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# Business Decision-Making and Complex Thinking: A Bibliometric Study

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**Abstract:** Complex thinking is an important tool for effective decision-making, as it helps people to better understand uncertain situations by considering the multiple variables and relationships involved in a situation, thus being able to identify patterns and connections that would not otherwise be evident. This article presents the results of a bibliometric study to identify academic publications that consider the correlation between decision-making in the business area and complex thinking competency and its sub-competencies. The intention was to have a theoretical horizon that provides a complete overview of the current academic situation regarding the correlation of both professional skills to identify areas of opportunity for new studies. Methodologically, we conducted a literature review using Scopus and Web of Science databases under the PRISMA (Preferred Reporting Items for Systematic reviews and Meta-Analyses) protocol from which a sample of 339 articles related to both topics was obtained. R, Rstudio, and Bibliometrix were used for the quantitative analysis of the data. The results showed an academic tendency to associate decision-making in business with critical thinking, paying little attention to the other sub-competencies of complex thinking. Furthermore, we found a concentration of research in specific universities and countries, repeating a tendency to study only a few sub-competencies. Overall, this work sheds light on the broad opportunity to link the complex thinking macro-competency with decision-making in business, to provide more extraordinary skills and tools to future professionals.

**Keywords:** professional education; educational innovation; future of education; complex thinking; business decision-making; higher education



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## 1. Introduction

Knowing how to make good decisions is fundamental for any professional. Making choices and decisions in the face of problems and challenges that are experienced daily can involve superficial issues as well as those with high organizational impact (Arend 2022). Therefore, universities pay much attention to training skills associated with decision-making, considering various pedagogical and didactic techniques that help students make better choices. Game-based learning, case method, and challenge-based teaching are just a few examples of tools that educational institutions adopt to develop better decision-makers (Hallo and Nguyen 2022).

Logically, knowing how to make good decisions implies a broad perception of reality. The acquisition and development of competencies such as complex thinking are highly valued because they require diverse skills that combine knowledge, processes, and attitudes relevant to rational choice (Tobón and Luna-Nemecio 2021).

Decision-making and complex thinking are closely related. Complex thinking refers to the ability to analyze and understand situations involving multiple variables and dynamic relationships between them. This way of thinking involves a deep understanding of complex systems and an appreciation of the interconnectedness between the different parts.

Complex thinking brings together the sub-competencies of systems, critical, scientific, and innovative thinking, which allow the individual to develop integrative reasoning toward the environment, impacting how they face challenges, solve problems and, therefore, make decisions (Cruz-Sandoval et al. 2022).

When it comes to decision making, complex thinking can help people better evaluate options and make more informed decisions. By considering the multiple variables and relationships involved in a situation, patterns, and connections can be identified that would not otherwise be evident. Complex thinking can also help people understand the long-term consequences of their decisions and consider how they may affect other parts of the system in which they are making decisions. This can help avoid short-term decisions that may have negative long-term consequences (Arend 2022).

In this sense, the present study is original and valuable, since, with the intention of having a clear theoretical horizon with a comprehensive view of previous studies that correlate decision-making in the business area with complex thinking, this article reports the results of bibliometric research identifying academic publications that have considered this relationship to date. This text includes a quantitative analysis of scientific papers published in the SCOPUS and Web of Sciences databases to argue for future studies that associate both skills. As a first step, a theoretical investigation was carried out to provide a frame of reference for the situation. Then, the PRISMA (Preferred Reporting Items for Systematic reviews and Meta-Analyses) protocol was executed, with which a sample of 339 articles related to both topics was obtained. Subsequently, an analysis was performed with the use of the computational tools R (R Core Team 2017), Rstudio (RStudio Team 2022), and Bibliometrix (Aria and Cuccurullo 2017). From these steps, the study presents valuable results attached to the stated objective.

## 2. Theoretical Framework

### *2.1. Decision-Making in Business Training*

In the mid-twentieth century, Barnard imported the term "decision-making" into the business world. The introduction of this phrase changed how managers conceived their roles and stimulated greater motivation for conclusive actions. "Deciding" implies the end of deliberation and the beginning of an effort (Barnard 1968).

From this period onwards, Barnard, March, Simon, and Mintzberg laid the foundations for the study of decision-making (Hochbaum and Levin 2006). One of the most influential theories to emerge from this period is known as the Theory of Bounded Rationality, which states that people, due to their cognitive, informational, and time limitations, make decisions partially irrationally. In this model, it is argued that people use heuristic algorithms to find solutions, defined as simple and straightforward rules that are useful for solving problems (Hochbaum and Levin 2006). However, even though applying these heuristics may generate reasonable solutions, they may also produce cognitive biases, i.e., systematic deviations in reasoning. In many cases, these deviations may be due to how decisions were made: for example, alternatives were not clearly defined, adequate information was not collected, and costs and benefits were not accurately weighed (Robbins and Judge 2009).

For executives, whose success depends on the many decisions they make daily, trying to avoid the errors contained in these heuristic methods becomes fundamental; the systematization of decision-making is a necessary task. That is, while decision-making can be seen as the "simple" act of choosing one from a set of many alternatives, the choice must result from a systematic and efficient process (Becker 2016).

Simon (cited by Robbins and Judge 2009) states that, in practice, decision-makers choose a "good enough" alternative rather than the optimal one. For Simon, it is necessary to reduce the number of dimensions contemplated in the problems to improve understanding and speed up the decision-making process, accepting that choosing an alternative does not maximize the proposed goal. One of the great difficulties that Simon establishes in his theory of bounded rationality is that decision-making implies that the decision-maker knows all the results of the proposed alternatives in an environment of certainty and

even knows all the possible options. However, nowadays, managers and/or directors of large companies and organizations are forced to decide in the face of a large amount of information under conditions of uncertainty and risk. This is why rationality assumptions are rarely used. Even if the environment presents an atmosphere of certainty, the premises may contradict each other (Robbins and Judge 2009).

