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A metadata review on business intelligence in the construction industry

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Abstract: Little effort has been made to know the status of BI in the construction industries. Business intelligence (BI) is critical for companies to migrate into Industry 4.0. Therefore, this study aims to review the literature related to BI in the construction industry to find out the status and presents directions for future research. Twenty-five articles were collected from the Scopus database from the year 2000 to April 2019. The study analysed the data through data mining and descriptive statistics. The findings revealed a growing upward trend in publications. Moreover, Artūras Kaklauskas was found as the top author and *Expert Systems with Applications* and *Journal of Construction Engineering and Management* were found to be the top journals that publish the most number of papers. This study contributes to literature by presenting a review paper on BI in the construction industry.

Keywords: business intelligence; construction industry; data mining; artificial intelligence; literature review.

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1 Introduction

The fourth industrial (Industry 4.0) revolution is on the horizon. It is often mentioned that several technological factors will make Industry 4.0 possible, including cyber-physical systems, the internet of things, and the internet of systems (Marr, 2018). Artificial intelligence has become essential for new manufacturing firms to embrace the Industry 4.0 challenge (Lee et al., 2018). Thus, the concept of business intelligence that applies artificial intelligence in solving data-related problems in new business firms has emerged (Chen et al., 2012). In the literature, the vast number of articles related to BI have also substantiated its importance in the academic arena. Since there are more papers in this area, there are potential concern of information diffusion. Hence, there is a need to summarise the literature to know the existing status and propose some future research agenda. Therefore, more literature review papers are essential and necessary to understand the context of BI in a summarised form.

There are several literature review papers related to BI in the literature. For example, Jourdan et al. (2008) presented a literature review on BI and collected data from several selected journals between the year 1997–2006. Moro et al. (2015) published a literature review on BI in the banking industry, which included publications from 2002 to 2013. A literature review on BI in cloud computing was proposed by Mwilu et al. (2016). Meanwhile, Trieu (2017) published a study of the literature with an emphasis on BI values. Mariani et al. (2018), on the other hand, reviewed the literature on business intelligence (BI) in the hospitality and tourism industries. Besides that, Hindrayani (2020) published a literature review on BI in the education sector, while Srivastava and Venkataraman (2021) examined studies on BI tools to discover superior systems. However, little attention has been given to the construction industry in particular. The construction industry plays a significant role in a nations' economic development. Therefore, this study aims to review the literature related to BI in the construction industry to investigate the current status and present future research directions.

The study will address the following research questions: What is the status of the papers related to BI in the construction industry published between the year 2000 to 2018? What are the future research possibilities of BI in the construction industry? The first research question will explore the trend of the recent publications, the top journals receiving the most number of publications, the influential authors, key papers with citations, etc. The second question will present the directions for future research based on the analysis of the first research question.

The data were collected from the Scopus database from the year 2000 to April 2019. After careful screening, 205 articles have been finalised for analysis purpose. The study analysed the metadata of the selected articles through data mining and presented descriptive statistics. This study contributes to the literature by including a literature review on BI focusing on the construction industry. To the researcher's knowledge, there are relatively few review papers in the literature that concentrate on BI in the construction industry. Moreover, the study provides a comprehensive metadata analysis for understanding the status of the extant literature. The rest of the paper is structured as follows: Section 2 presents the concepts of BI. This is followed by a detailed discussion of the underline method of data collection and analysis in Section 3. The result of the metadata analysis is presented in Section 4. Section 5 presents the conclusion, limitations, and direction for future research.

2 Business intelligence in the construction industry

Since humans can make choices based on circumstances, the term 'intelligence' is widely used to describe them. A machine, on the other hand, lacks intellect. A machine may be artificially intelligent if it is programmed with information in the form of instruction codes. Nowadays, BI has gotten a lot of recognition from both practitioners and academicians (Di Vaio et al., 2020; Richards et al., 2019; Teixeira et al., 2019). It has become a key success factor and a strategic weapon by many business firms (Tripathi et al., 2020; Wixom and Watson, 2010). BI refers to the set of process, methods, techniques, and theories that converts data into information for business purpose (Rud, 2009). Wixom and Watson (2010) presented BI as the technologies, applications, and processes for gathering, storing, accessing, and analysing data to help users make better decisions. Torres et al. (2018) defined it as an umbrella term that refers to information

systems which transform the data into meaningful information to minimise uncertainty in decision making. Moreover, Maffock et al. (2019) asserted that BI refers to technologies, applications, and practices for collecting, integrating, analysing, and presenting business information. With the above definitions, Business Intelligence can be defined as a wide category of applications and technology for gathering, storing, evaluating, and providing access to data to help business professionals make informed business decisions.

The literature presents discussion on BI in different contexts such as in chemical industry (De Carvalho and Sassi, 2014; Sikorski et al., 2017), healthcare industry (Khatib and Ahmed, 2020) insurance industry (Ranjan and Khalil, 2008), etc. BI in the construction industry has also gained a lot of attention. Naser (2019), for example, combined artificial intelligence with a genetic algorithm to better understand the complex behaviour of building materials in extreme conditions. In addition, Poh et al. (2018) presented a machine learning approach to predict safety behaviour in a construction company. They applied the cross-industry standard process for data mining (CRISP-DM) method to analyse the record, including safety inspection records, accident cases, and project-related data. Cheng et al. (2017) proposed a machine learning solution for construction equipment activity analysis problem. Their proposed system monitors the activity pattern of construction equipment using radio signals generated by the equipment. Núñez-Tabales and Rey-Carmona (2016) presented a pricing appraisal method based on artificial neural networks to determine the competitive price for commercial properties. Meanwhile, Bakhoun and Brown (2015) presented a computer-based decision support system to select sustainable building materials in the construction industry. Besides, Horta and Camanho (2013) presented a data mining technique to predict companies failure in the construction industry. Cheng et al. (2010) proposed an artificial intelligence approach, namely the evolutionary fuzzy hybrid neural network to estimate the cost of projects in the construction industry. Thus, it can be observed that the application of BI in the construction industry is very broad. Prior studies have shown that BI can be applied in different areas in the construction industry including in the analysis of economic feasibility of the projects, selection of suitable building materials, monitoring and predicting safety concerns in the construction sites as well as predicting the company failure, monitoring the heavy construction equipment and so on.

