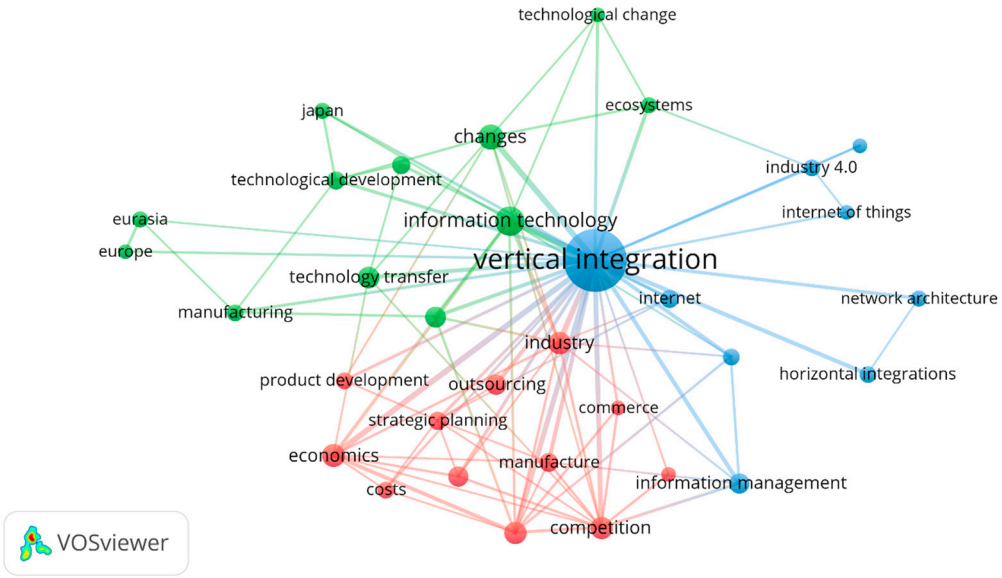

Figure 10. Mapping the occurrence of key words.

Table 5. Most cited documents of the cluster focusing on 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. Most cited documents of the cluster focusing on 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. Most cited documents in the cluster focusing on 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

3.2.1. Cluster Focused on Information Technologies (IT)

Although the importance of supply chain integration is widely unquestioned, previous studies aiming to understand the operational impact on the supply chain have neither taken into account the interrelationships and complexities between supply chain tactics [19], nor differentiated the benefits of the direction of integration. According to Frohlich and Westbrook in 2001 and Sahin and Robinson in 2002, the supply chain integration is the set of activities related to the coordination of flows between its partners, which include material movements, procedures, optimization processes, and transactions, which take into

account the information assumed from the flows [20]. At the tactical level, the literature suggests two interrelated 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 refers to the coordination of information transfers and communication, while operational integration consists of the development of joint activities, collaborative work processes and coordinated decision making among supply chain partners [20,24]. However, to really achieve operational advantages on both the supplier and customer side in the cost-efficiency and delivery criteria, it is shown that companies benefit from engaging in information exchange tactics along with integration tactics, such as operational integration. Both should function in a complementary manner rather than as a substitute because it is stated that information exchange alone is insufficient to achieve the intended aims. This point is in line with what Vereeck and Muylle [25] claim, that operational integration occupies a great responsibility in governing the relationship between information exchange and operational performance. It is also consistent with Kulp's [21] assertion that information exchange is necessary to achieve above-average profit margins, but that it is not a winning key. Another finding was the creation of operational benefits in both directions of supply chain partners, but mainly in integration initiatives with upstream partners (left); this argument is in line with that suggested by Kembro and Näslund [26] that the performance associated with information exchange depends on the position occupied in the supply chain. Specifically, it is suggested that the use of IT for integration with suppliers has a greater impact on operational performance than integration with customers. Sharing the same idea, Cheng [27] found that buyers benefit more from the exchange of information with suppliers than with customers, and that a possible explanation would be the existence of an incentive for suppliers to adopt the same type of technologies, due to the desire to want to keep the business. An example is what happened to the multinational Wal-Mart, which, in order to improve its operational performance, asked its main suppliers to adopt the same information systems and technologies, and they in turn made the same request to their suppliers. Note that in this example, the suppliers were required to make investments in the structure. The benefits for the buyer seem to be greater in the short and medium term, although in the long term, these costs may be offset by the willingness of the multinational to buy more, establish new contracts, and/or pay more for the services provided. In supplier operational integration, IT was found to affect cost efficiency and delivery performance for the buyer, while in customer operational integration, it also positively impacts delivery efficiency for the buyer, but does not help reduce costs for the focal company. The reason why the delivery performance improves significantly for both is due to the information exchange that is supported by the sound procedures shared and analyzed in the supply chain, thus reducing the bullwhip effect. Having said that, we can consider that the use of IT in cross-organizational tactics increases the speed and accuracy of the supply chain.