According to Robbins (Robbins and Judge 2009), the decision-making process consists of the following steps:

Identify a problem.
Identify decision criteria.
Assign values to the criteria.
Develop alternatives.
Analyze the alternatives.
Choose an alternative.
Implement the alternative.
Evaluate the effectiveness of the decision.

Even when the diagram appears simple, decision-makers (individually or in groups) find it difficult to systematically process and evaluate the relevant information. For Robbins (Robbins and Judge 2009), this analysis involves confronting different ways of assessing the outcomes of the alternatives under consideration. Each decision-maker must prioritize the main objective of the problem at hand. If more than one individual is involved, the priorities of the decision-makers involved may conflict, increasing the difficulty and complexity of the decision-making process. Group decision-making aims to find a collective solution to a decision problem based on the preferences (or opinions) expressed by a set of decision-makers (Hochbaum and Levin 2006). In general, decision-makers' preferences may differ considerably because they come from different fields with different backgrounds and knowledge interests.

Without a formal process for evaluating alternatives and priorities, there may be inconsistencies, variability, or lack of predictability about the importance of a factor or criterion. Any of these reasons can lead to a loss of credibility and legitimacy of decision-makers. Thus, new areas of research emerge in Decision-Making: on the one hand, group decision-making, and on the other hand, multi-criteria decision theory (Hallo and Nguyen 2022). Operations research has developed various approaches and methods to help people (and organizations) systematically structure and evaluate problems associated with operations research, making it possible, at least in theory, to arrive at preferable solutions in complex environments (Becker 2016). In practice, however, the usefulness of these decision-support methods and tools is often limited by the decision-makers' skills, particularly the understanding and complexity of the mathematical equations behind each model (White et al. 2016). If those applying a tool do not understand the characteristics of effective decision-making or if some constraint or feasible alternative is overlooked in the decision-making process, then even technically optimal choices based on appropriate alternative assessments would result in suboptimal decisions (Siebert and Kunz 2016).

A fascinating situation is that, although all people make decisions daily, the vast majority of people do not possess sufficient skills when faced with problems that are not well structured. Hammond et al. (2015) state that most people never formally learn to be effective decision-makers. Furthermore, they add that few people know how their decision-making is biased and deviates from the basic principles that characterize good decisions. Even though decision-making has been studied for decades by researchers from different disciplines, and there is a normative perspective on the prescriptive analysis to differentiate when a decision is right or wrong, people and organizations seem to omit this systematic procedure (Spetzler et al. 2016).

Robbins (Robbins and Judge 2009) state that to systematize the decision-making process, the decision-maker should proceed rationally, objectively, and logically with clear and specific goals. This is one reason executives choose an alternative based on a single objective (Aznar and Guijarro 2012). However, a company facing real problems

must select an option considering several objectives simultaneously. Thus, in this new millennium, multi-criteria decision theories have significantly grown in various fields (Mardani et al. 2015).

On the other hand, technological changes, the speed of knowledge transfer, massive volumes of information, and in general, all the characteristics of the VUCA world (volatile, uncertain, complex, and ambiguous) have changed the business environment and consequently, the needs of the labor market (Goos et al. 2019; LeBlanc 2018). Organizations want people who can learn by themselves and who possess the capacity to update their knowledge so that their skills do not become obsolete. In addition, they need people who can interpret reality and make good decisions, i.e., possess complex reasoning skills, systematize their decisions, and learn from their mistakes (van Laar et al. 2020). The real challenge is to create flexible organizations that can adapt quickly to changes in the business environment and to the wishes of consumers, and where each employee can expand their knowledge and make the right decisions (Sattar 2016).

The business environment is constantly changing, becoming more dynamic and less predictable than in the past (Papulova and Gazova 2016). Employees in an organization are confronted with various new situations every day. To solve them, they act more instinctively, trying to establish relationships and seeking to make connections with similar cases that have occurred in the past (Koudstaal et al. 2019). Not many companies have employees with sufficient skills to cope with these new conditions. A range of competencies will be fundamental in the 21st century, including learning-to-learn skills, openness to new ideas, critical thinking, problem-solving, information search and selection, reasoning-for-complexity, and self-direction (Almeida and Simoes 2019).

Despite efforts to promote new methodologies in universities, the gap between industry needs and recent graduates' competencies is widening (Sun and Song 2018). This is why in the last two decades, the use of more active methodologies that place the student predominantly as the constructor of their own learning has been more widely used (Vergara et al. 2020). Within these active methodologies, the use of simulators and serious games in teaching has a special place. Since the previous decade, game-based learning (GBL) has gained enormous popularity. This popularity is associated with its multiple benefits as a teaching-learning strategy, such as the possibility to modify behaviors, develop engagement, and generate learning (Dichev and Dicheva 2017). One of the enormous advantages of this educational technique is its ability to motivate people to spend many hours developing skills and acquiring knowledge voluntarily (Bond et al. 2020). Many studies highlight the various benefits of using this teaching technique: games promote continuous learning, increase comprehension, improve retention time, participation and engagement, student collaboration, and increase understanding, among others (Boskic and Hu 2015). In addition, Sailer and Homner (Sailer and Homner 2020) point out that games have the potential to generate meaningful learning in students.

