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MAPPING RESEARCH PUBLICATIONS RELATED TO BUSINESS INTELLIGENCE: AN OVERVIEW OF BIBLIOMETRIC DATA

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Abstract

Business intelligence is a relatively new concept as well as an attribute which deals with strategic initiatives of organization in justifying their complex business decision making as well as gaining competitive superiority. The purpose of this study is to explore a contemporary perspective on the emerging topics in business intelligence research publications using bibliometric approach. This involves the process of identifying and tagging business intelligence related topics as well as analyzing results of bibliometric indicators. To do so, this study used the Web of Science (WoS) and Scopus databases to extract related research publication outputs in the area of business intelligence studies. This included data on sources of articles, top universities or institutions that produce, high citation articles and have top authors with publications. This study manage to determine a total of 1103 research publications in WoS database and 2519 in Scopus that were published related to business intelligence context from the year 1980 to 2018. Out of this number, it was indentified that there were only 1744 journal articles and 1119 proceeding papers have been published. The results of analysis of these bibliometric data were highlighted and discussed.

Keywords: Business intelligence, firm performance, strategic management, bibliometric analysis.

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1. Introduction

Business intelligence (BI) is a very important attribute in ensuring the success of a firm. In fact business intelligence can be traced in the strategic, technical and technological decisions and practice in a firm. However, in tracing such attribute one should be aware that the basis of the term lies in the idea of intelligence. Business as according to Merriam-Webster is the "dealings or transactions especially of an economic nature" while intelligence is defined as "the ability to learn or understand or to deal with new or trying situations". In combination, the two revolve around how a business personnel comes to a business decision which can eventually affect the performance of a firm. On this basis, BI may, to a certain extent, be related to strategic business planning and decision particularly known as strategic management. However, such assertion does not carry much weight if the fundamental issues with regard to business and intelligence are not given due attention. It can be observed that many researchers have contributed significantly towards the development of BI (Ong & Siew, 2013). However, limited studies have identified the scientific progress of the publications development or historical perspectives related to BI. Currently, all historical and development studies in this area can only be found in the form of narrative literature reviews instead of the application of quantitative and statistics of the publications based on bibliometric data from the Web of Science (WoS) and Scopus databases. Hence, this study intends to further explore the construction of research publications on BI. This study can be valuable references to initial researchers who have just embarked in the mapping of related research publications on BI, so that they will be informed on the journals and authors to be consulted. Besides, it can also indirectly provide some insights to universities, policymakers, research directors and administrators, information specialists and librarians on the performance of research publications in this area.

2. Problem Statement

Despite the growing interest towards BI in strategic management studies, however, the analysis on the status regarding BI researches and publications are still inconclusive (Ong, Siew, & Wong, 2011; Jourdan, Rainer, & Marshall, 2008) and have yet to determine the amount or quality of research conducted in this area. Indeed, the bibliometric analysis of the existing studies on BI were also limited. This led to the notion that the existing literature on BI have not been systematically processed. Due to this, the direction of BI as a field of study in business management has been both mysterious and misleading. This study try to closed this gap by using bibliometric analysis in analysing several scientific preferences (i.e., authorship, number of citations, journal sources, publishers, institutions, and countries, year of publication, categories, and author keywords)

3. Research Questions

This study attempt to answer the following questions:

- What is the extent of research publications that are growing in the area of BI?
- What is the structure and trend of research publications related to BI?

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4. Purpose of the Study

This paper aims to quantitatively analyze existing researches on BI. Specifically, the objectives of the paper are: (1) To identify a number of BI research publications output based on several scientific bibliometric preferences; (2) To map the structure of research publications related to BI and its relevance areas.