Other study has suggested that the impact of IT, under certain conditions of industry concentration and demand uncertainty, can vary firm boundaries [28]; that is, when demand uncertainty is high or industry concentration is low, IT is associated with a decrease in vertical integration. In fact, the increase in vertical integration in these scenarios may increase coordination and production costs, and in these environments, less integrated firms invest more in IT to coordinate with specialized firms. On the other hand, when industry concentration is high or demand uncertainty is low, IT is associated with an increase in vertical integration, which is actually due to the fact that vertical integration may decrease coordination and production costs; in these environments, integrated firms invest more in IT. Another argument is that in conditions of uncertainty in demand and unstable competitive environments, IT is associated with a reduction in vertical integration, since companies, trying to maintain flexibility, reduce commitments in specialized assets. At this juncture, IT offers the ability to coordinate with different external partners [29]. In opposite situations, in concentrated environments with predictable demand, IT can be associated with increased vertical integration, thanks to firms using IT to coordinate

activities within the firm in order to increase revenue and capture added value. Similarly, these observations contribute to explanations of the different behaviors of B2B (business-to-business) exchanges, which are also influenced by industry environments [28]: when demand uncertainty is high, firms are more likely to adopt B2B electronic exchanges and coordinate with suppliers and customers; this idea is shared by Hoffman [30]. On the other hand, in more concentrated environments, such as in the chemical industry, B2B exchanges are used to coordinate activities with business partners with whom there are ongoing relationships [31].

Another analysis that was done verified the use of IT as a way to complement or replace vertical integration in the hospital sector and at the country level. It was observed in the hospital sector that without there being competitive pressures from the private sector, nonprofit organizations are more prone to inefficient operations. In this panorama, it is shown that IT improves the degree of efficiency in production by being a substitute for other factors, among them medical capital and labor in IT [32]. In other words, there has been a shift towards computational distribution, where each department is in charge of data entry and some IT processing responsibilities; in other words, it is now the doctors who enter the data into the computer and have a more participative use of the IT tools. At the country level and based on production theory, it was analyzed that IV (vertical integration) has positive impacts on production, and therefore on production efficiency. It was also observed that the relationship between IR and IT can be complementary or substitutable [33].

Within the red cluster, we observed studies of IT performance and studies of IT investments: using the contingency theory that speculates on the alignment among "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 related to IT spending. These results are in line with those of Dewan [35], who found that more coordination-intensive firms, such as vertically integrated ones, have a higher demand for IT, and with those of Barney [36], that IT may result in positive effects on performance [37].

Turning to the impact of IT investment on a firm's return and financial performance risk, we reported that IT investment increases the firm's risk; however, the fact that IT interacts with the frontier strategies increases the return and decreases the risk margin. That is, a company can make an investment in IT and increase the company's risk, but if it combines this investment with the integration or not of its processes, the company's risk can be minimized; more specifically, the manager should align his IT investment with the costs of internal vs. external coordination, to check whether it is more rewarding to integrate or to disintegrate [38].

3.2.2. Cluster Focused on Innovation

In this cluster, the topic of the impact of innovations is addressed. A first point is the following question: how do the challenges faced by external innovators affect the results of the focal firm? To answer this question, it is suggested to distinguish components from complements: components are the inputs received from suppliers; complements are the offerings that are bundled to the focal firm's product, for example, a firm producing computers and printers receives chips to manufacture the computers, and that is a component. A complement is the printer. The focus is on the effect of the challenges of components and complements that arise during technology transitions, with a vertical integration strategy being in place. It is proposed that when contracting suppliers for component innovation, the focal company presents two types of uncertainty: technological uncertainty, which consists of not knowing if and when suppliers will discover the appropriate solutions to the problems of the innovation; and behavioral uncertainty of if and when suppliers will behave opportunistically in order to renegotiate agreements and redefine terms in their favor. It was found that, as technology cycles advance, technological uncertainty is resolved and reduces; however, it is not imperative that the same happens with behavioral

uncertainty. The existence of a possible balance between these two uncertainties will tend to be established at the end of the technology cycle [39]. Having said this, it is argued that the benefits of vertical integration should increase throughout the technology life cycle, an idea supported by Argyres and Bigelow in (2007) [40] and Novak and Stern in (2008) [41], after studies carried out in the automobile industry. In fact, the upstream and downstream obstacles of a focal company reveal major differences in the company's ability to create value with its offering. The upstream component challenges prevent the firm from offering its innovation to the market, while the downstream complementary challenges prevent the focal firm's customers from using the innovation to its full potential. While these challenges result in bottlenecks to value creation, they have distinct effects on the firm's ability to capture value and create competitive advantage [39]. This finding supports calls in the literature on understanding the dynamics of value creation [42,43].