Serious games have been used to develop and strengthen essential learning skills. Lopez-Sanchez & Gonzalez-Lara (López Sánchez and Lara 2020) used a serious game to enhance mathematical and logical reasoning in upper-secondary students. Rosenthal and Ratan (Rosenthal and Ratan 2022) claim that knowledge acquisition positively relates to game progress. Pacheco (Pacheco-Velazquez 2022) states that using serious games with an appropriate level of complexity can favor critical thinking, decision-making, and reasoning for complexity. This statement is supported by Gurbuz and Celik (Gurbuz and Celik 2022), who add that serious games offer great potential to develop future skills, among which they cite problem-solving, collaboration, and teamwork. Furthermore, they point out that this methodology is the basis for self-directed learning.

In this fast-changing environment, few leaders are capable of leading effectively. Moreover, leaders must act with incomplete or insufficient information, with little time to reflect and reason about the complexity of different systems. They are forced to operate with a limited understanding of events and their meanings (Arend 2022). Establishing teaching methodologies that prepare students to face challenges, analyze options, decipher the differ-

ent variables involved in problem-solving, and set systematic parameters on the suitability of their decision-making, is undoubtedly one of the main tasks of universities. Given this, creating relevant games and scenarios could be highly favorable to generate leaders who face this critical period and turn risks into opportunities (Hallo and Nguyen 2022).

### 2.2. The Competency of Complex Thinking

We understand complex thinking as the competency acquired by individuals that allows them to develop a holistic vision of the world, enabling them to carry out cognitive analyses and syntheses to face challenges and solve problems (Vázquez-Parra et al. 2022a) For Morin (Morin 1990), complexity should be understood as the need to comprehensively understand the context, consider the multidimensionality of reality, and integrate all the elements of a perceived phenomenon or situation. Unlike concrete thinking, which fragments reality, complex thinking incorporates all the elements, adding up the parts and recognizing their interaction and interdependence (Hiver et al. 2022). Thus, complex thinking considers 4 types of reasoning or sub-competencies: critical thinking, innovative or creative thinking, systemic thinking, and scientific thinking (Vázquez-Parra et al. 2022b).

Systems thinking refers to the ability to analyze problems integratively, considering inter- and transdisciplinarity, appreciating the interconnectedness of reality, and considering its complexity and the multiple elements that comprise it (Jaaron and Backhouse 2018). Critical thinking is a skill that allows individuals to evaluate the validity of reasoning to make their own logical judgments in a situation or problem, rethinking existing paradigms in terms of current affairs (Cui et al. 2021). For its part, scientific thinking involves problem-solving with vision and objective, validated, and standardized methods that address reality through structures of inquiry and research based on concrete evidence. It allows the individual to solve the challenges of the environment through various cognitive processes, such as inductive and deductive reasoning, and the formulation and testing of hypotheses (Suryansyah et al. 2021). Finally, innovative thinking (or creative thinking) considers mental processes of search and discovery that allow the person to position the problem, visualize it from different angles and perspectives, and come up with original and feasible solutions (Zhou 2021).

These sub-competencies support the categorization of complex thinking as a general competency, i.e., it is linked to knowledge, skills, and attitudes relevant for any person, as it enables decision-making and problem-solving (Drucker 2021). Critical thinking, problem-solving, communication, collaboration, creativity, innovation, intercultural skills, productivity, responsibility, and leadership comprise the complex thinking skills indispensable for decision-making in any professional field (Koerber and Osterhaus 2019).

### 2.3. Bibliometric Studies

There is no doubt that academic publication is a natural and necessary part of any research process since, without proper documentation and dissemination of knowledge, findings, and discoveries would have little impact, losing much of their meaning (Donthu et al. 2020). Therefore, in recent decades there has been exponential growth in scientific production, strengthening areas of study of high academic interest and making visible disciplines that have been little studied and remain exploratory research sectors (Donthu et al. 2021).

Much of this development and mass production of scientific knowledge is due to information technology, which has opened up more opportunities for the various channels and tools of scholarly communication to reach more people, regardless of distance, location, or socio-demographic conditions (Moral-Muñoz et al. 2020; Orhan 2022) Logically, this socialization of science has occurred in both directions. Just as access to journals and academic articles is becoming more commonplace, opportunities are also opening up to expand scientific production, requiring the processes of submission, review, and publication in prestigious journals to be more efficient (Goyal and Kumar 2021).

In this sense, with the increase in scientific production and publication, the need arises to develop an area of study that measures the progress of the generation of academic knowledge, developing indicators that provide an objective assessment of the documentation of science (Castaño et al. 2022). Although bibliometric studies are not new, they take on new meaning in responding to this need, becoming relevant when providing information on the progress and direction of academic literature (Gaviria-Marin et al. 2019). A bibliometric study becomes the scientific area where quantitative analyses of the literature produced on a topic or study area allow us to appreciate what has already been researched and the potential for additional research. It considers the authors, their institutions, and the countries where they reside (Forliano et al. 2021). In general, bibliometrics with academic analysis provides a broad view of the current state of scientific knowledge on specific topics, allowing us to appreciate the advances made and the areas of opportunity for future research (Vázquez-Parra et al. 2022b).

For improved accuracy, bibliometrics is usually based on selecting databases that, due to their prestige, impact, or visibility, can spotlight the relevance of particular articles (Ye et al. 2021). Unfortunately, in very broad or highly productive areas of study, it is not feasible to guarantee the exhaustiveness of bibliometric studies, which, from the outset, must state their scope, level, and categories of analysis (Yaldız and Bailey 2019). Although bibliometric studies allow analyzing a large number of documents, the inclusion of all of them cannot be guaranteed (Cebral-Loureda et al. 2022).

