# SCIENTIFIC MAPPING OF BUSINESS INTELLIGENCE AND ENTERPRISE RESOURCE PLANNING FROM 2003 TO 2022

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**Abstract:** The changes in global markets have represented an important challenge for firms, therefore the integration of strategic processes, the efficiency of operations, the management of information and the knowledge generated, have been the basis for incorporating advanced management tools in the era of digitalization. In this sense, business intelligence (BI) and enterprise resource planning (ERP) systems are two topics that have become widespread and researched in recent years. The present study aims at the conceptual analysis of ERP-BI topics with information collected from the web of science database from 2003 to 2022, identifying the most representative approaches and quantifying the main bibliometric indicators with the support of an open access technological tool SciMAT. The results show a growing trend of publications related to the incorporation of business systems and their conceptual relationships to sustainable development, knowledge management (KM), big data, among others. This study highlights the growth of research on BI and ERP systems, integrating organizational processes and generating knowledge based on valuable information for decision making with a positive impact on productivity and innovative strategy.

**Keywords:** Enterprise resource planning systems, business intelligence, information management, data analytics, scientific maps.

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## Introduction

Global markets have represented a severe test for firms, especially for those that do not improve their business processes by managing and implementing technology that allows them to react to economic and social issues. Decision-making in a globalized business environment is a challenge faced by managers. Although today's firms have incorporated advanced management systems, the use of technology for decision making at the corporate level is not sufficiently developed (Richards et al., 2019). Firms that promote innovation in their strategies have faced changes by incorporating technological tools such as ERPs, which have proven to have a significant impact on productivity and quality service (Sastrodiharjo & Khasanah, 2023); without neglecting the incorporation of specialized technology such as BI systems that incorporate the management of data, transforming and presenting them into useful information (Mariani et al., 2018). Consequently, firms use BI to support multiple strategic decisions such as more competitive pricing, positioning product, value chain integration in a single application, and efficiency in operational processes (Torres et al., 2018).

The most outstanding approaches are related to topics such as big data, KM, data mining, between others (Olszak, 2022). Based on the above, the aim of this research is to establish the basis for the integration of ERP and BI approaches under the same perspective, pointing out the main lines of research and publications over a period of twenty years (from 2003 to 2022), most cited authors, most cited articles, and the analysis of scientific maps.

## 1. Theoretical framework

### 1.1. Business intelligence

The term BI has positioned itself as a driving force in constant growth. This is because firms are focusing on incorporating valuable information that has been generated over time. For researchers Mariani et al. (2018), visualization of information is most effective when combining external data derived from the customer markets and internal data. The term BI was mentioned by IBM researcher Luhn in 1958, where he mentioned that BI was the ability to understand the interrelationships of facts presented in such a way as to guide action toward a desired aim (Luhn, 1958).

The interest of firms has developed in the fields of administration, business management, among others (López-Robles et al., 2020). The term shows strong relationship with four approaches: big data (Acharya et al., 2018), data analytics (Arunachalam et al., 2018), machine learning, which is represented by Olivas (2010) as a tool that includes algorithms with a great capacity to identify valid information and detect patterns. Finally, data mining has been used to improve the intelligence and efficiency on production (Lv et al., 2018).

Today, the scientific and business community has had the opportunity over time to create research, achieving to explain with publications the relationship between these topics and how they complement and integrate other approaches such as: Industry 4.0 (Chen et al., 2023; Tseng et al., 2021), information technologies (Gunasekaran et al., 2006), competitive advantages (Heredia & Duréndez, 2019), innovation (Caseiro & Coelho, 2019), between others.

### 1.2. Enterprise resource planning systems (ERP)

The ERP approach in the last two decades has been a basic and evolving topic that has allowed multiple research projects in businesses. ERPs are known as a set of packaged technology tools that integrate business processes and functions based on an IT architecture (Ruivo et al., 2020). ERP implementation requires time, resources, and represents a significant cost (Koh et al., 2009). However, they have become a strategic tool for improving business and organizational processes (Rodrigues et al., 2021). For authors Bendoly & Jacobs (2004), this impact on business performance will depend on the alignment of ERP systems with operational requirements. Firms are combining big data with ERP systems to improve responsiveness to the user (Bandara et al., 2023).