5. Research Methods

This study started bibliometric analysis with the identification of related keywords for BI in order to limit the scope of the search. Besides, to increase the validity of the search terms and appropriate keywords, an email survey was conducted on 30 experts identified as respondents who can verify relevant keywords regarding business intelligent strategy (Chabowski, Samiee, & Hult, 2013; Zupic & Čater, 2015). The bibliometric data utilized in this study were derived from two different online databases namely, the Web of Science(WoS) and Scopus. The fact why the WoS and Scopus databases were chosen for this study was because they can provide data of scientific research output that enabled a reliable bibliometric analysis to be administered (De Bakker, Groenewegen, & Den Hond, 2005). The data in this study were extracted on the 2nd of June 2018 and then analyzed based on the extracted keywords applied to search related article publications from WoS core collection and Scopus database in terms of topic (including four sections: title, abstract, author keywords, and keyword plus) within the publication year limited to the period from 1980 to 2018.

In order to analyze the research publication outputs, these keywords were searched: (“business intelligence*”) OR (“competitive intelligence*”) OR (“technical intelligence*”), and were used to extract all related publication from WoS core collection and Scopus databases in terms of topic. Based on these keywords, a total of 4,008 publications were found in WoS database and 10,586 publications in the Scopus database. The low number of publication outputs related to WoS database was expected since this database has been more strongly associated to science and technology categories and this was consistent to several past studies (Abdullah, Waemustafa, & Mat Isa, 2017; Rey-Martí, Ribeiro-Soriano, & Palacios-Marqués, 2016). Since this study only concerned with publications related to business and management subject area, all of these publications that were not closely related were refined by WoS Categories: Business Finance, Management, Business and Economics and Scopus Categories: Business, Management & Accounting. Accordingly, this study managed to determine a total of 1103 research publications in WoS database and 2519 in Scopus that were published related to Business Intelligence context. Due to this, this study perceived that significant publications could be overlooked while attempting to qualify a review of relevant publication to the field of study. Besides, to avoid omitting significant published papers that did not meet the selection criteria, this study also conducted a search in Google Scholar for highly cited publications (i.e., 100 or more citations in total) and the results of the search was identical. This was consistent to a procedure proposed by West and Bogers in 2014.

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6. Findings

This section presents all the related bibliometric data found based on the routinization of the WoS and Scopus databases from the year 1980 to 2018. A search for the research publications related to BI in these databases has revealed the existence of an article written in 1983. This document, however, shows that the term BI business intelligence was addressed to a concept of small computer rather than a criticism of business and management perspectives. Based on the further observation, this study found that from 2001 onwards, continuous fluctuating trend can be noticed. This was followed by a rise in 2006 and 2007. In 2007, the yearly number of publication was at its peak. In the subsequent years, from 2008 to 2010, a significant drop can be seen. Surprisingly, in 2011 to 2014, a surge was seen to tail the previous drop before another slight but gradual decline from 2015 to 2017. It was hard to tell how 2018 would end. At the moment, however, the total number of publication since its commencement stood at 1103. Although the Scopus database has been a more suitable option as a reference for academic documents source (Aghaei et., 2013), due to its coverage of almost twice more than the WoS journals, this study still perceived that the use of both databases were more relevant for researchers to address different gaps and relevant focus studies related to BI.

