

# Mapping of Business Intelligence Research Themes: Four Decade Review

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*Research on business intelligence continues to develop but is limited to one country and/or one field. From the perspective of bibliometric reviews, this study purposes to visually research mapping and research trends in the field of business intelligence on an international scale. This study used bibliometric techniques with secondary data from Scopus. Analyze and visualize data using the VOSViewer program and the analyse search results function on Scopus. This study analyzed 244 scientific documents published from 1975 to 2020. According to the research, Monash University, and Yeoh, W. had the most active affiliated institutions and individual scientists in business intelligence research. Business, management, and accounting; and Lecture Notes in Business Information Processing were the most studied and disseminated outlets of business intelligence research. There were five category maps of collaborative researchers from around the world. Based on the identification of a collection of knowledge accumulated from over forty-five years of publication, this research proposes a grouping of business intelligence research themes: Business analytics, Element of marketing, Competitive intelligence, Intelligence system, Industry, and Business process abbreviated as BECIIB themes.*

**Keywords**—business intelligence, bibliometric, research themes, research trends, research mapping

## I. INTRODUCTION

Technology affects organizational and business performance. Organizations can now produce data much quicker than ever before thanks to recent technological revolutions such as social media [1]. Because of its immense ability to influence big data, industry, and its technology applications in most business intelligence have gotten a lot of attention in recent years [2]. The term Big data refers to large volumes of data that are beyond the ability of current technology to collect, manage, and addressable [3]. Big technology and its evolving innovations, such as analytics of big data, not only change the operation businesses work, but they also open up new possibilities for researchers and businesses in conventional data analytics and business analytics [1], [4]–[6].

Many companies have recognized the importance of information or expertise. Business intelligence (BI) in this sense emerges as a new approach to assisting businesses in gathering valuable information to improve their performance [7]. Businesses have developed significant

investments in business intelligence tools due to the rising value of data analysis and intelligence for leaders, stakeholders, and the business external environment [8]. Business intelligence is a necessary precursor to the gathering, integrating, analyzing, and visualizing of company information that can enhance and assist decision-making [9]. By combining data from several sources, business intelligence is a concept used to describe an organization's information assets and how they can be used to obtain a better understanding of business patterns and make informed decisions [10], [11].

Business intelligence examines a company's success to boost revenue and productivity [12]–[14]. BI also aids in the creation of innovative market techniques to boost earnings [15], [16]. BI systems help organizations make better decisions in an increasingly competitive world by allowing them to gather and present data in a variety of ways [15]. BI extracts information or insights from vast quantities of business information using a variety of analytical techniques and data mining to help businesses make better decisions [17]–[19].

Research related to business intelligence in the business, computer science, and industry has been carried out and developed at the international level over the last few years. Due to the difficulties in collecting data and making decisions, BI aims to improve the quality, access, and role of the data and address issues for reality decision-making [9]. On the other hand, improved technology and sophisticated Cyber-Physical Systems have new BI dynamic capabilities including adaptive and predictive metrics [20] previously immeasurable. However, previous studies on the topic of green operations were typically restricted to a single nation and/or one field in particular [21], [22]. There hasn't been much reported on business intelligence, Despite providing a large image map visualized on a global scale year after year using data from many published studies. There has been no publication that directly discusses the strong positive relationship between relationships, scholars, and scholarly studies' influence.

One of the methods used to view research, in general, is the bibliometric method. Bibliometrics is a method for measuring and analyzing scientific references with a combination of mathematical and statistical methods.

Bibliometrics is a statistical technique for analyzing bibliometric publication data such as peer-reviewed journal articles, reports, reviews, books, periodicals, conference proceedings, and related publications. Bibliometric methods have been widely used to present the relationship between the quantitative methods and the research domain [23]. This study proposes research questions, what is the mapping and trend of business intelligence research using visual bibliometric analysis?. From the perspective of bibliometric reviews, this study purposes to visually research mapping and research trends in the field of business intelligence on an international scale.