The approach to this variable shows several relationships in different contexts such as: Implementation, related to the adoption and use (Vicedo et al., 2020), followed by the benefits of post-implementation (Ruivo et al., 2014), critical success factors (CSF) (Eampoonga & Leelasantitham, 2023), and Adoption of ERP (Junior et al., 2019). Firms should identify that enterprise systems are the source of data that support information modeling (Bendoly et al., 2009). The literature mentions other approaches such as: sustainable development (Tseng et al., 2021), corporate social responsibility (Di Vaio et al., 2020) and technology acceptance model (TAM) (Wixom & Todd, 2005).

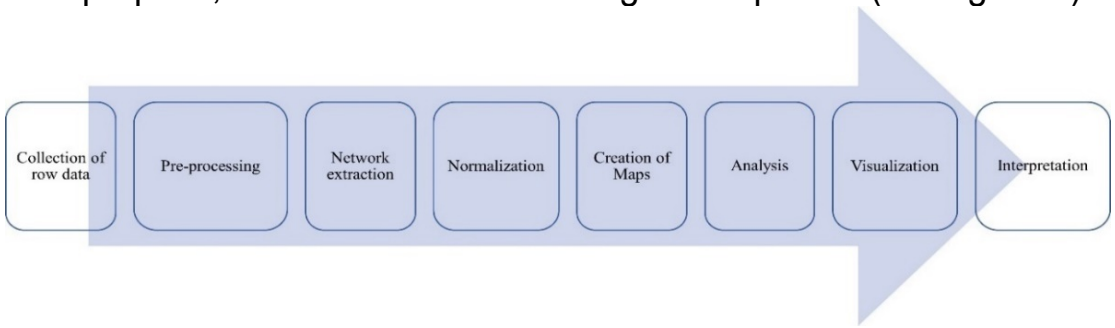
The degree of development and integration of advanced management systems will represent a technological strategy for firms to react to the global market.

## 2. Methodology

### 2.1. Bibliometric method

In recent years bibliometric methods have been widely accepted to measure certain scientific indicators (Gomez-Jauregui et al., 2014; Liang & Liu, 2018). Bibliometrics is a research methodology in the field of library and information science (Callon et al., 1991). This study relates the variables BI and ERP in a common and evaluative context. Researchers Hsu & Chiang (2017) mention that bibliometrics is a way to explore the trend of publications, knowledge base, and importance of topics.

The study used a bibliometric tool called SciMAT (Cobo et al., 2012). For this purpose, the research follows a logical sequence (see figure 1).




*Source (s):* (Cobo et al., 2012)

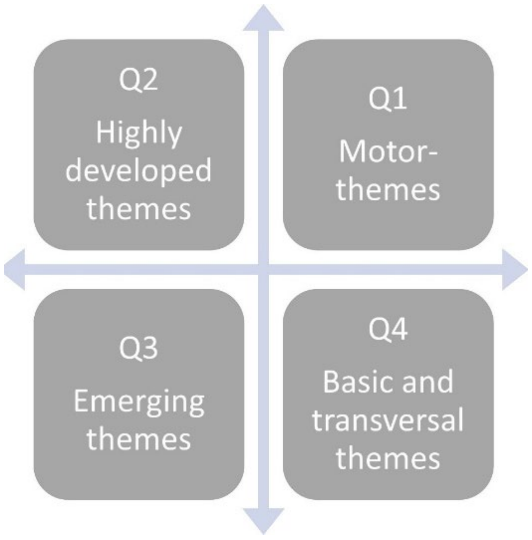
*Figure 1. Methodological Workflow.*

### 2.2. Dataset

Based on the workflow, a bibliometric analysis was developed with information available from 2003 to 2022 in the Web of Science (WoS) database (Clarivate, 2024). The information was retrieved on May 3, 2023, using the following query (CT): TS="Business intelligence" OR TS="Enterprise resource planning" , filters (F): Database: Web of Science Core Collection; Editions: Science Citation Index Expanded (SCI) -1900-present in Social Sciences Citation Index (SSCI) -1956-present; Types of documents: DT="article" OR DT="review article"; Publication years: 2003 to 2022; References areas: management, economics, design and