6.1. Document types and sources of articles based on number of publications

This study found that there was a variations in the distribution of document types based on WoS and Scopus databases. It was observed that all the documents can be categorized into six different types of documents which are Proceeding paper, Article, Books, Editorial Material, Book chapter and Other. “Proceeding paper” in conferences was the leading type of documents found in WoS database with 471 papers. This was accompanied by “Article” with 440 papers and “Book Chapter” with 113 documents. It can also be observed that “Editorial material” and “Book” had 35 and 14 documents respectively. In addition, there were 30 documents categorized as other types of documents associated in the area of business intelligence. Different from WoS, this study found that “Article” was the leading type of documents in Scopus database with 1304 papers. There were 648 “Proceeding paper” documents while 146 documents were categorized as “Book chapter”. This was followed by 10 and 28 documents identified as “Editorial material” and “Book”. Furthermore, this study noted that 383 documents were categorized as other types of documents whereby it was more than in WoS database. On this basis, the two databases have yielded different outcomes despite some of the documents appeared in both databases (Aghaei Chadegani et al., 2013). Based on the bibliometric data, this study also had indentified top sources of journal based on the number of article publications related to BI. It was found that the most popular source of articles in Scopus database were from Decision Support Systems Journal with a total of 46 papers. This journal was ranked at 6 by Scopus Business, management & Accounting category under “Industrial Relations” sub-area and received 3.29 impact factors. In contrast, the most popular source of articles in WoS database was Journal of Intelligence Studies in Business published by little known Hamstad University in Sweden with a total of 32 papers. Moreover, this study also observed that there were two similar journals which were listed as top 10 sources of articles in WoS or Scopus database. These included International Journal of Technology management, and Technological Forecasting and Social Change. Despite coming from the

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same journals and of the same publishers, surprisingly this study found that the number of paper publications by these journals was recorded differently by different databases. Nevertheless, this study still acknowledged that these journals were among the top journals in the area and should be highly cited.

6.2. Top 10 research publications based on institutions and countries

This study also ananlyze top ten institutions that contributed papers related to BI in the fields of business and management. On overall, it was noticed that more than 27 different universities and institutions have contributed research papers in this area with at least two publications. However, based on the number of paper publications, this study found that Bucharest Academy of Economic Studies in Romania had contributed 50 papers making it the highest number of papers on BI related studies in the area of business and management. This was followed by a USA private college (i.e., Ithaca College) which has contributed 19 papers. University System of Georgia and Marist College in New York, USA were the closest challengers with 18 and 17 papers respectively. Alexandru Ioan Cuza University and University of Tunku Abdul Rahman with 13 and 12 papers respectively. One of the possible explanations for the variations of research publications among these institution/universities was because of the differences in the spending and support for the research by institution/universities (Abdullah et al., 2017). Furthermore, this study also indentify the top 10 countries that have published BI related research. Based on the overall analysis, it was found paper publications were dominated by the United States of America (USA) with 220 papers in WoS and 607 papers in Scopus. This was followed by China (i.e., 138 Wos and 221 Scopus), Romania (i.e., WoS 102), United Kingdom (i.e., 35 WoS and 150 Scopus) and Australia (i.e., 41 WoS and 95 Scopus). The difference in the number of documents was because most journals were from the USA or the UK while journals from other countries might be listed in one or none of the databases. It should also be noted that, the study did not include other remaining countries in the analysis because they had fewer publications despite their relevancy to BI related studies.Since there were variations in the number of publications, further analysis was also conducted to identify the variations and the similarities of all the publications. Consequently, it was found that the same research publications were recorded in these two databases. One of the reason the databases yielded these results can be attributed to the fact that the journals were listed in both databases.

6.3. Top 10 articles with the highest number of citations related to BI studies

Table 01 exhibits the first top ten authors based on the most cited papers and the title of the articles for each authors based on WoS database. Study by Chen, Chiang and Storey, entitled “Business intelligence and analytics: From big data to big impact” in 2012 was the highest cited article with 805 citations. Next, an article by Kostoff and Scaller (2001) entitled “Science and technology roadmaps” which bagged 285 citations was at the second.