In this sense, this text aims to present the results of a bibliometric study focused on identifying existing academic articles that consider the correlation between decision-making in the business area and complex thinking and its sub-competencies. The study is limited to the SCOPUS and Web of Sciences databases as sources for our analyses.

## 3. Materials and Methods

For this study, we conducted a systematic literature review in SCOPUS and Web of Science (WoS). These are considered databases with the most impact and relevance in the scientific and academic fields (Vázquez-Parra et al. 2022b). As a methodology, the systematic literature review (SLR) allows responding in a timely, accurate, and impartial way to the questions and/or hypotheses that guide particular research, avoiding biases and spurious analyses (García-Peñalvo and Ramírez-Montoya 2017). The methodology was executed using the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) protocol. Prisma is based on QUOROM (QUality Of Reporting Of Meta-analyses). However, this has been summarized, renamed, and updated based on conceptual and practical advances in the science of systematic reviews by Moher et al. (2009). The Moher et al. (Damian and Cabero 2022) protocol is characterized by four stages: (i) identification; (ii) screening; (iii) eligibility; and (iv) inclusion. The first stage refers to identifying the publication history of the topic of interest. Screening, however, consists of removing duplicate material from the original search. The eligibility stage refers to specific inclusion and exclusion criteria for the analysis. Examples of this include the type of product desired (books, articles, and conference proceedings, among others), language, authors, and time period. Finally, the inclusion stage refers to all accepted material after a qualitative and quantitative analysis of its content has been carried out. The four steps described above, in turn, pertain to two major actions that serve as a frame of reference: planning framework and action framework. To illustrate the above, Figure 1 is the flow chart of the standardized stages of the PRISMA protocol.

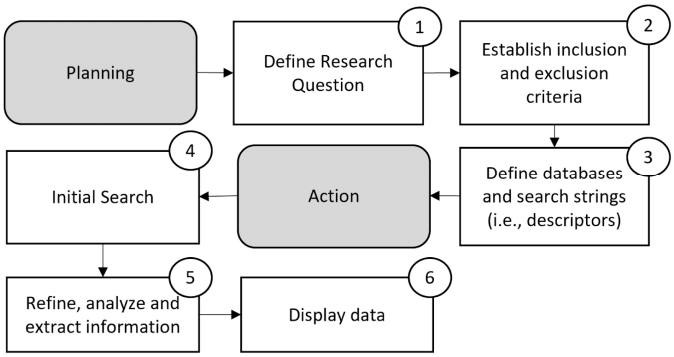


**Figure 1.** Flow chart. Source: Created by the authors.

### *3.1. Research Questions*

This study's research questions aimed to inform all those interested in knowing whether decision-making in the business world at a generational level is associated in some way with the competency of complex thinking. In case decision-making is not correlated with complex thinking (under the understanding that complex thinking is a macro-competency), we sought to determine complex thinking's correlation with meta-competencies (also known as sub-competencies). Table 1 shows the research questions guiding this work. The time frame for the results covered January 1989 to 1 December 2022. The initial date of the proposed time frame started from the first output that considered the relationship between managerial decision-making in business and the macro-competency of complex thinking.

**Table 1.** Research questions and possible answers per dimension.

| Dimension | Research Questions | Possible Answer |
|---|---|---|
| Outreach | RQ1. Do the studies the relationship between business decision-making and the competency of complex thinking? | -Yes<br>-No |
| | RQ2. Do the studies address the relationship between decision-making and the sub-competencies of complex thinking? | -Yes<br>-No |
| Approach | RQ3. To which sub-competency of complex thinking is decision-making in business usually related? | -Scientific<br>-Critical<br>-Innovative/Creative<br>-Systemic |
| Metrics | RQ4. What is the amount of published material on competitive business decision-making? | -Number of publications per year |
| | RQ5. Which institutions have produced the most products on business decision-making related to the complex thinking competency and its sub-competencies? | -University institutions |
| | RQ6. Which countries have the largest number of papers published that address business decision-making with the complex thinking competency or one of its sub-competencies? | -Country |
| | RQ7. What are the main terms or keywords in the studies? | -Keywords<br>-Co-occurrence network. |
| | RQ8. What has been the trend of terms or keywords in the studies over time? | -keyword trend by year. |

Source: Created by the authors.

### 3.2. Inclusion and Exclusion Criteria

Table 2 shows the inclusion and exclusion criteria adopted for this study. It is worth mentioning that the selection of these criteria directly impacts the results and conclusions. Consequently, this process is a critical element of systematic literature reviews.

**Table 2.** Inclusion and exclusion criteria.

| Inclusion Criteria | Exclusion Criteria |
| --- | --- |
| Publications indexed in SCOPUS and Web of Science (WoS) databases. | Publications that are not indexed in the SCOPUS and Web of Science (WoS) databases. |
| Publications contain the following terms in their title, abstract, and keywords: Enterprise, decision-making, complex thinking, scientific thinking, critical thinking, creative thinking, innovative thinking, and systems thinking. | Publications that do not include the following terms in their title, abstract, or keywords: Business, decision making, complex thinking, scientific thinking, critical thinking, creative thinking, innovative thinking, systems thinking. |

Source: Created by the authors.

### 3.3. Descriptores

Table 3 presents the descriptors entered in the SCOPUS and WoS databases. The descriptors were entered in the title, abstract, and keywords criteria.

**Table 3.** Query string parameters.

| Element 1 | Element 2 | Competency | SCOPUS | Web o Science (WoS) |
| --- | --- | --- | --- | --- |
| Decision making | Business | -"Complex thinking"<br>-"Scientific thinking"<br>-"Critical thinking"<br>-"Creative thinking"<br>-"Innovative thinking"<br>-"Systemic thinking" | (TITLE-ABS-KEY (Element 1) AND TITLE-ABS-KEY (Element 2) AND TITLE-ABS-KEY (Competency) | Element 1 + Element 2 + Competency |

Source: Created by the authors.