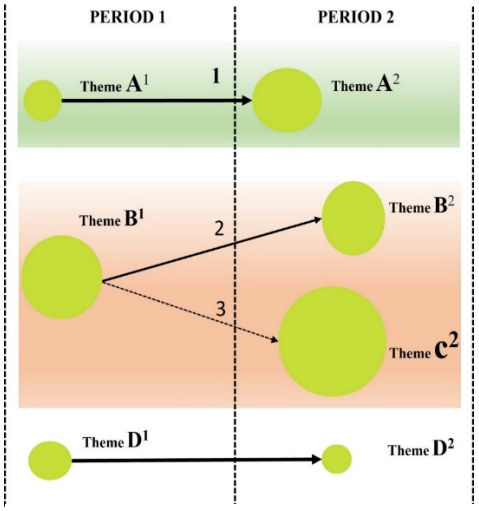
manufacturing, manufacturing, metal processing, supply chain and logistic, business economics. A manual review of the exported documents was carried out to ensure homogeneity and avoid duplication, n=3,675 documents were finally used.

Topics are determined by applying a clustering algorithm (Juliani & de Oliveira, 2016) on a normalized co-word network (Callon et al., 1983). To visualize Callon et al. (1991) measure them in terms of centrality and density range values. Centrality measures the degree of interaction of a network with other networks, and it can be defined as $c = 10 * \Sigma e_{kh}$, where k is a keyword belonging to the topic and h is a keyword belonging to other topics. Density measures the internal strength of the network, and it can be defined as $d = 100\ (\Sigma e_{ij}/w)$, where i and j are keywords belonging to the topic and w is the number of keywords in the topic. A research field can be represented as a set of research topics and visualized by means of a strategic diagram (see Figure 2).




*Source (s):* (Cobo et al., 2011)

*Figure 2. Strategic diagram.*




*Source (s):* (Cobo et al., 2011)

*Figure 3. Evolution map.*

Figure 3 shows an example of an evolution map. The research topics are presented through an evolution diagram, relating the topics of consecutive periods that maintain a conceptual relationship (Cobo et al., 2011).

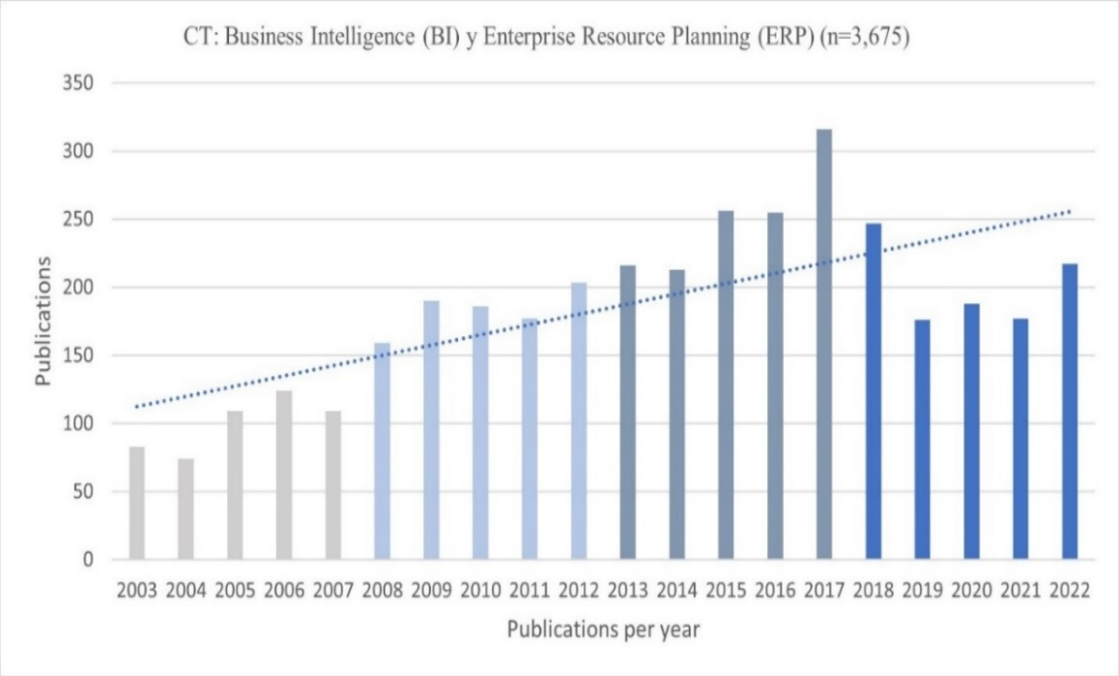
In the quest to avoid flatness of the data, the years as a whole were split into consecutive periods. By authors López-Robles et al. (2019), periods are often used to cover the same period of time. Given

that the research presents a significant number of publications, the period 2003 to 2022 was divided into 4 periods 2003 to 2007, 2008 to 2012, 2013 to 2017 and 2018 to 2022.