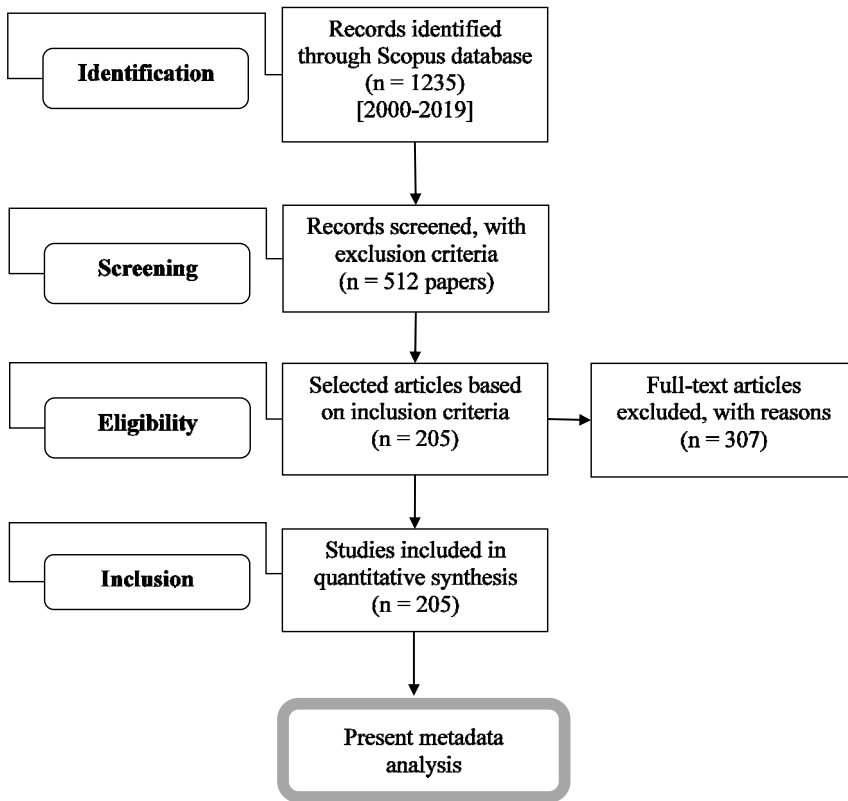
3 Method

Paul and Criado (2020) presented a systematic literature review using a range of 40 to 500 papers. They added that articles could be collected through a keyword search in the databases. Tranfield et al. (2003) narrated that one of the objectives of a review paper is to presents gaps in the literature. Thus, this study has followed a similar norm to collect the data and present the literature gap.

This study selects the Scopus database for searching the keyword to collect the data. Table 1 presents the systematic process of data collection. This process began with defining the relevant keywords to derive the desired contents. A combined advanced search string was employed to derive the data, i.e., ('construction industry' OR 'real estate') AND ('business intelligence' OR 'data mining' OR 'decision support system' OR 'knowledge discovery' OR 'business analytics' OR 'machine learning' OR 'artificial intelligence'). The search result was limited between the year 2000 and 2019 (up to April 30), which generated 1235 items. After filtering the exclusion criteria, it then generated

512 records. These records have been carefully screened with the inclusion criteria to fit with BI’s broad context in the construction industry, and 205 papers were finalised for analysis purpose. The study used the metadata of 205 papers to present the descriptive statistics through data mining and other graphical presentations.

Figure 1 Systematic literature review process used by this study



The Scopus database is known for hosting metadata information of contents by many well-known publishers: Science Direct, PLOS, IGI Global, Emerald, Taylor and Francis, Springer, Willey, and many more. Hence, this database is reliable for data collection. In the literature, many prior studies collected the data for literature review purpose from this database (Islam et al., 2017; Seuring and Müller, 2008; Tseng et al., 2019). This study has confined the search result from 2000 to April 30, 2019. Several studies in the literature have used a similar approach to minimise information diffusion (Govindan et al., 2015; Maditati et al., 2018). Figure 1 represents the method used in this study. This method has been adapted based on previous studies (Islam et al., 2020; Moher et al., 2009; Tseng et al., 2019) except that this study did not go for qualitative synthesis for content analysis. Instead, this study limited its scope to the quantitative synthesis, e.g., metadata analysis.