### 3.4. Data Collection and Analysis

Figure 2 shows the data collection and analysis process from the PRISMA protocol's four phases (identification, screening, eligibility, and inclusion). The figure illustrates the search results for descriptors in the identification phase. In the screening phase, duplicate items were removed. In the eligibility stage, the publications that meet the inclusion criteria described above were considered. Finally, in the inclusion stage, the papers were considered after having conducted a quantitative and qualitative analysis of each per the research questions. In this context, since the products obtained provide answers to one or more research questions, only replicated products have been eliminated and excluded

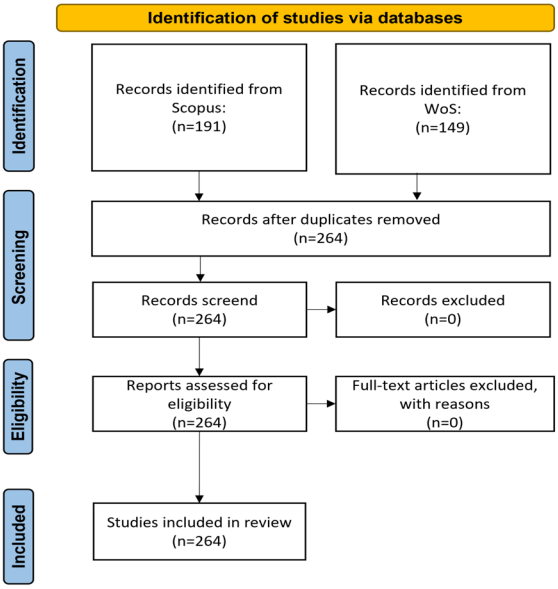


**Figure 2.** PRISMA Review Phases Source: Created by the authors.

### *3.5. Data Representation*

Data processing and representation were carried out through the computational package R (R Core Team 2017) and Rstudio (RStudio Team 2022) the Bibliometrix package, and the Biblioshiny library (Aria and Cuccurullo 2017).

## 4. Results

The results of the bibliometric analysis for each research question are shown below.

### *4.1. RQ1. Do the Studies Address the Relationship between Complex Thinking Competency and Business Decision-Making?*

From the analysis conducted, we found only one study that described and directly associated the terms "business" with "decision making" and the competency of "complex thinking." This study was conducted by Damian and Cabero (2022) of the University of São Paulo (USP), Brazil. In it, the author approached Edgar Morin's (1990) complexity theory to study knowledge management and conscious capitalism. Notably, of the 340 original papers searched in the Scopus and WoS databases, the paper by Damian and Cabero (2022) indexed in SCOPUS is the only one to associate complex thinking with decision-making in business (see Table 4).

**Table 4.** Articles linking business decision-making and complex thinking.

| Search Chain | Database | Publications |
|---|---|---|
| "Business" and "decision making" and "complex thinking" | Scopus (191) | 1 |
| | WoS (149) | 0 |

Source: Created by the authors.

### *4.2. RQ2. Do Studies Address the Relationship between Business Decision-Making and Any of the Sub-Competencies of Complex Thinking?*

As a result of the insufficient literature relating complex thinking to business decision-making, we analyzed the sub-competency level of complex thinking. Table 5 shows the results of published products that relate business decision-making at the managerial level to scientific, critical, systemic, and innovative (or creative) thinking. The table shows that critical thinking was the sub-competency with the most scientific production associated with business decision-making (SCOPUS 126 and WoS 92). It is also noteworthy that the affiliation with the highest number of products related to these aspects is the University

of California, followed by Harvard University, the University of Cape Town, Indiana University Bloomington, and the University of Cape Town Graduate School of Business. On the other hand, the sub-competency associated the least in the published production with business decision-making was the sub-competency of scientific thinking (three products in total). The affiliations addressing this association were New York University, the University of Technology, Sydney, and a Seattle Seahawks sports organization. Something similar was discovered by Costa et al. (2017), when they found a strong concentration of studies associated with decision-making and cognitive aspects in the United States and its universities.

**Table 5.** Articles linking business decision-making and complex thinking sub-competencies.

| "Decision Making" + "Business" + "Sub-Competency" | | |
|---|---|---|
| **"Sub-Competency"** | **SCOPUS** | **WoS** |
| Scientific thinking | 2 | 1 |
| Critical thinking | 126 | 92 |
| Innovative thinking | 9 | 10 |
| Creative thinking | 41 | 35 |
| Systemic thinking | 12 | 11 |
| Total: | 190 | 149 |

Source: Created by the authors.

### *4.3. RQ3. To Which Sub-Competency of Complex Thinking Is Decision-Making in Business Usually Related?*

Complementing the previous analysis, Figure 3 illustrates in a better way the complex thinking sub-competencies with which business decision-making is associated. The figure shows that studies tend to relate more to the sub-competencies of critical and innovative (or creative) thinking. Finally, the published products show a deficit in association with systems and scientific thinking.