In a second point, the analysis of innovation in the context of companies of different sizes was verified. A huge discrepancy was observed between SMEs (small and medium enterprises) and GEs (large enterprises). In fact, regarding the current and future methods related to the supply chain, there is a significant difference in the adoption of these methods, by SMEs, which may translate into a loss of efficiency of transactions in relation to large companies. Thus, there seems to be resistance from SMEs when it comes to evolution and change, reflecting in a lag in competitiveness due to supply chain efficiency. This resistance to change creates a huge gap between these two types of companies, since almost all planning and control methods are electronic. This indifference to technological issues provides a competitive advantage to EGs, which by adopting technological methods are able to reduce transaction costs and introduce new and improved methods of processes and materials [44]. The advantage of SMEs in being smaller and therefore more flexible is diminished by the fact that technology can overcome some barriers and create new opportunities. EGs are moving their business processes to retailers—home shopping—and electronic shopping to the market [45]. A final point on the issue of technology in SMEs is that they do not necessarily need to own the technology, and through networking and resource sharing, the cost of acquiring the technology can be minimized.

A third point was that of the impact of innovation in a context of a complex, interdependent, and communicative global society where cooperation and coalitions between companies inevitably play an important role. It has been shown that in environments of technological change and uncertainty, firms disintegrate and form alliances [46].

Finally, it was verified why specialized and industry-integrated firms remain in the face of innovations in industries. Contrary to the literature (which suggests that firms go through cycles of integration and disintegration), this study explains that firms prefer to remain vertically integrated and take profitability losses when low-cost firms produce the same product as them, especially in industries characterized by successive innovations [15]. Integrated firms expect compensating profits from further innovations and preferentially bear the losses of maintaining their integrative capabilities, even in the knowledge that they will earn less profit. Often, vertically integrated firms end up deciding to put pressure on prices as a way to resist the low prices charged by specialized firms. The analysis also suggested that these two types of firms (integrated and specialized) are more likely to exist in industries of repeated innovations than in industries with a lower number of innovations; however, there are examples of integrated firms in either high or low innovation intensity industries [15]. Another important reflection is that integrated firms, because they have developed large integrative capabilities, are more likely to develop innovations than specialized ones in an industry associated with high rounds of technological innovations [47]. Indeed, when the sunk costs of developing integrative capabilities are high and innovations occur frequently, firms remain integrated over time. Qian et al. (2012) [48], found that diversified firms, which have likely developed integrative capabilities by operating in several businesses, are likely to enter another vertically integrated industry and overcome barriers to growth after market entry.

3.2.3. Cluster Focused on Processes

Regarding processes, studies have been witnessed that emphasize that to achieve effective cooperative relationships, both suppliers and buyers must make mutual sunk cost commitments with a view to a long-term partnership of win–win business relationships [49]. Empirical studies indicate that the adoption of a general IT system does not result in increased performance, and that instead of developing an electronic platform to support an "electronic marketplace", an "electronic partnership" should be realized, where the IT system implemented is relationship-specific: specialized in the practices of the relationship, which supports exchange with partners as if it were a mutual commitment. A long-term partnership is achieved by employing a superior mode of governance of electronic integration, which reduces transaction costs and earns relational rents through mutual commitments of sunk costs. As suggested by Dyer and Singh (1998), partnerships devise relational rents as they move their relationships away from markets. This relationship-specific IT system, in addition to entailing the mutual commitments with suppliers and retailers, also acts as a 'strategic hostage that supports economic exchange [49]. In other words, it is like an economic guarantee that protects the contractual parties against the possibility of opportunistic contractual hold-up problems. Such a type of system therefore replaces the management hierarchy by serving the joint functions of improving information processing and mitigating opportunism [49].