Table 1 The process of collecting the data (2000–2019)

<i>Phases</i>	<i>Description</i>	<i>Items</i>	<i>Remarks</i>
Keyword search in Scopus database	(‘construction industry’ OR ‘real estate’) AND (‘business intelligence’ OR ‘data mining’ OR ‘decision support system’ OR ‘knowledge discovery’ OR ‘business analytics’ OR ‘machine learning’ OR ‘artificial intelligence’).	1,235	Limit to: Article title, abstract, and keywords. Year 2000–April 30, 2019.
Exclusion criteria	Excluded items appeared as conference papers, book chapters, conference reviews, articles in press, books, notes, editorials, articles not written in English.	512	Articles only
Inclusion criteria	Further filter items based on studies focusing on the broad area of BI in the construction industry have been prioritised in ranking and shortlisting.	205	Finalised for metadata analysis

4 Metadata analysis and discussion

This section addresses the first research questions of this study by investigating the current status of the literature. The following subsections present the results of metadata analysis. To answer the first research question, this study explores publications by year, journals, top authors, institutions, countries, subject areas, and so on. During the analysis this study considers one single paper into multiple places. For example, if there are three co-authors in a single paper, each of them gets one unit of publication credit, and each of their countries and institutions gets one unit of publication credit. In addition, the results of the descriptive statistics, which are described in the form of figures and tables, are summarised. For example, the top ten author list or the top twenty keyword list, and so on.

4.1 Publications by year

Figure 2 presents the trend of publication from the year 2000 to April 2019. The figure shows a positive upward trend of publications throughout this period. Just two papers were published in the year 2000, according to the data. However, as time goes on, the number of publication increased extensively. During mid-2010, ten publications were produced, whereas 32 publications were produced in 2018. According to the most recent year, there have already been 20 papers written (up to April 2019). While there are some ups and downs in the number of publications, there is an upward trend in the number of publications over time. The increased number of recent publications on BI in the construction industry may be due to the fourth industrial revolution’s emergence. This positive trend of publication also provides evidence that the researchers are helping new business firms by studying problems related to BI and providing solutions to better cope with future industrial revolutions.

Figure 2 Publications on BI in the construction industry by year (see online version for colours)

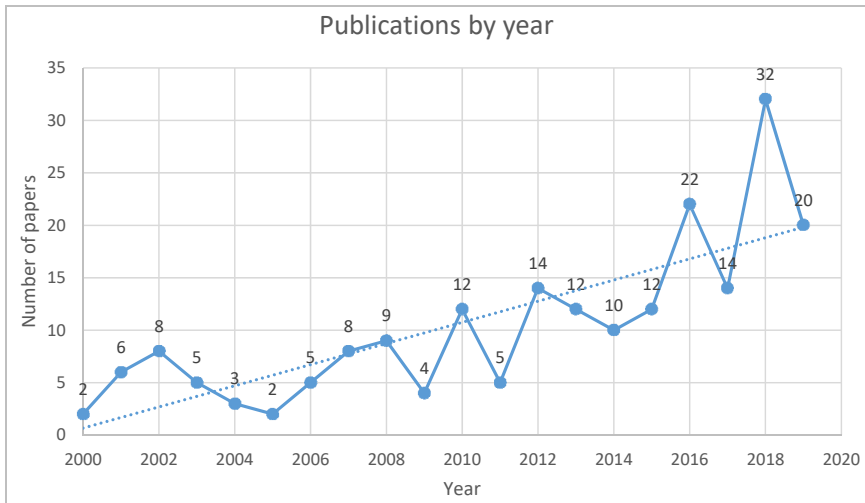
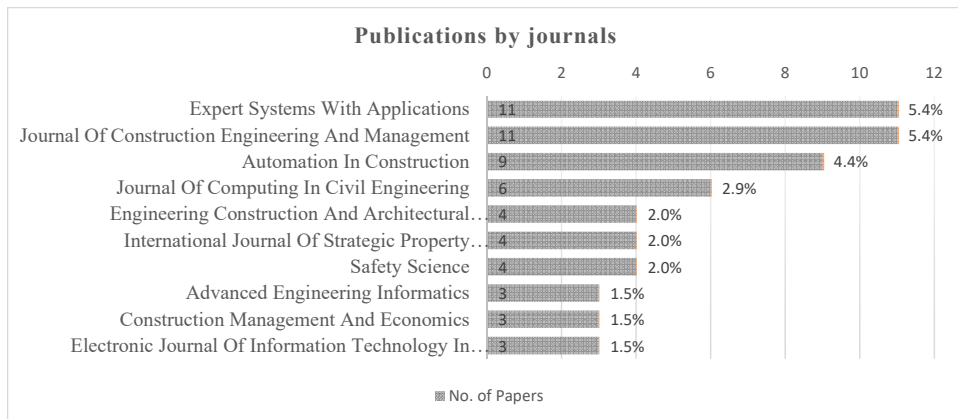


Figure 3 Publications on BI in the construction industry by journal



4.2 Publications by journal

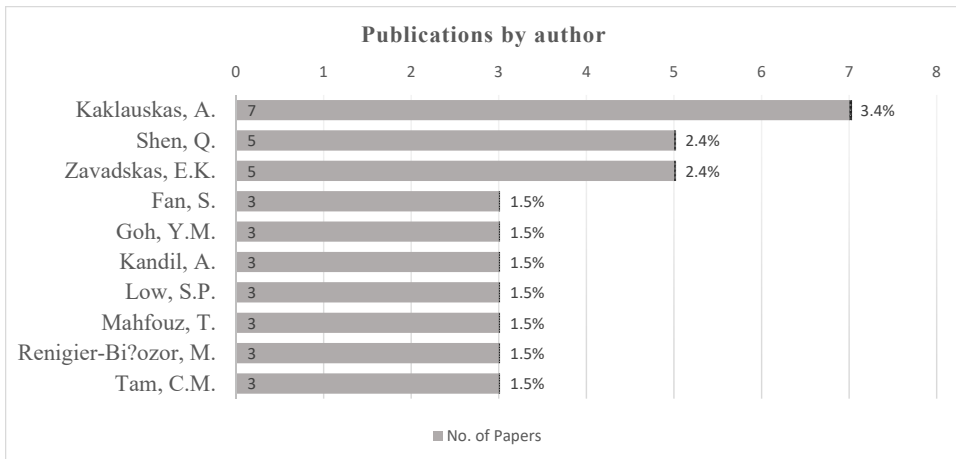
This section presents the top ten list of journals that received the most publications on BI in the construction industry. Figure 3 illustrates that the *Journals of Expert Systems of Applications* and the *Journal of Construction Engineering and Management* are tied for first place in terms of the number of publication credits received. Both of the journals jointly contributed 22 papers, whereas each of them have a share of 5.4% of the total (205 papers). Automation in Construction Journal holds the second position by publishing nine papers in the same area with a 4.4% share. *Journal of Computing in Civil Engineering* stands in the third position by publishing six papers and having a share of 2.9%. Three journals, namely *Engineering Construction And Architectural Management*, *International Journal of Strategic Property Management*, and *Safety Science*, hold the fourth rank jointly by publishing four papers. Finally, *Advanced Engineering Informatics*,