This scientific article is organized into several sections. The first part of the introduction discusses the background, questions, and objectives of the study. The second part of the method describes the scientific approach used in the research. The third section results and discussion explains the research findings and the fourth section summarizes the essence of the research. Finally, followed by acknowledgments, and references.

## II. RESEARCH METHODS

This study has used bibliometric analysis in a comprehensive literature database. In order to search for and classify similar documents in the global Scopus database, this survey listed important keywords related to a business intelligence report. Researchers have used the Scopus database as the main source of information because it is considered a reliable source of scientific publications by academics.

This research has used the keyword "business intelligence" in the title, abstract, and author keywords to get the necessary data from the Scopus database. Data mining is limited to annual data to obtain fully published data for twelve months each year. Data mining uses the following search query option (TITLE-ABS-KEY ("business intelligence") AND PUBYEAR < 2021 AND (LIMIT-TO (SUBJAREA, "BUSI"))) as of April 2021. In this step, we have found 1,664 publications over the last 45 years from 1975 to 2020. In the study at this point, the Scopus result metadata has been extracted in the CSV dataset format [24].

The Scopus website provides an analyze search results function that displays bibliometric information from selected publications. We have used this service to analyze and visualize the publication productivity of researchers, institutions, and countries. Besides, this feature is to measure the number of annual publications and publication citations, as well as the proportion of subject areas and source documents [25], [26].

In the next stage, the researcher analyzed the collected documents using the VOSviewer ver. 1.6.16 for co-occurrence and co-authorship analysis. To create a research network of international collaborative scholars, this study used co-authorship analysis with the author's analysis unit and the complete computation systematic technique using VOSViewer. This study employs VOSViewer to create a network of keyword maps for research themes, as well as a thorough co-occurrence analysis, keyword relationship

analysis, and a fully systematic computation technique [27], [28]. Simple statistics and tables have been calculated and tabulated using Microsoft Excel. Then, the research results were synthesized and triangulated.

## III. RESULT AND DISCUSSION

This segment discusses the growing results of data based on the most common organizational affiliation, nations, individual studies, the largest frequency of subject areas, yearly source documents, annual documents and cited papers, research of the map, and networks of authorship in the field of the business intelligence.

### A. Most Productive Organizational Affiliations in Business Intelligence Research

160 affiliated organizations have researched business intelligence. The higher organization that researches business intelligence publications was the Monash University, Australia (n = 18). Then followed by Universidade do Minho, Portugal (n = 15), Univerza v Ljubljani, Slovenia (n = 15), Bina Nusantara University, Indonesia (n = 14), The University of Arizona, Unites States (n = 13), University of Toronto, Canada (n = 13), Bucharest University of Economic Studies, Romania (n = 13), The University of North Carolina at Greensboro, United States (n = 12), University of Tehran, Iran (n = 12), and Universiti Tunku Abdul Rahman, Malaysia (n = 12).

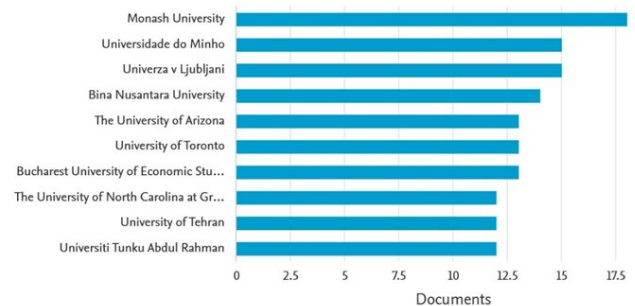


Fig. 1. Affiliation with an Institution Annual Publication Count of Business Intelligence

It can be seen that there were two universities from America in the most productive research organization affiliates in the business intelligence study. This is because the United States was the country that supports development and research, including in the business intelligence area. Business intelligence research in general is carried out spread out by several countries and is not dominated by certain countries.