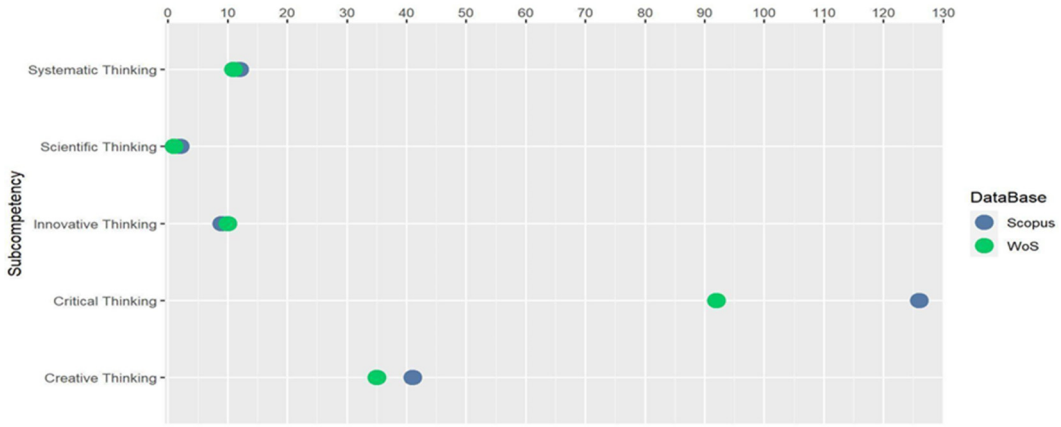


**Figure 3.** Managerial decision-making in business correlated with sub-competency of complex thinking: Search results in Scopus and Web of Science (WoS). Source: Created by the authors.

### *4.4. RQ4. What Is the Annual Production Discovered by the Established Search Chains? (What Is the Amount of Published Material on Competitive Business Decision-Making?)*

Considering that complex thinking is a macro-competency, Figure 4 shows the total annual production of products indexed in SCOPUS and WoS that associate business decision-making with one of its sub-competencies. In general, from 1989 to the present day, the output of studies associating business decision-making with complex thinking or some of its sub-competencies has increased (especially in the years 2004, 2011, and 2017). In this sense, it would be particularly interesting to know the historical contextual factors that caused an increase in production.

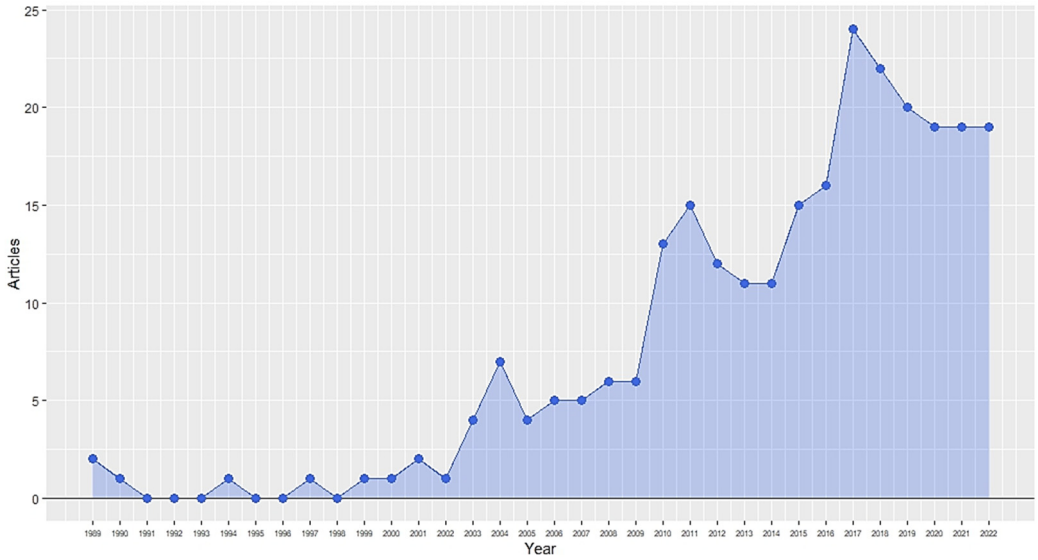


**Figure 4.** Annual Production. Source: Created by the authors.

### *4.5. RQ5. Which Institutions Have Produced the Most Products on Business Decision-Making Related to the Complex Thinking Competency and Its Sub-Competencies?*

The institutions whose production links business decision-making with complex thinking or its sub-competencies are primarily located in the United States, with Georgetown University Medical Center producing the most academic publications with this thematic association. On the other hand, to a lesser extent, the University of Cape Town in South Africa or the University of Maribor in Slovenia had publications on these topics, but not as significant (Table 6).

**Table 6.** Institutions with the highest number of published articles.

| Institution | Country |
|---|---|
| Georgetown University Medical Center | United States of America |
| Harvard University | United States of America |
| James Madison University | United States of America |
| Michigan State University | United States of America |
| Mount Sinai School of Medicine | United States of America |
| Ohio Northern University | United States of America |
| University of Cape Town | South Africa |
| University of California | United States of America |
| University of Maribor | Slovenia |

Source: Created by the authors.

### *4.6. RQ6. Which Countries Have the Largest Number of Papers Published That Address Business Decision-Making with the Complex Thinking Competency or One of Its Sub-Competencies?*

To illustrate scientific production territorially, Figure 5 shows the existing production on business decision-making and its correlation with complex thinking or its sub-competencies by country. The United States had the highest output with correlations of the above-mentioned aspects. This figure shows the asymmetries that exist between countries addressing these issues. As shown, the relationship between business decision-making and complex thinking or its sub-competencies is a topic that, although researched internationally, has not been done homogeneously among countries. These results (Table 6 and Figure 5) are not strange, since there are previous studies that, although they did not focus on complex thinking, did perform bibliometric studies associated with decision-making with similar results, such as Hossain et al. (2020), who found a large part of the concentration of publications in the United States, Europe, and Australia.