Construction Management and Economics, and *Electronic Journal of Information Technology in Construction* jointly hold the fifth rank by publishing three papers. Appendix presents the complete list of journals along with the number of papers.

4.3 Publications by author

This section presents the top ten authors who publish the highest number of papers on BI in the construction industry. Figure 4 shows that Artūras Kaklauskas is the leading author who publishes the highest number of BI papers in the construction industry. He contributed seven papers and is holding the share of 3.4% in total. After that, Shen and Zavadskas both contributed the same number of publications (five papers), having a share of 2.4% each. The rest of the authors published an equal number of papers with 1.5% of share each. This finding reveals that the papers are not concentrated on a handful of authors. Instead, the publications are dispersed, and many authors have contributed to the extant body of knowledge related to BI in the construction industry.

Figure 4 Top ten authors by publications



4.4 Publications by citation

Citation is one of the ways to identify influential papers from the literature. Previous studies have highlighted the key papers using citation analysis (Fahimnia et al., 2015; Tseng et al., 2019). This section presents the top ten list of most cited papers on BI in the construction industry as appeared in the Scopus Database. Table 2 shows that the paper that ranks at the top is about knowledge discovery and is authored by Soibelman and Kim (2002). Their paper has received 91 citations, which means it has been quoted in 91 other publications. The second most cited paper is authored by Anumba et al. (2002), which received 87 citations.

It is difficult to rank the influential authors because there is little coherence between the top ten authors and the top ten cited papers. The authors of the top five cited articles do not appear in the top ten authors' list, which is surprising. In comparison, a few authors who appear in the top ten authors list still appear at the bottom of the top ten cited

papers list. For example, Kaklauskas, who ranks at the top ten list of authors by publishing the highest number of papers, finds himself at the bottom of the most cited paper (at position 9). Kanapeckiene et al. (2010) wrote the paper on the integrated knowledge management model. Kaklauskas and Zavadskas are ranked first and third in the top ten authors by publication, respectively. Based on Table 2 and Figure 3, it is difficult to rank the most influential authors. However, it can be concluded based on the findings that Kaklauskas and Zavadskas are among the influential authors in BI in the construction industry since they appear in the top ten list in terms of the number of publications as well as the number of citations.

Table 2 The top most cited papers

<i>Authors</i>	<i>Titles</i>	<i>Year</i>	<i>Citations</i>
Soibelman and Kim	The data preparation process for construction knowledge generation through knowledge discovery in databases.	2002	91
Anumba et al.	Collaborative design of structures using intelligent agents.	2002	87
Cheng et al.	Use of association rules to explore cause-effect relationships in occupational accidents in the Taiwan construction industry.	2010	76
Liao and Perng	Data mining for occupational injuries in the Taiwan construction industry.	2008	73
Fern and Givan	Online ensemble learning: an empirical study.	2003	70
Tam et al.	Non-structural fuzzy decision support system for evaluation of construction safety management system.	2002	67
Tserng and Lin	An accelerated subcontracting and procuring model for construction projects.	2002	62
Ur-Rahman and Harding	Textual data mining for industrial knowledge management and text classification: a business oriented approach.	2012	57
Kanapeckiene et al.	Integrated knowledge management model and system for construction projects.	2010	57
Goh and Chua	Case-based reasoning approach to construction safety hazard identification: Adaptation and utilisation.	2010	51

Note: Citations presented here are based on the papers cited by Scopus indexed journals only (as of April 2019).

4.5 *Publications by institution*

This section presents the top ten institutions as per the records in the database. Figure 5 shows that Hong Kong Polytechnic University ranks number one by publishing nine papers and holding a 4.4% share in total. The second most papers are jointly published by the National University of Singapore and Vilniaus Gedimino Technikos Universitetas. Both of these institutions have a record of eight publications each. National Taiwan University of Science and Technology appeared next by publishing six papers and having a share of 2.9%. Purdue University and the City University of Hong Kong both share

2.4% of the total publications by publishing five papers each, followed by Uniwersytet Warmińsko-Mazurski w Olsztynie by four publications. The rest of the institutions, namely the University of Colorado at Boulder, Loughborough University and Universiti Utara Malaysia, contributed an equal number of papers with a 1.5 % share.