## 3. Bibliometric performance analysis of BI and ERP

### 3.1. Publications

Figure 4 shows the publications by year related to the BI and ERP approaches from 2003 to 2022.




*Source (s): Authors' elaboration based in Web of Science* (Clarivate, 2024)

*Figure 4. Publications per year in Web of Science from 2003 to 2022.*

Three trends of the topics can be identified. The first one, which corresponds to the period 2003 to 2007, seems to be one of the least productive, the second one occurs in the period from 2013 to 2017, where in the year 2017 the maximum number is reached with a total of 316, and finally the third one occurs in the period from 2018 to 2022 with the decrease of publications due to the Covid-19 pandemic.

### 3.2. Most productive authors and cited publications

Table 1 shows the most productive authors.

*Table 1.*
*Most cited authors from 2003 to 2022*

| Number of publications | Authors |
|---|---|
| 14 | Bendoly E, Garcia IM, Gunasekaran A, Oliveira T, Popovic A |
| 13 | Soja P |
| 12 | Koh SCL |
| 11 | Chen HC, Chung WY, Newell S, Rizzi S, Wang ETG |
| 10 | Kumar A, Olson DL, Raymond L |
| 9 | Raymond L, Feng YQ, Golfarelli M, Gupta S, Hwang Y, Jaklic J, Lee S, Li L |
| 8 | Boiral O, between others |

*Source (s): Authors' elaboration based on Web of Science* (Clarivate, 2024)

Table 1 contains a summary of the number of articles by each author. For example, there are five authors who have published 14 articles each, giving a total of 70 articles for the first line. The authors are presented in alphabetical order according to their number of publications. Highlighting author Bendoly with publications related to ERP systems and their relationship with industries and researcher Gunasekaran focuses on the adoption of ERP and BI systems.

The most cited articles on BI and ERP are presented in Table 2 and 3.

*Table 2.*
*Most cited publications based on the topic BI from 2003 to 2022*

| Publication name | # of citation | Year of publication | DOI |
|---|---|---|---|
| BI in blogs: Understanding consumer interactions and communities. | 189 | 2012 | 10.2307/41703504 |
| BI for enterprise systems: a survey. | 178 | 2012 | 10.1109/TII.2012.2188804 |
| Motivational differences across post-acceptance information system usage behaviors: An investigation in the BI. | 166 | 2013 | 10.1287/isre.1120.0456 |
| BI and big data in hospitality and tourism: a systematic literature review. | 155 | 2018 | 10.1108/IJCHM-07-2017-0461 |
| The measurement of BI. | 140 | 2006 | 10.1201/1078.10580530/45769.23.1.20061201/91770.4 |

*Source (s): Authors' elaboration based on Web of Science* (Clarivate, 2024)

The manuscripts are published in high impact journals, H-index higher than 62, and with a citation rate superior to 139 (see table 2).

*Table 3.*
*Most cited publications based on the subject of enterprise resource planning from 2003 to 2022*

| Publication name | # of citation | Year of publication | DOI |
|---|---|---|---|
| Examining the critical success factors in the adoption of ERP. | 293 | 2008 | 10.1016/j.compind.2007.12.001 |
| Job characteristics and job satisfaction: Understanding the role of ERP system implementation. | 254 | 2010 | 10.2307/20721418 |
| The relation of interface usability characteristics, perceived usefulness, and perceived ease of use to end-user satisfaction with ERP systems. | 232 | 2004 | 10.1016/j.chb.2003.10.004 |
| ERP systems, management control and the quest for integration. | 210 | 2005 | 10.1016/j.aos.2004.11.004 |
| Identifying critical issues in ERP implementation. | 200 | 2005 | 10.1016/j.compind.2005.02.006 |

*Source (s): Authors' elaboration based in Web of Science* (Clarivate, 2024)

Table 3 shows manuscripts published in high impact journals, with an H-index higher than 116, and a citation rate greater than 199.