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Table 01. Top 10 articles with the highest number of citations in WoS

No	Research Title	Total Citations	Publication Years
1.	Business intelligence and analytics: From big data to big impact. Authors: **Chen H.C., Chiang R.H.L., Storey, V.C.** *Journal: MIS Quarterly*	805	2012
2.	Science and technology roadmaps. **Authors: Kostoff R.N., Scaller R.R**. *Journal: IEEE Transactions on Engineering Management*	285	2001
3.	Antecedents of information and system quality: An empirical examination within the context of data warehousing**. Authors: Nelson R.R., Todd P.A., Wixom B.H.** *Journal: Journal of Management Information Systems*	245	2005
4.	A critical analysis of decision support systems research. **Authors Arnott D., Pervan G.** *Journal: Journal of Information Technology*	192	2005
5.	Moral awareness in business organizations: Influences of issue-related and social context factors**. Authors: Butterfield K.D., Trevino L.K., Weaver G.R.** *Journal: Human Relations*	190	2000
6.	A confessional account of an ethnography about knowledge work. **Author Schultze U.** *Journal : MIS Quarterly*	154	2000
7.	Innovation forecasting. Authors: **Watts R.J., Porter A.L.** Journal: *Technological Forecasting and Social Change*	134	1997
8.	Knowledge management technology and the reproduction of knowledge work practices. **Authors: Schultze U., Boland R.J.** *Journal: Journal of Strategic Information Systems*	128	2000
9.	Corporate foresight: Its three roles in enhancing the innovation capacity of a firm. **Authors: Rohrbeck R, Gemunden, H.G.** *Journal: Technological Forecasting and Social Change*	85	2011
10.	Business Intelligence in Blogs: Understanding Consumer Interactions and Communities. **Authors: Chau M., Xu J.** *Journal: MIS Quarterly*	83	2012

This was followed by Nelson, Todd and Wixom (2001) entitled "Antecedents of information and system quality: An empirical examination within the context of data warehousing" with 245 citations and, Arnott and Pervan (2005) entitled "critical analysis of decision support systems research" with 192 citations. Besides, a close observation on all top ten articles showed that these articles were subject to information system and knowledge management sub-research area. Indeed, this sub-area only highlighted the concept and descriptive ideas which emphasized the formal theory and structure review on BI related issues. Perhaps, these articles were the early stages of research and were likely to be referred by researchers in business schools in administering and performing field of BI related studies because they may not typically be able to relate BI into laboratory experiment, experimental simulation, judgment task, and computer simulation. This study also observed that the majority of these top articles used the concept of computer simulation research strategy that was written by computer scientists and computer engineers.

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Table 02. Top 10 articles with the highest number of citations in Scopus Database

No	Research Title	Total Citations	Publication Years
1.	Business intelligence and analytics: From big data to big impact **Authors: Chen H., Chiang R.H.L., Storey V.C.** *Journal: MIS Quarterly: Management*	1267	2012
2.	Conformance checking of processes based on monitoring real behavior **Authors: Rozinat A., van der Aalst W.M.P.** *Journal: Information Systems.*	485	2008
3.	IT-dependent strategic initiatives and sustained competitive advantage: A review and synthesis of the literature. **Authors: Piccoli G., Ives B.** Journal: *MIS Quarterly: Management*	359	2005
4.	Analysis of interactions among the barriers of reverse logistics **Authors: Ravi V., Shankar R**. *Journal: Technological Forecasting and Social Change*	344	2005
5.	Antecedents of information and system quality: An empirical examination within the context of data warehousing. **Authors: Nelson R.R., Todd P.A., Wixom B.H.** *Journal of Management Information Systems*	377	2005
6.	Types of information technology capabilities and their role in competitive advantage: An empirical study: **Authors: Bhatt G.D., Grover V.** *Journal of Management Information Systems*	501	2005
7.	Business process modelling: Review and framework. **Authors: Aguilar-Saven R.S.** *International Journal of Production Economics*	428	2004
8.	The influence of an integration strategy on competitive capabilities and business performance: An exploratory study of consumer products manufacturers**. Authors: Rosenzweig E.D., Roth A.V., Dean Jr. J.W.** *Journal of Operations Management*	430	2003
9.	An empirical investigation of KM styles and their effect on corporate performance. **Authors: Choi B., Lee H.** *Journal: Information and Management*	358	2003
10.	A perception-based model for EDI adoption in small businesses using a technology-organization-environment framework. **Authors: Kuan K.K.Y., Chau P.Y.K.** *Journal: Information and Management*	538	2001