Figure 5 Top ten institutions by publication

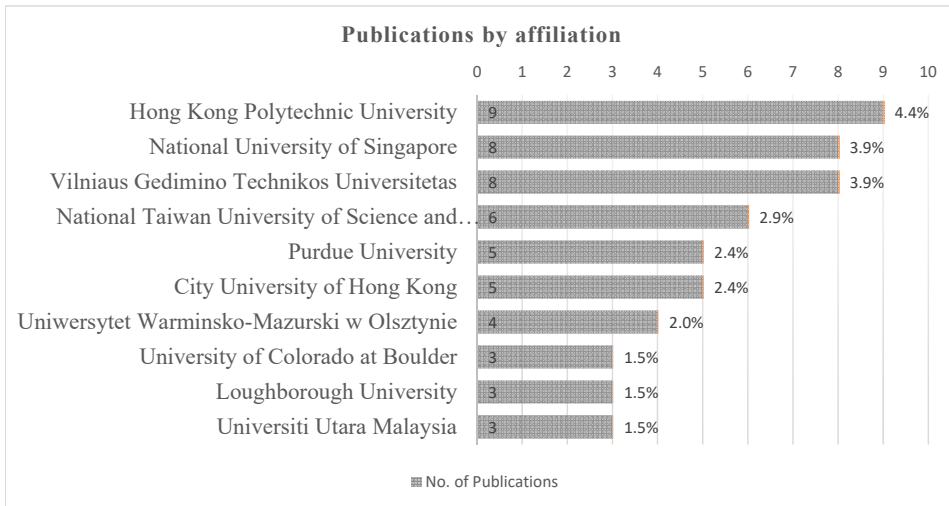
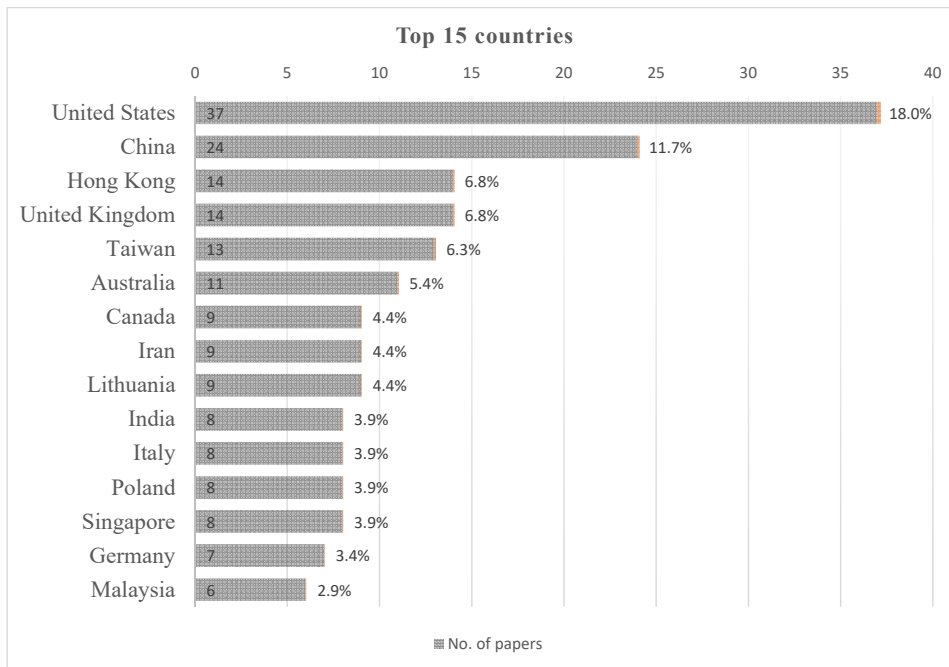


Figure 6 Top 15 countries by publication



4.6 Publications by country

This section presents the top fifteen countries whose authors publish the most papers on BI in the construction industry. Figure 6 shows that the USA appears at the top by publishing 37 papers, holding a share of 18%. China came in second with 24 articles, accounting for an 11.7% share in total. Both Hong Kong and the UK published the same number of articles, accounting for 6.8% share. Malaysia is ranked 15th by publishing six papers and with a share of 2.9%. The top two nations, the USA and China, are estimated to have contributed about 30% of the papers on BI in the construction industry. Table 3 presents the top fifteen countries based on their continents. Figure 6 also shows the share of papers based on continents. Table 3 and Figure 7 show that two continents, namely Africa and South America, are staying behind in publications. To reduce the knowledge gap in this context, researchers from these regions should contribute more articles. The other continents, on the other hand, have all contributed to the literature. Figure 7 shows that Asia dominates the literature by holding a share of 44%. Both North America and Europe jointly hold a 25% share, followed by Australia, which holds a 6% share.

Table 3 Continental categorisation of top fifteen countries by publication

<i>Continents</i>	<i>Countries</i>	<i>Publications</i>	<i>Share</i>
	USA	37	18.05%
	Canada	9	4.39%
<i>North America</i>		46	22.44%
	UK	14	6.83%
	Lithuania	9	4.39%
	Italy	8	3.90%
	Poland	8	3.90%
	Germany	7	3.41%
<i>Europe</i>		46	22.44%
<i>Australia</i>		11	5.37%
	China	24	11.71%
	Hong Kong	14	6.83%
	Taiwan	13	6.34%
	Iran	9	4.39%
	India	8	3.90%
	Singapore	8	3.90%
	Malaysia	6	2.93%
<i>Asia</i>		82	40.00%

Figure 7 Distribution of top 15 countries by continent (see online version for colours)