### B. Most Individual Researcher in Business Intelligence Research

There was 159 individual researcher that has researched business intelligence. Yeoh, W. from Washington University in St. Louis, United States was the researcher with the most writings in the field of business intelligence (n = 14). Pursued by Palvia, P. from The University of North Carolina at Greensboro, United States (n = 12); Jaklič, J. from University of Ljubljana, Slovenia (n = 10); Arnott, D. from Monash University, Australia (n = 9); Jacks, T. from Southern Illinois University Edwardsville, United States (n = 7); Popovič, A. from NEOMA Business School, France (n = 7); Sutton, S.G. from School of Earth and Environmental Sciences, James Cook University, Australia (n = 7); Chen, H. from University of Arizona, United States (n = 6); Koronios, A. from a University of South Australia, Australia (n = 6); and Rouhani, S. from University of Tehran, Iran (n = 6).

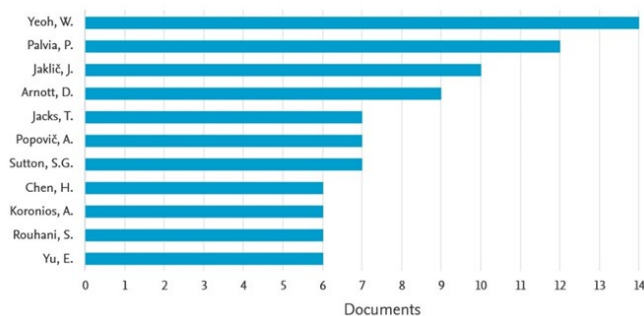


Fig. 2. Most Individual Business Intelligence Publication Researcher

It can be seen that the most productive individual researcher in the business intelligence study mostly come from the United States and Australia. William Yeoh has a citation of 1,801 and an h-index of 23 [29]. Prashant Palvia has a citation of 10,764 and an h-index of 46 [30]. And, Jurij Jaklič has a citation of 2708 and an h-index of 22 [31].

### C. Most Productive Nation's Business Intelligence Publications

93 countries are identified to have researched business intelligence. The United States was the leading research nation in business intelligence publications (n = 325) and Germany was next (n = 118). China (n = 85), India (n = 86), Australia (n = 82), The United Kingdom (n = 80), Italy (n = 61), Portugal (n = 56), Canada (n = 49), and Malaysia (n = 43) were the next countries to join. Germany, the United Kingdom, Italy, and Portugal are the most active nations in terms of business intelligence publications.

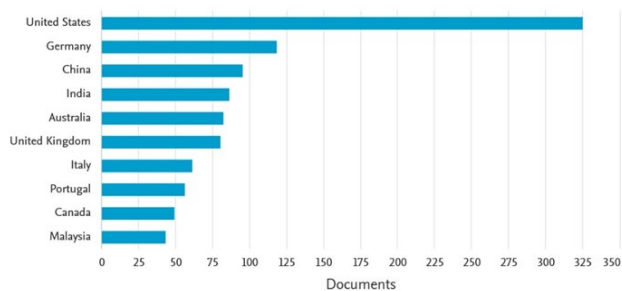


Fig. 3. Nation Number of Annual Publication of Business Intelligence

Most business intelligence publications were dominated by developed countries with a high human development index and a very supportive research ecosystem compared to developing countries [32].

### D. The Subject Area Frequency of Business Intelligence Research

Business intelligence research has been researched in a variety of subject areas. Business, management and accounting (n = 1,664 or 39.0 percent) is the subject area with the most global publications in business intelligence research. This was followed by decision sciences (n = 721 or 16.9 percent); computer science (n = 705 or 16.5 percent); engineering (n = 418 or 9.8 percent); economics, econometrics, and finance (n = 259 or 6.1 percent); mathematics (n = 184 or 4.3 percent); social science (n = 121 or 2.8 percent); and psychology (n = 48 or 1.1 percent).