Table 02 above presents the first top ten authors based on the most cited papers in Scopus database. Similar to WoS, study by Chen, Chiang and Storey, in 2012 entitled "Business intelligence and analytics: From big data to big impact" was the leading paper. This was followed by Rozinat and van der Aalst (2008), entitled "Conformance checking of processes based on monitoring real behavior" with 485 citations and Piccoli and Ives (2005) with 359 citations through the publication of "Review: IT-dependent strategic initiatives and sustained competitive advantage: A review and synthesis of the literature". Similar to WoS, this findings also showed that majority of top cited articles were related to information system management and knowledge management sub-areas which emphasized on the formal theory and structure review on BI related issues. There appeared to be lack of empirical investigations on BI related issues. However, three of these studies were found to be focusing research on BI implementation related to operation management, business performance, organization business framework and competitive capabilities. In this regard, this study perceived that the focus of BI related areas still offered many areas of study since BI was still relatively new and required more empirical investigations which were highlighted in all of these top cited articles. One of the reasons that can be supported was probably the difficulties in quantifying the benefits

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of improved decision making attributed to BI. Although these results were not robust enough to provide strong justification of BI related studies, it is hope that these results have provided some insight for future efforts on BI related studies.

6.4. Related authors research subject areas (i.e. Keywords analysis)

Further exploration on BI related studies can provide a new dimension on an area that is far from being saturated can be expected. Such deduction was made in accordance to Fu and Ho, (2012), who claimed that research trends can also be viewed by quantitatively analyzing the frequency of author keywords that can provide a reasonably sophisticated picture of the papers' subjects. In this respect, this study had analysed the most frequent keywords used by the authors related to BI in their publications. The results of analysis show that the most frequent keywords used by the authors view in this area was 'competitive intelligence'. This keyword was used not less than 916 times. Furthermore, it was also noticed that, three other frequently applied author keywords were "business intelligence" (811 times), "decision making" (232 times) and "knowledge management" (192 times). Since some of these identified keywords were collocations of several words, this study also further analyzed the separated keywords, and 'intelligence' was found 2051 times and regarded as the most preferred keywords. This was followed by "management" at 1283 times and 'business' at 1275 occassion while 'competitive' and 'information" were used 1202 times and 829 times respectively. Besides, this study also performed to analyse other BI related frequently used keywords. It was found that several new dimension (i.e., keywords) of the BI related research areas quite interesting to be further investigate. These keywords included "intelligence data" 137 times, followed by 'big data' and 'intelligence decision". It should be noted some of these keywords such as 'technical intelligence", "industrial intelligence" and "technology intelligence" have started to find their footing in BI related studies. Perhaps warrant more studies can be conducted.

6.5. Top authors based on number of publications

It was necessary to provide the readers with a quantified overview of the top author in the field (Bayley, Brooks, Tong, & Hariharan, 2014). This study used the term "articles" instead of documents so that documents that were not articles were filtered from the databases as to ensure the consistency of the h-index and the number of author citations (Bornmann & Daniel, 2007). Based on results of bibliometric analysis regarding authors and number of publications related to BI, this study found that Alnoukari (i.e. 14 articles) was the most prolific author for WoS and while Porter (i.e. 8 articles) was in the first place from a list of top ten authors for the Scopus repositories. The study found of the twenty authors identified in the list of the top ten authors in WoS and Scopus, only one author appeared in both list. Unlike the other nineteen authors who appeared only in one of the repositories, Porter's name was mentioned in both the WoS and Scopus list. It was also discovered that Alnoukari and Porter published the most number of BI related papers in WoS and Scopus respectively, while the remaining top authors had published 5 to 7 articles in Scopus and 7 to 12 articles in WoS. For that reason, the claim that Alnoukari and Porter were the top authors in the field appeared to be pre-matured. They may have produced the most number of articles but it appeared there were fewer references made on them. Instead, top most cited author was Chen with 805 citations followed by Kostoff (i.e., 285 citations) and Arnott (i.e., 192 citations). Indirectly, this meant that