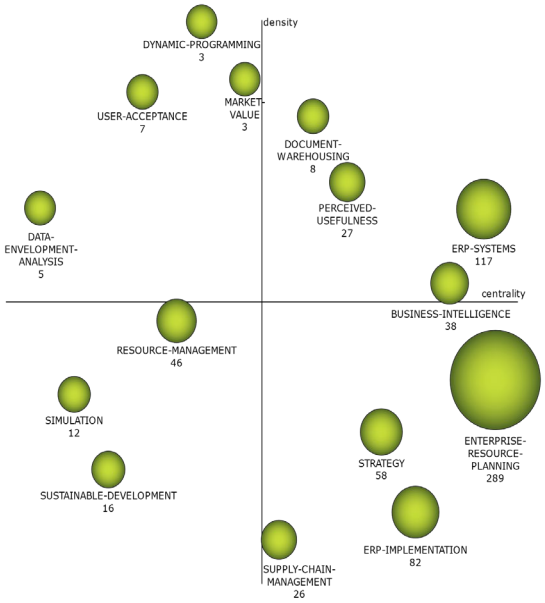
## 4. Scientific map analysis of BI and ERP

To analyze and visualize the ERP-BI research approaches emphasizing their relationship and evolution. Scientific maps are presented with a sample of n=3,675 publications extracted from the WoS database in the period from 2003 to 2022.

### 4.1. SciMat conceptual evolution map

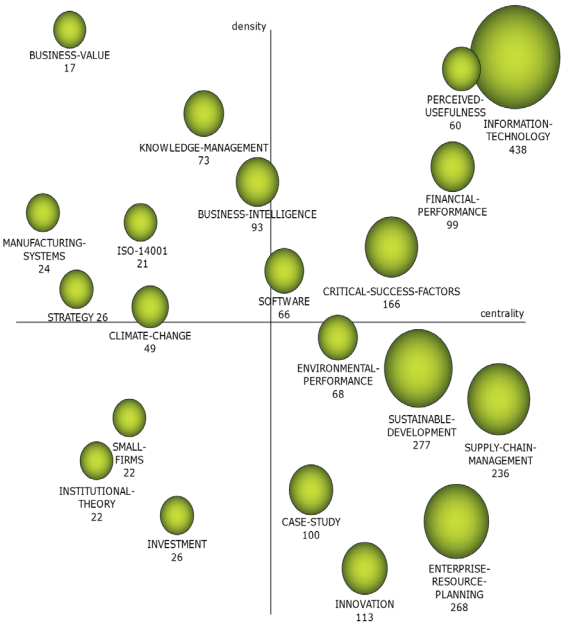
The method was developed in eight steps: Data collection, preprocessing of information, extraction process of the network, normalization process, creation of the cluster-based map, analysis of the topic representation, visualization, and interpretation.

The mapping is presented in four periods of five years each as follows:




*Source (s): Authors' elaboration using SciMat* (Cobo et al., 2012)

*Figure 5. ERP-BI strategic diagram period 2003 to 2007*

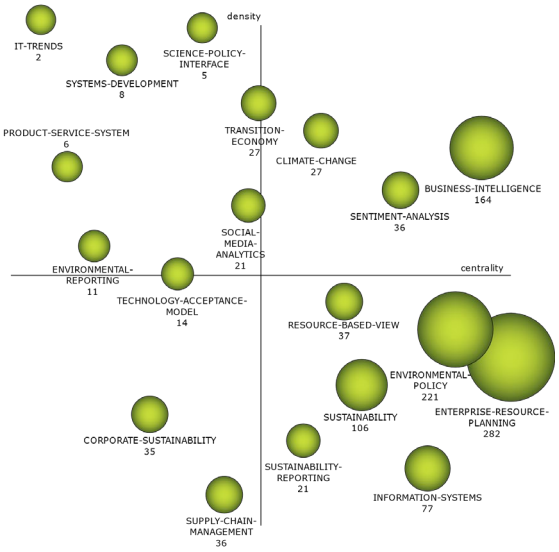



*Source (s): Authors' elaboration using SciMat* (Cobo et al., 2012)