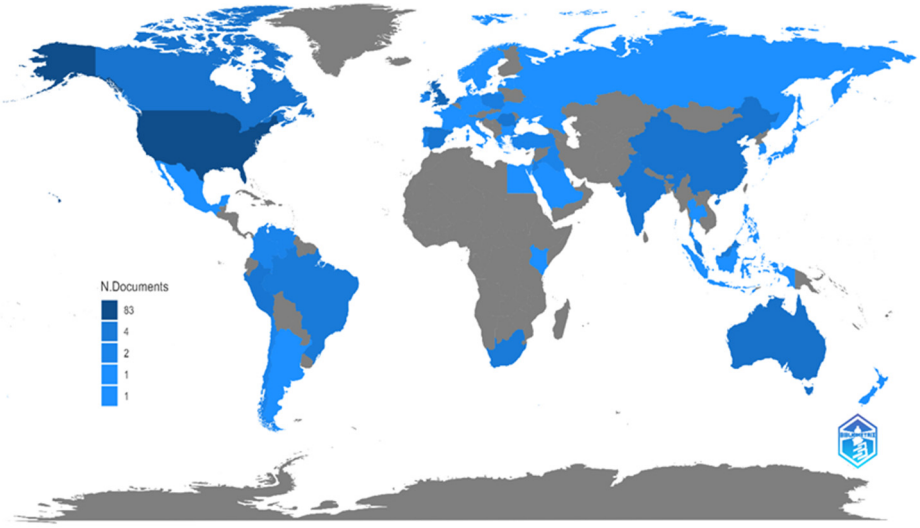


**Figure 5.** Country Scientific Production. Source: Created by the authors through Bibliometrix.

### *4.7. RQ7. What Are the Main Terms or Keywords of the Studies?*

The main terms used in the products dealing with managerial business decision-making and the macro competency of complex thinking are shown in Figure 6. It is possible to observe that critical and creative thinking are the terms with the highest frequency of appearance in topics associated with managerial business decision-making. Similarly, the term referring to the sub-competency of systems thinking is also observed, although to a lesser extent. Likewise, the frequency of the keywords "design thinking," "business students," "business education," and "business schools" stands out. This could mean that the correlation of decision-making terms at the managerial level in business with complex thinking is related to and occurs in higher education training processes.

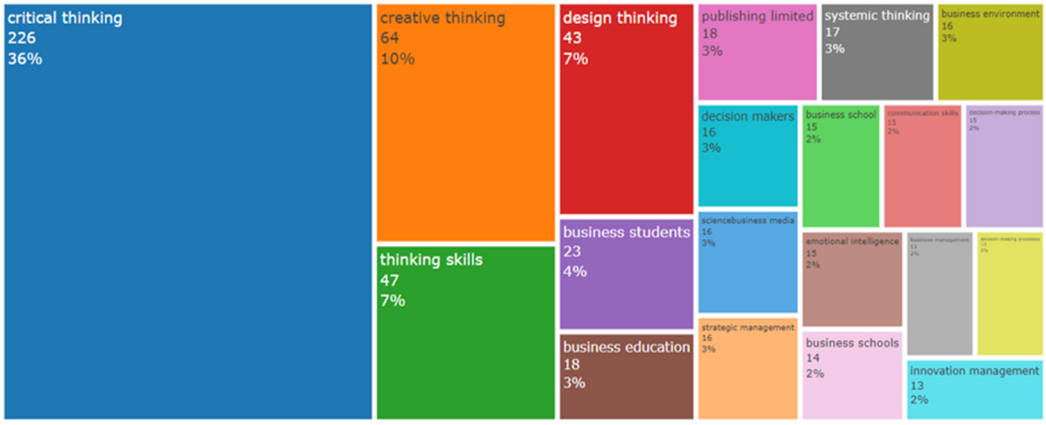


**Figure 6.** Most frequently used keywords in the articles. Source: Created by the authors through Bibliometrix.

It is possible to find that the attention paid to critical thinking (Figures 6 and 7) is such that there are even specific studies on this subcompetency and its relationship with processes associated with decision-making, such as the case of (Tintaya et al. 2022; Nor and Sihes 2022; Castaño et al. 2022; Sudirman et al. 2023).