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research working in the area of BI should not only include work by both Alnourkari and Porter but also should consider the work of Chen, Kostoff and Arnott. The number of citations an article receives and the studies cited in an article are two of the most popular bibliometric indicators used to determine an article's quality (See Abdullah et al., 2017; Bayley et al., 2014; Baltussen & Kindler, 2004). Nevertheless, the number of citations received by an article may be attributed to the popularity of the article's author or research field rather than the relevance of the article itself.

6.6. Discussion

The bibliometric analysis of BI research documents gathered from the WoS database and Scopus identified only 1744 scientific articles. The most published area under WOS was business, management, economics while the most published area under Scopus was business, management and accounting (i.e., appear in the database system ranking). This study found that the term BI from business and management perspectives made its first appearance in 1985, but only after 2003 the concept really began to attract researchers' attention, and the number of publications started to gather momentum publishing more than 1000 documents. The country responsible for most BI research was the United States of America (USA). The journal that has published the most on BI research was the Decision Support Systems (83 documents) and Journal of Intelligence Studies in Business. The most prolific BI author based on number of publications were Alnoukari, (i.e., 14 articles) and Porter (i.e., 8 articles) however, top authors based on the number of citations was Chen. Based on the keywords analysis (see Section 3.5), a general view regarding the emerging topic can be laid out towards BI by looking into several author keywords. Looking into all these keywords, this study perceived that several areas related to BI were interesting to be further explored particularly by looking at other related keywords. This included intelligence data, technical intelligence, industrial intelligence and technology intelligence. This study was aware that there has been no strong basis to claim that these were the emerging topics but it was believed that some ideas can be triggered and used as guides for other researchers in the field of BI.

Further literature reviews (i.e., scoping review or meta-analysis) could perhaps broaden the research dimensions in BI. In this regard, future BI studies may be able to identify the details research focus in lights of the generalizability, and realism of context. There are several limitations with respect to this study. Firstly, this study only used bibliometric data to map the area of related BI studies within WoS and Scopus databases which could restrict some good and relevant articles that have not been indexed in WoS and Scopus databases. Data from the non-WoS and non-Scopus may supply the researchers with more comprehensive and robust analysis on BI related studies. Secondly, this study identified some inappropriacy on the citation count since there was a tendency for authors' to self-cite, or cite free full access articles, review papers, well known authors, papers by colleagues as well as cited papers from the journal they were going to submit their work to. Thirdly, another limitation of this study was due to the bias against older research papers. The publication year influenced citation indexes and the number of citations for each paper and therefore, the new papers would not have sufficient time to reach a higher citation rate compared to older papers. Moreover, this study only focused on bibliometric analysis by studying only BI articles within the WoS and Scopus by excluding any document that was not classified as an article, like reviews, proceedings, book reviews, and so forth. The absence of this data at certain points may weaken some of the

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justifications due to the lack of variety in research publication outputs. However, the good news was that many of the research areas in BI in general were open for future research efforts. It can be perceived that this research analysis could provide a foundation for further efforts that could enhance the body of knowledge and theoretical development of BI in business and management perspectives.

7. Conclusion

There has been positive development in research on BI since its inception in 1983. Though the number of research publications is gradually increasing, they are still relatively low. It can be expected the number will surge as new and promising researchers began to explore the area of BI. The bibliometric analysis of the BI related articles have revealed positive potentials in the research dimensions of the BI related study. The revelation of emerging areas of study for BI namely technical intelligence, industrial intelligence and technology intelligence means that there are more to come from this. The emergence of BI related studies can be expected to happen and to gain momentum in the following years.

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