*Figure 6. ERP-BI strategic diagram period from 2008 to 2012*

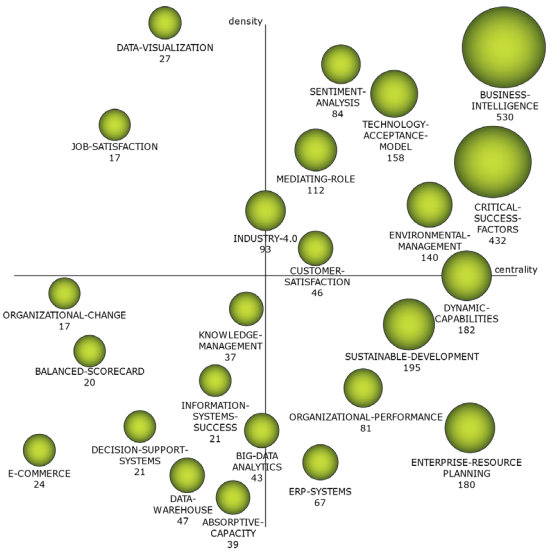
**First period (2003-2007):** In Figure 5, four major topics can be identified in quadrant Q1, where BI and ERP systems stand out, followed by user perceived usefulness (PU) and document repository. In quadrant Q2 - user acceptance, data analysis, dynamic programming and market value, for the quadrant Q3 - resource management, sustainable development (SD) and simulation and finally, in quadrant Q4 there is the term ERP, ERP implementation, strategy and supply chain management (SCM).

**Second period (2008-2012):** In Figure 6, information technology and CSF are presented as two transcendent focuses in quadrant Q1, followed by financial performance, systems and PU. In quadrant Q2, BI, KM, climate change, manufacturing systems, strategy, ISO 14001 and business value are presented, the third quadrant Q3 shows investment, institutional theory and small businesses, and quadrant Q4 shows SD, ERP, SCM, innovation, case studies and environmental performance.




*Source (s): Authors' elaboration using SciMat* (Cobo et al., 2012)

*Figure 7. ERP-BI strategic diagram period from 2013 to 2017*




*Source (s): Authors' elaboration using SciMat* (Cobo et al., 2012)

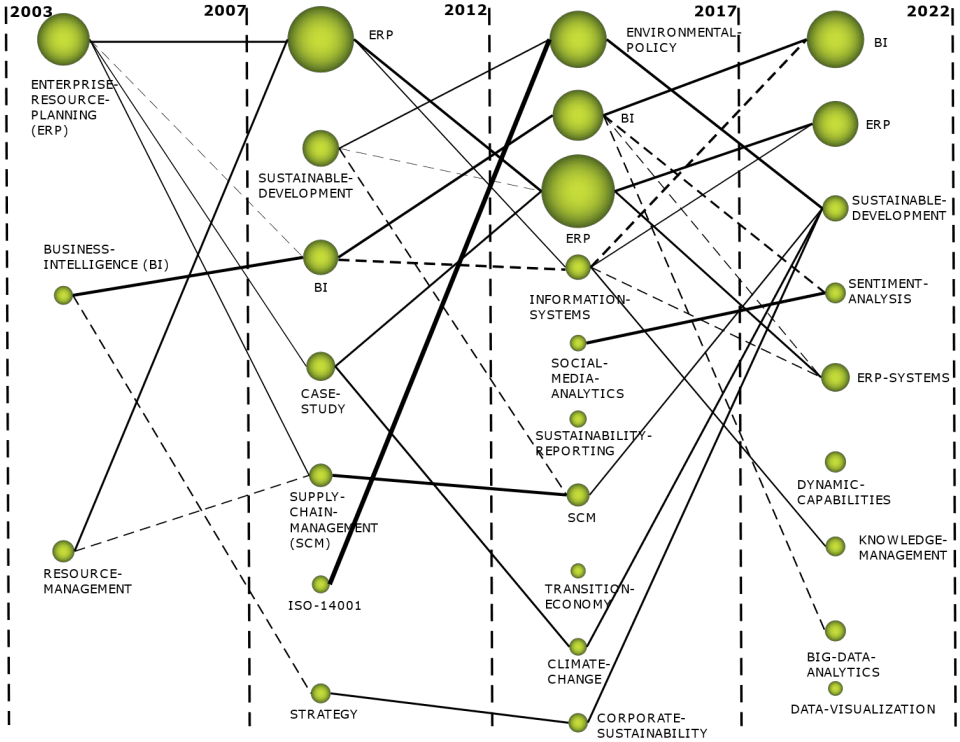
*Figure 8. ERP-BI strategic diagram period from 2018 to 2022*

**Third period (2013-2017):** In Figure 7, BI, sentiment analysis and climate change can be visualized in quadrant Q1. In quadrant Q2 economic transition, social network analytics, environmental reporting, systems development, product-service system, science policy interface and IT trends are shown, for quadrant Q3 - SCM, corporate sustainability and TAM and quadrant Q4 reflects ERP, environmental policy, sustainability, information systems, resource-based view and sustainability reporting.