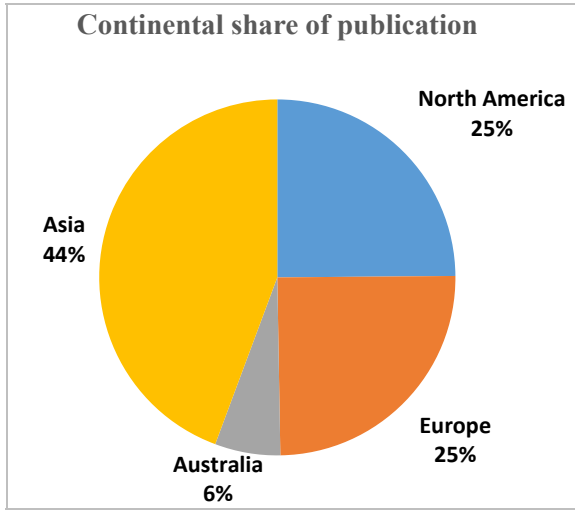
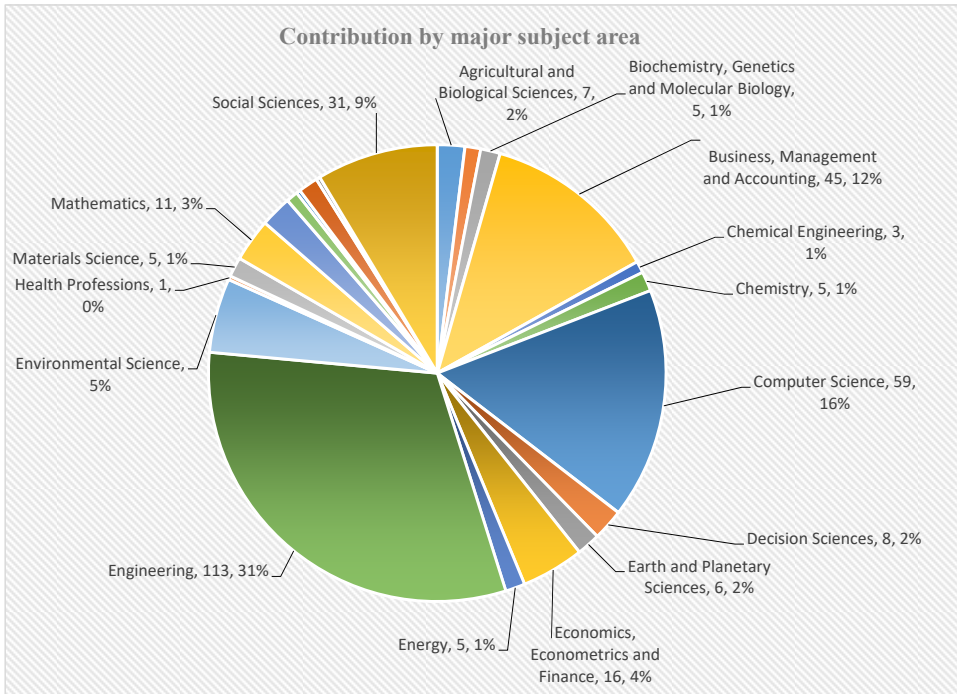


Figure 8 Contributions by selected subject area (see online version for colours)



4.7 Contribution by subject area

Figure 8 presents the major contributing subject areas on BI in the construction industry. The figure shows that the engineering area contributes the highest number of publications

followed by computer science and business management which takes the second and third place. The engineering field alone contributed 113 papers, accounting for 31% of the total share. Meanwhile, the field of computer science comes in second with 59 papers, accounting for 16% of the share. The business management section contributed 45 papers, with 12% of share. Moreover, many more subjects also contributed to BI in the construction industry, including social sciences, environmental sciences, economics, mathematics and many more. The figure also reveals that a large number of the mentioned subject areas contributed to the literature. This multidisciplinary engagement on this topic necessitates BI’s significance in the construction industry among the wider academic community.

4.8 Most common words used in the titles

This section presents the results based on the data mining technique. The data mining concept has been used to identify the most common words used in the title. For data mining, this study employs open source software, namely wordart.com. The findings are presented both in tabular and word cloud formats. The top ten lists of the most common words used in the titles are summarised in Table 4. The table shows that the word ‘construction’ and ‘system’ were both identified as the most common words used in titles by 54 papers out of 205 papers. The second most popular word in the titles was ‘support,’ which was used 42 times, followed by the words ‘data,’ ‘use,’ and ‘decision,’ which were all used 38 times.

Table 4 Top ten most common words appeared in the titles

<i>Words</i>	<i>Numbers</i>	<i>Words</i>	<i>Numbers</i>
Construction	54	Decision	38
System	54	Model	36
Support	42	Based	36
Data	38	Real	36
Use	38	Estate	33

The word cloud is another data mining technique that presents the results in a cloud-like image. Figure 9 presents the most common words as appeared in the titles. The bigger the font size indicates a higher frequency of words. In contrast, the smaller the font size indicates a lesser frequency of words. For example, the word ‘construction’ and ‘system’ identified as the most common words in the titles also appear in bold and bigger fonts in the word cloud. Besides the top ten lists, there are many more words that appear in the cloud that have been used in the titles by prior studies. The most used or the least used common words can be easily identified from the word cloud. It is worth mentioning that this picture provides common topics and gives hints about the gaps or areas where limited studies have been conducted. For example, assessment, evaluation, the words big data, triple bottom line (TBL), sustainability, etc., are not visible in the figure. The word cloud found to be a useful technique that can summarise and visualise information from a large dataset (Hearst et al., 2019; Islam et al., 2020).

show evidence of both similar and infrequent studies in the literature. It also provides the idea to propose for future research possibilities.