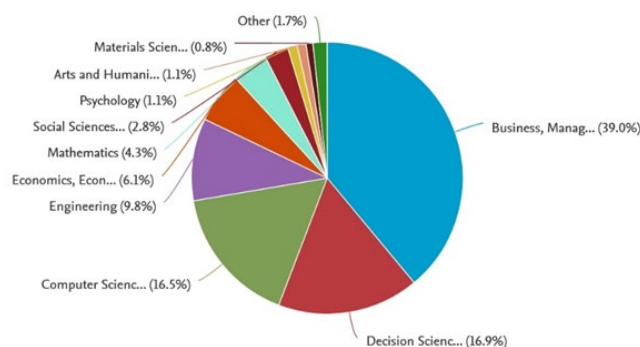


Fig. 4. The Subject Area Frequency of Business Intelligence Research

Modern business intelligence is a synergy between business, decision science, and computer science. Computer science-based decision-making for business and management purposes. This is partly why the subject area of business, computer science, and decision sciences dominates business intelligence research.

### E. Publication Sources for Business Intelligence Documents by Year

TABLE I. NUMBER SOURCES OF THE BUSINESS INTELLIGENCE RESEARCH

Scientific journals	SJR	Article
Lecture Notes in Business Information Processing	0.26	159
Decision Support Systems	1.92	39
International Conference on Information and Knowledge Management Proceedings	0	26
Journal of Decision Systems	0.3	26
International Journal of Business Intelligence and Data Mining	0.17	23
IBM Data Management Magazine	0	22

101 publication sources have published business intelligence research. The top number of articles per year based on sources in the business intelligence research was "Lecture Notes in Business Information Processing", SJR 0.26 (n = 159); "Decision Support Systems", SJR 1.92 (n = 39), "International Conference on Information and Knowledge Management Proceedings", SJR 0 because conference proceeding (n = 95); "Journal of Decision Systems", SJR 0.3 (n = 26); International Journal of Business Intelligence and Data Mining, SJR 0.17 (n = 23); and "IBM

Data Management Magazine”, SJR 0 because of not journal (n = 22).

The SCImago Journal Rating (SJR) ranks journals according to their average prestige per article, and the subject area, quality, and reputation of journals by the value of a citation. The most productive journals that publish business intelligence research have medium SJR indicators, 0.17 - 1.92 [33].

F. The Business Intelligence Sector's Annual Publications

The number of annual international publications on business intelligence studies tends to show an increasing trend. With 140 publications, Figure 5 shows the highest peak of publishing in 2020. Since 1975 it has been noted that researchers have been researching business intelligence. The business intelligence study will have 131 documents in 2019, compared to 111 in 2018, 138 in 2017, 115 in 2016, and 144 in 2015.

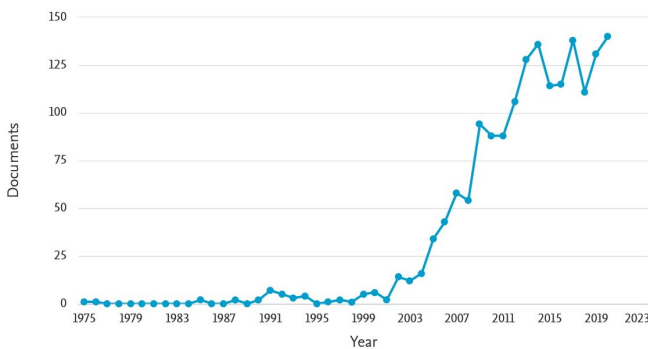


Fig. 5. The Business Intelligence Sector's Annual Publications

College of Management, University of Arizona, United States. Chen is one of the top individual researchers in business intelligence research with 6 documents.