**Fourth Period (2018-2022):** In Figure 8, BI, CSF, environmental management, TAM, mediation roles, sentiment analysis and customer satisfaction are positioned in quadrant Q1. In quadrant Q2 industry 4.0, data visualization and job satisfaction are mentioned, for quadrant Q3 - data warehouses, big data analytics, absorptive capacity, KM, e-commerce, information systems success, decision support systems, dashboards and organizational change and in quadrant Q4 - SD, dynamic capabilities, ERP, business performance and ERP systems.

It is worth noting that in the last two periods, the BI approach is presented as a driving and constantly growing topic. Three major approaches can be noted that try to measure the behavior of the main topics through TAM, CSF and sentiment analysis.

Considering the results of the content analysis of the articles published in each period, a second analysis is focused on the conceptual evolution of each topic as shown in Figure 9.




*Source (s): Authors' elaboration using SciMat* (Cobo et al., 2012)

*Figure 9. Evolutionary map by ERP-BI topic area (2003 to 2022)*

Figure 9 shows the relationships between ERP-BI approaches where the solid lines represent conceptual relationships, and the dotted lines represent non-conceptual relationships. Eight topics are identified: business systems, sustainable development, KM, big data analysis, data visualization, information systems, environmental policies and SCM. These approaches consolidate the main reason for the study based on the subject of ERP-BI systems.

## 5. Conclusions

The research reflects one of the first bibliometric studies on BI and ERP approaches and their main topics. In terms of bibliometric performance, publications have shown a notable increase in the last

20 years (2003 to 2022) due to the volume in the number of publications and citations received in their respective fields of study. However, it is important to mention a milestone that occurred in the period from 2018 to 2022, with a decrease in publications in the years 2020 and 2021 mainly related to the Covid-19 pandemic that froze, in some cases partially, the operations and in others - totally.

This study highlights the growth of the BI and ERP, two topics related to the technological area, but that are significantly affecting the integration of organizational processes and that allow storage, extraction, transformation and visualization through data management; the generation of knowledge that provides a natural way to support the decision making of managers. The information is presented on the basis of a bibliometric study that provides an overview of the development, evolution, structure, and main approaches to ERP-BI terms.

The BI and ERP include the integration of processes within their functionality, information flow between organizational areas, and data management have an important relationship with other concepts, such as: Big data: offers valuable resources for developing, building capabilities, and creating a knowledge-based culture in people (Pancić et al., 2023). Data analytics: Having advanced management systems will allow decision makers to have knowledge to improve productivity and processes (Romero & Abad, 2022). Data mining: Its main function is to analyze a large amount of data that is stored over time. It tends to highlight behavior patterns in different areas (Wang & Huang, 2022). CSF: Identify the main factors that facilitate the success in the adoption and implementation (Eampoonga & Leelasantitham, 2023; Xie et al., 2022).

Based on the information in the literature, it appears that the term BI supported by ERP and in combination with its related approaches are likely to evolve in future research and will be closely related to topics related to artificial intelligence and machine learning.

The results of this investigation have important implications for policymakers and managers who seek technological development. The information generated by ERP-BI is high when it is relevant and pertinent, the impact generated can make a difference in the innovation strategy. Policymakers should address changes that promote the implementation and optimization of ERP-BI systems, laws that favor innovation and close collaboration with universities. Managers should

not focus only on technical aspects but visualize the impact on the firm; ensure that ERP-BI systems are reliable, efficient and easy to use (Jo & Park, 2023). There is an opportunity to adopt ERP-BI systems that allow the economic growth of firms.

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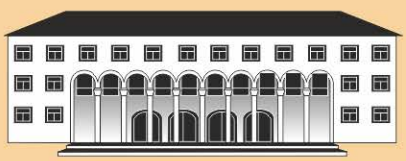

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