Table 5 Most common keywords used in past publications

<i>Keywords</i>	<i>Frequency</i>	<i>Keywords</i>	<i>Frequency</i>
Construction industry	86	Machine learning	14
Decision support system	69	Regression analysis	12
Artificial intelligence	63	Support vector machines	12
Data mining	45	Decision theory	11
Decision making	30	Costs	10
Project management	25	Fuzzy logic	10
Neural networks	19	Decision trees	9
Real estate	18	Knowledge-based systems	9
Learning systems	17	Accidents	8
Forecasting	16	Construction projects	8

5 Conclusions and future research

The construction industry is heading towards Industrial revolution 4.0, where BI’s application would be a key competitive advantage to survive and continue with its operation. BI in the construction industry has been widely discussed in the literature. This study systematically reviewed the literature on BI in the construction industry from a reliable database to present perspectives on the current state of the field and research directions for the future. The metadata review results show that there has been an increasing upward trend in publications over time. *Expert Systems with Applications* and *Journal of Construction Engineering and Management* jointly appeared as top journals by publishing the highest number of BI papers in the construction industry. Artūras Kaklauskas ranks as the top author by publishing the most number of papers. As for institution, Hong Kong Polytechnic University published the highest number of publications. Meanwhile, publications by country revealed that the USA published the highest number of papers. As for the subject area, the engineering discipline contributed around 31% of papers. The word ‘construction’ was identified as the most common word used in the past title of publications, while the keyword ‘construction industry’ was found to be the most common keyword used in past publications.

The following discussion answers research question number 2; What are the future research possibilities on BI in the construction industry? First, the use of big data would be an interesting subject, as the word cloud in Figure 8 shows that only a few studies used big data in their study. Second, since few studies in the literature have used social media data in their research, social media data, in particular, will be an interesting topic for future research. Third, the construction industry has identified sustainability assessment and evaluation using the TBL approach as a research area. The use of big data with BI in balancing profit, planet, and people would be an attractive topic in the coming years. Fourth, given the scarcity of papers from other continents, especially Africa and South America, preference should be given to papers from these regions. As a result, researchers from these continents are strongly urged to contribute to the literature. The

study adds to the body of knowledge in a variety of aspects. BI in the construction industry is currently the focus of very few literature review papers. Therefore, by presenting a literature review paper on BI in the construction industry, this study contributes to the current knowledge. Secondly, most of the current review papers related to BI presented the analysis based on very short list of papers. This study considered more than two hundred papers for analysis purpose. Thus, the results of this study minimise the potential risk of a representative sampling problem. Furthermore, the study's metadata review provides many new insights for a deeper understanding of the state of the existing literature on BI in the construction industry. However, there are some limitations to this study. First, the researchers only used data from the Scopus database. Only articles from selected journals are included in the Scopus database index. As a result, there is a chance of data loss. Future studies may use Google Scholar to minimise the risk of data loss. Second, the keywords used for searching the contents in the database may not be sufficient to grab BI's entire spectrum. Future studies can try adding more keywords especially, 'construction industry' OR 'real estate' AND 'business intelligence' OR 'data mining' OR 'decision support system' OR 'knowledge discovery' OR business analytics' OR 'machine learning' OR 'artificial intelligence', to derive more contents from the database. Third, the study analysed the metadata of the selected papers and present descriptive analysis. Future studies may employ content analysis to bring further insights, including the classification of papers based on clusters. Moreover, future studies may conduct an empirical study to see whether this study's findings align well with industry trends. A survey-based qualitative approach targeting the industry experts as respondents is highly recommended. Finally, this study included the papers from the year 2000 to April 2019 and excluded papers published before the year 2000.

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Appendix

Table A1 Total no of publications by journal

<i>Journals</i>	<i>No of papers</i>
<i>Expert Systems With Applications</i>	11
<i>Journal of Construction Engineering and Management</i>	11
<i>Automation in Construction</i>	9
<i>Journal of Computing in Civil Engineering</i>	6
<i>Engineering Construction and Architectural Management</i>	4
<i>International Journal of Strategic Property Management</i>	4
<i>Safety Science</i>	4
<i>Advanced Engineering Informatics</i>	3
<i>Construction Management and Economics</i>	3
<i>Electronic Journal of Information Technology In Construction</i>	3
<i>International Journal of Project Management</i>	3
<i>Journal of Advanced Oxidation Technologies</i>	3
<i>Journal of Civil Engineering And Management</i>	3
<i>Journal of Property Research</i>	3
<i>Real Estate Management and Valuation</i>	3
<i>Construction and Building Materials</i>	2
<i>Engineering Applications of Artificial Intelligence</i>	2
<i>Journal of Architectural Engineering</i>	2
<i>Journal of Organizational Computing and Electronic Commerce</i>	2
<i>Revista Ingenieria De Construccion</i>	2
<i>Wit Transactions on Ecology and the Environment</i>	2
<i>AI and Society</i>	1
<i>Abstract and Applied Analysis</i>	1
<i>Accident Analysis And Prevention</i>	1
<i>Advances in Decision Sciences</i>	1
<i>Advances in Environmental Biology</i>	1
<i>Advances in Information Sciences and Service Sciences</i>	1
<i>Aestimum</i>	1
<i>Agro Food Industry Hi Tech</i>	1

Table A1 Total no of publications by journal (continued)