Another analysis taken from the datasets with focus on processes, was the one applied to a model with perfect competitiveness scenario, where it was hypothesized that internal organizational effects can have significant consequences at the industry level, unlike the strategic and collusive interactions (agreement between parties to harm third parties) between firms that dominate the global economy literature. The stated model provides an explanation for heterogeneity (coexistence of integration and non integration) in firm performance and shows the industry response to demand or technology shocks: If there are positive technological shocks, and elastic demand increases (demand variety increased), it is more advantageous to be integrated due to market trade-offs. However, if supply increases, firms may even disintegrate if the price falls too low; this is because reorganization can substantially absorb the aggregate benefit of technological improvements. However, a firm that benefits from significant changes in technology need not reorganize depending on integration decisions [50]. At the same time, it illustrates how market forces can be determinants in organizational design. This industry equilibrium model is based on a major trade-off between non integration and integration. Non integration is strong in internalizing private costs and weak in coordinating decisions; integration has the opposite strengths and weaknesses. Another important theory is that of the profitability of integration when prices are high: when demand is higher, the equilibrium price increases, the output generated is higher, and under these conditions, the tendency to integrate increases because the costs of failing to work are high. On the other hand, at low prices, it is more profitable to specialize [50]. Taking into account welfare, the study shows that consumers have a preference in organizations that make and sell their products (preference for integrated firms), an influential thought indicates that competition in the product market should ensure efficiency of results: firms that do not sell their products at the lowest possible cost, regardless of their reason, will be overtaken by those that do [50].

The nature of the participants' network is also important for studying the processes; related to this theme, it has been observed that the nature of the participants' networks dramatically shapes the outcomes of technology transfer. The manner in which participants are able to share knowledge and information, the choice of coordination devices, and the degree of trust within the network influence the volume of exchanges of technological flows in the program. It was emphasized that the collective construction of knowledge within a network is an important factor of the diffusion of innovative ideas and principles of a project. This joint construction accelerates the process of validation and testing of novelties and the discovery of new fields of application. This process requires that each participant has a substantial level of absorption of the network's knowledge and a considerable

capacity to analyze, interpret, and transmit the new knowledge. The intensity of knowledge transferred in the network is influenced by the cognitive capacity of the network elements. The properties of the structure of the organization of each element in a project (existence of vertical links, degree of decentralization of decision-making and specific incentives to favor technological transfer) condition the stimulus of new ideas for fertilization among the various branches of activity of the company [51]. The contractor's elasticity to modify its organization and deal with new technical resources is also crucial. For a transfer to be successful, it must be aligned with more commercial characteristics in terms of quantity, price, and deadline, so that they are able to move their expertise from complex products to production programs. With the advent of economic transfer, the objective of companies is changed from maximizing the technical capability of a product's performance to maintaining costs.

In this range of articles, we looked at examples of the processes applied to railways and haulers in Europe. Focusing on efficiency, the performance of European railways was analyzed—testing for gamma economies, which result in a higher level of efficiency. The analysis was to find out whether joint production is more efficient than separate production. Gamma economies occur when there is a decline in total production costs with the addition of product variety—for example, a pizza factory already has cooks who make pizzas and graphic designers who produce the boxes and designs; if the factory adds more products such as pasta or salads instead of just pizzas, it achieves gamma economies. In relation to this issue, it was noted that integrated firms are relatively more efficient than virtually integrated firms and that the reason for this is the existence of a capable manager who generates productivity advantages, i.e., gamma economies [52].

For example, in the European carrier sector, it is suggested that many carriers in Europe integrate vertically because they do not achieve economies of scale; researchers propose that efficiencies are achieved through contractual means and hybrid forms, and that firms integrate due to the adoption of public policies that promote integration [53].

3.3. Trends in Key Concepts in Recent Years

This study assesses the temporal change in key concepts from the year 2000 to the present day. By once again using the VosViewer tool to map all concepts in our sample, the authors were able to identify the main themes and key concepts of the publications from a time perspective. In fact, it is observable in Figure 11, that the interest of the literature has been moving between concepts and that in the defined time period the terms that have been the subject of study the longest are those focused on the theme of processes, among which the concepts of strategic planning and product development stand out. Likewise, it is witnessed that in later periods, the focus ceased to be centred on processes to be conducted on information technology, which gained increasing popularity as of the year 2008. Finally, in a more recent phase, the literature portrays the theme of innovation, an area that in our subject matter gained enormous relevance, after having ascertained the other two themes.

Finally, we can summarize the main implications for theory and practice regarding vertical integration in technology into three main themes: IT integration, business innovation, and process innovation. These three topics are well related and integrated; according to Helfat (2016)'s perspective, in their research, IT integration is creating new business opportunities through new business models and embedded technology. It is also relevant to mention that the study allows one to understand that in line with Adner (2010), IT vertical integration permits companies to diversify their business and create economies of scale. From a practical and enterprise perspective, companies face relevant challenges and opportunities, in particular:

- Cloud integration: companies are moving their data and applications to the cloud and integrating them with their existing systems for improved efficiency and scalability.
- Internet of Things (IoT): with the rise of IoT devices, companies are integrating them into their existing systems to collect and analyze data for improved decision making and operational efficiency.