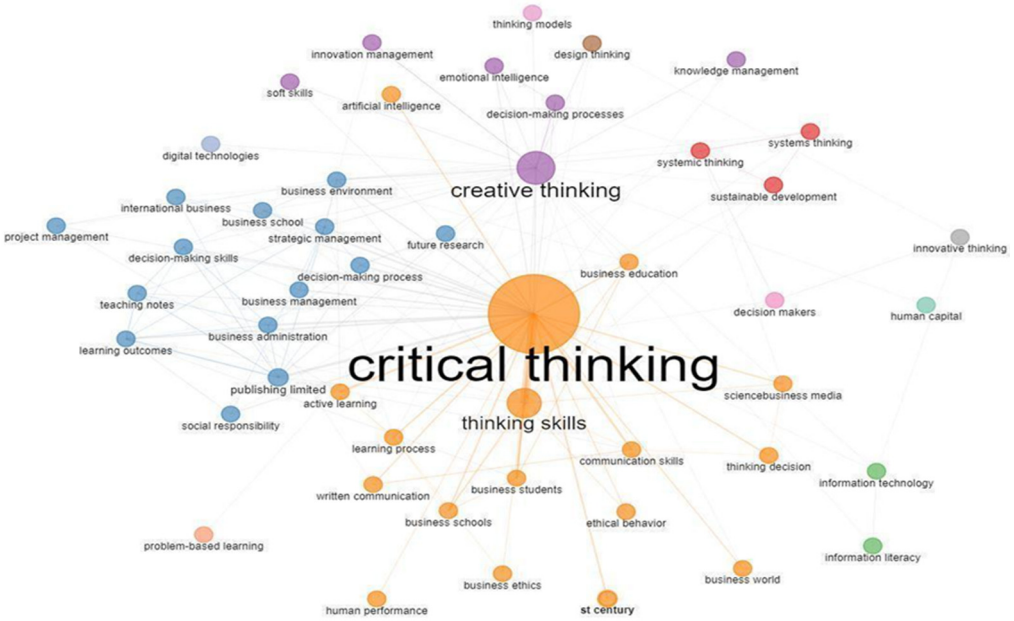


**Figure 7.** Co-occurrence network. Source: Created by the authors through Bibliometrix.

On the other hand, Figure 7 shows the co-occurrence network (i.e., also known as the semantic network), whose purpose is to establish the relationships between the most frequently used terms. The figure shows the sub-competency of "critical thinking" as the central element, with the highest number of interactions with the other words. To a lesser extent (interactions), but importantly, are the nodes of creative thinking and thinking skills. The figure shows that the relationship between managerial and business decision-making and critical thinking is also linked to artificial intelligence. Thus, it could be assumed that mathematical models are being created for decision-making at the managerial level in business.

### *4.8. RQ8. What Has Been the Trend of Terms or Keywords in the Studies over Time?*

Concerning the trend of the primary keywords over the years, 2009 was when products correlating business decision-making at the managerial level with the sub-competencies of complex thinking began to emerge (see Figure 8). Notably, in 2009, the association with systems thinking arose, which would be strongly linked for a decade. Next, innovative (or creative) thinking began to be associated with decision-making in business (2010 and 2011, respectively), but this association began to be diluted in 2018. Finally, the third moment was the association of studies with critical thinking. From 2013 onwards, the correlation of this sub-competency with decision-making emerged, but its occurrence frequency diminished in 2019. Finally, it should be noted that the trending topics from 2020 onwards have corresponded mainly to "international business," "decision-making process," "business students," "business ethics," "knowledge management," and "design thinking."

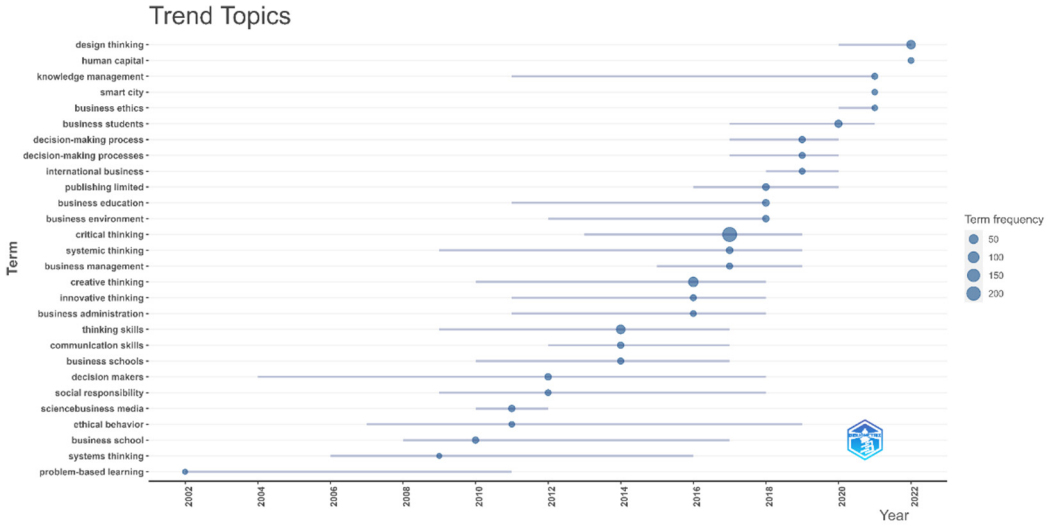


**Figure 8.** Trending topics per year. Source: Created by the authors through Bibliometrix.

## 5. Conclusions

The purpose of this article was to present the results of bibliometric research focused on identifying studies that consider the relationship between decision-making processes in the business area and complex thinking or any of its sub-competencies. As noted at the time, the quantitative results showed a clear area of opportunity in the research on this topic, as very few studies were found that directly addressed this linkage. However, this does not mean that these notions were not indirectly associated academically; although the relationship was not revealed with the macro-competency of complex thinking, it appeared in the sub-competencies, especially critical thinking.

It can be concluded that academic approaches continue to focus only on specific characteristics and skills associated with complex thinking, leaving out the breadth of elements that can impact the decision-making process in business. We note that particular institutions and countries study this correlation but have a history of focusing only on some complex thinking sub-competencies. Finally, it can be seen that critical thinking is considered the most significant sub-competency of complex thinking in the decision-making process, leaving out other equally valuable elements.

Thus, this study opens up ample opportunities for future academic work, both at the research level and in a practical sense within educational institutions. In research, it would be relevant to measure how complex thinking impacts the decision-making process within businesses and evaluate all its sub-competencies, not just critical thinking. On the other hand, this study invites business training institutions to consider the relevance of integrative thinking for future professionals when facing challenges and solving problems. Undoubtedly, scientific, systemic, and innovative reasoning are equally valuable tools as critical thinking.

Although the low number of articles linking the main topics (complex thinking and decision-making in business) is a study limitation, its value is that it delved into the subject to discover the other findings related to the sub-competencies. Therefore, what is presented here is valuable and significant for educational and business studies.

Thus, although this is a bibliometric study with a focused objective for quantitative identification, it opens the possibilities for future studies that delve into the correlation between this pair of elements, emphasizing the impact that this can have on developing excellent capabilities and skills in the future professional decision makers.

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