<i>Journals</i>	<i>No of papers</i>
<i>American Eurasian Journal of Sustainable Agriculture</i>	1
<i>Annals of GIS</i>	1
<i>Annals of Regional Science</i>	1
<i>Applied Economics</i>	1
<i>Applied Sciences Switzerland</i>	1
<i>Applied Soft Computing Journal</i>	1
<i>Arabian Journal for Science And Engineering</i>	1
<i>Architectural Science Review</i>	1
<i>Archives of Civil Engineering</i>	1
<i>Arpn Journal of Engineering And Applied Sciences</i>	1
<i>Biotechnology an Indian Journal</i>	1
<i>Building And Environment</i>	1
<i>Business Theory and Practice</i>	1
<i>Canadian Journal of Civil Engineering</i>	1
<i>Communications in Computer and Information Science</i>	1
<i>Computational Materials Science</i>	1
<i>Computers and Concrete</i>	1
<i>Computers Environment and Urban Systems</i>	1
<i>Computers in Industry</i>	1
<i>Cost Engineering Morgantown West Virginia</i>	1
<i>Cybergeo</i>	1
<i>Data And Knowledge Engineering</i>	1
<i>Decision Support Systems</i>	1
<i>Disaster Prevention and Management an International Journal</i>	1
<i>Economic Research Ekonomiska Istrazivanja</i>	1
<i>Energy and Buildings</i>	1
<i>European Journal of Operational Research</i>	1
<i>European Journal of Social Theory</i>	1
<i>Geoinformatica</i>	1
<i>Geosciences Switzerland</i>	1
<i>Green Energy and Technology</i>	1
<i>Hkie Transactions Hong Kong Institution of Engineers</i>	1
<i>IEEE Transactions on Information Technology in Biomedicine</i>	1
<i>IFAC Papersonline</i>	1
<i>ISPRS International Journal of Geo Information</i>	1
<i>Ieej Transactions on Electronics Information and Systems</i>	1
<i>Informatologia</i>	1
<i>International Journal of Agricultural and Environmental Information Systems</i>	1

Table A1 Total no of publications by journal (continued)

<i>Journals</i>	<i>No of papers</i>
<i>International Journal of Applied Engineering Research</i>	1
<i>International Journal of Artificial Intelligence</i>	1
<i>International Journal of Business Intelligence and Data Mining</i>	1
<i>International Journal of Civil Engineering</i>	1
<i>International Journal of Civil Engineering and Technology</i>	1
<i>International Journal of Computers Communications and Control</i>	1
<i>International Journal of Construction Education and Research</i>	1
<i>International Journal of Control and Automation</i>	1
<i>International Journal of Engineering and Advanced Technology</i>	1
<i>International Journal of Engineering AND Technology</i>	1
<i>International Journal of Engineering and Technology UAE</i>	1
<i>International Journal of Geographical Information Science</i>	1
<i>International Journal of Geomate</i>	1
<i>International Journal of Information System Modeling and Design</i>	1
<i>International Journal of Injury Control and Safety Promotion</i>	1
<i>International Journal of Intelligent Systems Technologies and Applications</i>	1
<i>International Journal of Management and Decision Making</i>	1
<i>International Journal of Mathematical Models And Methods in Applied Sciences</i>	1
<i>International Journal of Online Engineering</i>	1
<i>International Journal of Pharmacy and Technology</i>	1
<i>International Journal of Sustainable Building Technology and Urban Development</i>	1
<i>International Journal of Sustainable Development And Planning</i>	1
<i>International Journal of Sustainable Engineering</i>	1
<i>International Journal of Web Portals</i>	1
<i>Journal of Applied Business Research</i>	1
<i>Journal of Building Engineering</i>	1
<i>Journal of Business and Industrial Marketing</i>	1
<i>Journal of Business Economics and Management</i>	1
<i>Journal of Civil Structural Health Monitoring</i>	1
<i>Journal of Cleaner Production</i>	1
<i>Journal of Computational Information Systems</i>	1
<i>Journal of Construction in Developing Countries</i>	1
<i>Journal of Economics and Finance</i>	1
<i>Journal of Financial Management of Property and Construction</i>	1
<i>Journal of General Management</i>	1
<i>Journal of Green Engineering</i>	1
<i>Journal of Housing and the Built Environment</i>	1

Table A1 Total no of publications by journal (continued)

<i>Journals</i>	<i>No of papers</i>
<i>Journal of Information and Computational Science</i>	1
<i>Journal of Knowledge Management</i>	1
<i>Journal of Management In Engineering</i>	1
<i>Journal of Money Laundering Control</i>	1
<i>Journal of Multiple Valued Logic and Soft Computing</i>	1
<i>Journal of Property Investment and Finance</i>	1
<i>Journal of Quality in Maintenance Engineering</i>	1
<i>Journal of Real Estate Literature</i>	1
<i>Journal of Real Estate Portfolio Management</i>	1
<i>Journal of Real Estate Research</i>	1
<i>Journal of the International Academy for Case Studies</i>	1
<i>Jurnal Teknologi</i>	1
<i>Ksce Journal of Civil Engineering</i>	1
<i>Ksii Transactions on Internet and Information Systems</i>	1
<i>Kuwait Journal of Science and Engineering</i>	1
<i>Machine Learning</i>	1
<i>Measurement Journal of the International Measurement Confederation</i>	1
<i>Natural Hazards Review</i>	1
<i>OECD Observer</i>	1
<i>Pacific Rim Property Research Journal</i>	1
<i>Pakistan Journal of Statistics</i>	1
<i>Plos One</i>	1
<i>Pollack Periodica</i>	1
<i>Procedia Manufacturing</i>	1
<i>Research Journal of Applied Sciences Engineering and Technology</i>	1
<i>Scientific Research and Essays</i>	1
<i>Statistics Optimization and Information Computing</i>	1
<i>Structural Engineering and Mechanics</i>	1
<i>Survey Review</i>	1
<i>Sustainability Switzerland</i>	1
<i>Sustainable Cities and Society</i>	1
<i>Symmetry</i>	1
<i>Technological and Economic Development of Economy</i>	1
<i>Tehnicki Vjesnik</i>	1
<i>Transactions in GIS</i>	1
<i>Transport Policy</i>	1
<i>Tsinghua Science and Technology</i>	1
Total	205