H. Research Theme Map

The research theme map is a review that seeks to identify business intelligence research based on keyword linkages between publications. The VOSViewer software was used to evaluate and visualize the construction of the business intelligence keyword scheme for the business intelligence of the research theme map. For the minimum number of keyword-related articles, fifteen repetitions were required. As a consequence, 6,978 keywords out of 101 met the criteria.

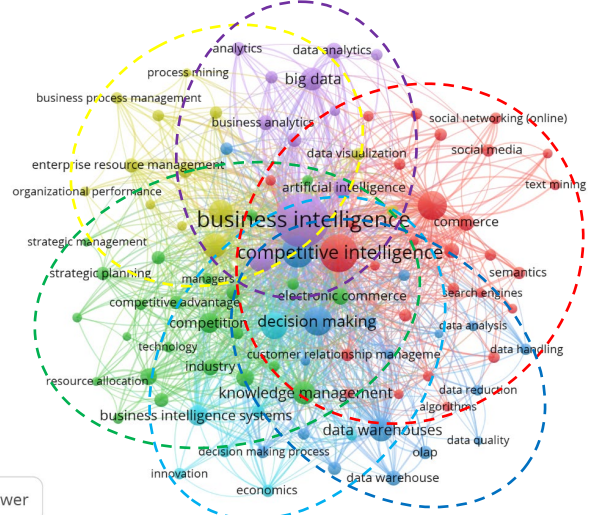


Fig. 6. Map of Research Themes

G. Business Intelligence Publications Documents Cited

TABLE II. DOCUMENT CITED OF BUSINESS INTELLIGENCE PUBLICATION

Document title	Authors	Year	Source	Cited by
Business intelligence and analytics: From big data to big impact	Chen, H., Chiang, R.H.L., Storey, V.C.	2012	MIS Quarterly: Management Information Systems 36(4), pp. 1165-1188	2713
Antecedents of information and system quality: An empirical examination within the context of data warehousing	Nelson, R.R., Todd, P.A., Wixom, B.H.	2005	Journal of Management Information Systems 21(4), pp. 199-235	522
The application of data mining techniques in financial fraud detection: A classification framework and an academic review of literature	Ngai, E.W.T., Hu, Y., Wong, Y.H., Chen, Y., Sun, X.	2011	Decision Support Systems 50(3), pp. 559-569	480
A critical analysis of decision support systems research	Arnett, D., Pervan, G.	2005	Journal of Information Technology 20(2), pp. 67-87	309
Measuring the effects of business intelligence systems: The relationship between business process and organizational performance	Elbasha, M.Z., Collier, P.A., Davison, M.J.	2008	International Journal of Accounting Information Systems 9(3), pp. 135-153	274

The study "Business intelligence and analytics: From big data to big impact" by Chen, H., Chiang, R.H.L., Storey, V.C. was the highest documents based on the business intelligence cited. Hsinchun Chen from Eller

Figure 6 represents six research theme groups for international academic publication of business intelligence, which have been simplified and abbreviated as BECIIB themes, based on research keywords.

1. Business analytics clusters (purple). This cluster contains business analytics themes. Analytics, data analytics, cloud computing, big data, big data analytics, and decision support. This cluster was linked to the majority of these keywords.
2. Element of marketing clusters (red). This cluster contains an element of marketing themes. Commerce, sales, social media, social networking (online) This cluster was dominated by customer relationship management. Many of these keywords have something to do with marketing in some way.
3. Competitive intelligence cluster (dark blue). We can find competitive intelligence themes in this cluster. Decision making, data analysis, data integration, data handling, data quality, data warehouse, data reduction, and metadata.
4. Intelligence system cluster (light blue). The keyword of economics, innovation, sustainable development dominated the intelligence system cluster.
5. Industry cluster (green). This cluster contains industry themes. This cluster is connected by keywords electronic commerce, management, industrial management, risk management, strategic planning strategic management,



and enterprise resource planning dominated this cluster. Several of these keywords are concerned with industry topics.