- Artificial intelligence (AI) and machine learning (ML): AI and ML technologies are becoming more prevalent in vertical integration, allowing companies to automate processes and make data-driven decisions.
- 5G network integration: 5G networks are enabling new possibilities for vertical integration by providing faster and more reliable connectivity, enabling real-time data transfer and remote operations.
- Blockchain: Blockchain technology is becoming increasingly integrated into various industries for secure and transparent data management and supply chain tracking.

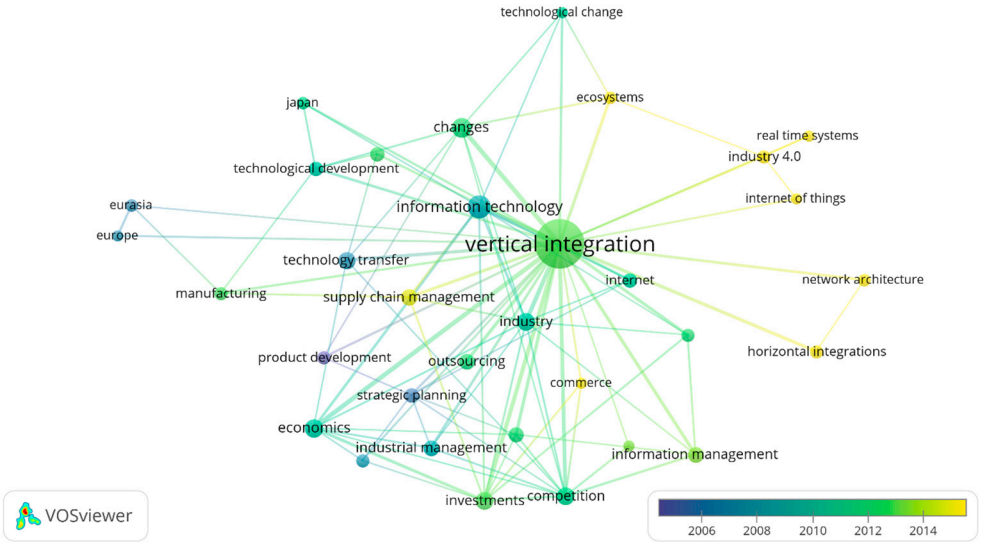

Figure 11. Visualization over time of the occurrence of the keywords.

These implications demonstrate the increasing importance of vertical integration in technology and the role it plays in driving business growth and competitiveness.

4. Conclusions

The topic of vertical integration associated with technologies has been the subject of attention in the scientific literature, as we can see in this integrative review, which shows that in the last 22 years, this topic has been studied regularly and increasingly in recent periods. Ideas such as information technology, innovation, and processes were explored in a study that was found to be longitudinal and covered different foci. This review proved to be an effective method, which allowed for the collection, selection and summarizing of a set of evidence revealing the proposed objective.

In short, companies benefit from engaging in information exchange, which improves delivery performance, and in operational integration, as a complement to each other. However, it was observed that there are more benefits for operational integration with suppliers than with buyers, as in the former case, integration leads to a reduction in costs for the focal firm, and in the latter case, this does not happen. It was also found that industry concentration and uncertainty in demand are relevant factors that managers must take into account when reflecting on integration tactics and the impact of investments in IT, since this investment results in an increase in the company's risk; however, if well aligned with the costs of internal vs. external coordination, these investments reduce the risk margin and increase the company's return. Likewise, another factor that influences vertical integration is innovation cycles, where it was found that when these cycles are recurrent, integrated companies are generally leaders in product innovation, and that contrary to what the literature suggests, if companies have developed integrative capabilities, they find it more viable to remain integrated and bear the profitability losses when competing with specialized companies, rather than disintegrating.

Author Contributions: Conceptualization, P.N. and L.P.; methodology, P.N. and L.P.; software, P.N. and L.P.; validation, P.N., A.D. and R.L.d.C.; formal analysis, P.N. and L.P.; investigation, P.N. and L.P.; resources, A.S. and A.D.; data curation, P.N. and L.P.; writing—original draft preparation, L.P.; writing—review and editing, P.N. and L.P.; visualization, L.P.; supervision, L.P.; project administration, A.S.; funding acquisition, L.P. All authors have read and agreed to the published version of the manuscript.

Funding: This work was supported by Fundação para a Ciência e a Tecnologia, grant UIDB/00315/2020.

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: https://github.com/pmsna-iscteiul/VerticalIntegrationDynamicstoInnovatein~TechnologyBusiness.git (accessed on 5 December 2022).

Conflicts of Interest: The authors declare no conflict of interest.

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