6. Business process cluster (yellow). The keyword of business process management, management science, enterprise resource management, key performance indicators, and benchmarking dominated this cluster. Many of these terms are associated with business process themes.

### I. Authorship Network

Business intelligence studies have been researched by several research groups. The authorship network map was created using the VOSviewer software, which is based on the business intelligence researcher system. Three papers were one of the requirements for a minimum collection of research publications per author. As a result, only 157 scholars out of 3,242 were found to meet the criteria. There were five community collaboration networks between international researchers in business intelligence research publications, as shown in figure 7.

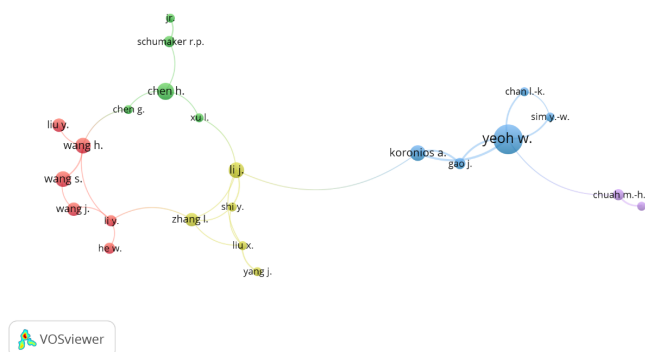


Fig. 7. Authorship Network Map

Liu, Y., Wang, H., Wang, S., Wang, J., Li, Y., and He, W. were included in the red cluster of business intelligence release. They're from the United States. The green cluster containing Jr., Schumaker, R.P., Chen, H., Cheng, G. and Wu, L. They are from the United States. Li, J., Shi, Y., Zhang, I., Liu, X., and Yang, J. are part of the yellow cluster. They have complete control over China. Chan, L. – K., Sim, Y. –W., Yeoh, W., Koronios, A. and Gao, J. make up the blue cluster. They have a stronghold in the United States. Chuah, M. –H. and Wong, K. –L. are part of the purple cluster. They are from the United States.

## IV. CONCLUSION

The number of international publications on business intelligence, as well as maps and visual trends, has been growing on an annual basis, according to the findings. The United States was the leading contributor to business intelligence research publications, with 325 articles. With 18 papers published in the business intelligence journals, Monash University, Australia was the most involved research institution. Yeoh, W. from Washington University in St. Louis, Specific academic researchers from the United States had the most publications in the business intelligence journal, with 14 articles. Business, management, and accounting was the most intensively studied field in the

business intelligence publication, with 1,664 documents (39.0 percent). Lecture Notes in Business Information Processing was the most published source on business intelligence with 159 documents and 0.26 SJR rank. The year 2020 saw the most academic publications in the field of business intelligence research, with 140 papers published worldwide. Chen, H., Chiang, R.H.L., Storey, V.C.'s publications earned the most citations in 2012, the journal "MIS Quarterly: Management Information Systems" cited 2,713 "Business intelligence and analytics: From big data to big impact" papers. The publishing of business intelligence is related to five researcher collaboration groups.

The convergence axis is classified in this research, which includes publication in business intelligence, to categorize the body of knowledge produced over forty-five years of academic publication in terms of knowledge contributions: Business Analytics, Element of Marketing, Competitive Intelligence, Intelligence System, Industry and Business Process abbreviated as BECIIB themes. As a practical result of identifying key themes in the business intelligence field, practical studies are required to clarify general backgrounds and subjects, as well as study gaps, there is a clearer understanding of the need for them. All of this will lead to new research into the disciplines' lack of advanced expertise and analysis. The potential of business intelligence to contribute to decision support systems, manager, and management information systems are frequently studied themes.

## ACKNOWLEDGMENT

The writers are grateful to Airlangga University for providing access to Scopus database on scholarly publications and Bina Nusantara University for supporting the article processing cost.

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