The Impact of Big Data on Banking Operations

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Research

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Abstract

In the current technological advances with the rise of the information revolution through mobile internet, cloud computing, big data, and the Internet of Things (IoT), the banking industry is receiving new opportunities and facing critical challenges. It motivates us to develop the proposed research concept to examine how data innovation influences banking operations. We employ the systematic qualitative research methodology based on the existing literature from Web of Science and SCOPUS database to accomplish our research objectives. The findings of this study include the positive implications of big data, challenges, and banking security as essential data-driven banking issues. This research will have a significant implication in the banking industry that big data operation is critical for data-driven banking decisions.

1. Introduction

This study provides a broad overview of how banking operations have been influenced by the emergence of big data, which involves the enormous data captured and stored at unprecedented levels of volume, velocity, and variety (Cohen, 2018). The impressive explosion of data and the rapid development of new technology have significantly transformed business strategies and management through AI, IoT, Bigdata analytics, cloud, and blockchain (Akter, Michael, et al., 2020). In the earlier periods, big data was considered insignificant for most firms; however, the value of big data is now commonly accepted (González-Carrasco et al., 2019). Most of the companies worldwide started exploiting the potential opportunities offered by utilizing big data. For example, recently, financial institutions have stored hundreds of millions of data for various purposes in their operations (Oracle, 2012; Yu & Guo, 2016b). Big data and data analytics have become day-to-day activities of firms. Though capturing and storing data has been invested heavily, less than 0.5% of the collected data was analyzed or used (Cohen, 2018). This situation forces financial institutions to consider transforming the existing data into valuable knowledge for management and creating as much profit as possible for the enterprises (Ngo et al., 2020; Raman et al., 2018).

Big data has played an increasingly important role in the growth of banking or the financial services sector. A large amount of customer information can help banking organizations to learn their customer's preferences to improve service quality, enhance business profit, and finally satisfy their customers. Based on the big data provided, the intelligent system may provide bankers with valuable tools to support the decision-making process, consisting of dealing with complicated portfolios (González-Carrasco et al., 2019). Besides, the unstoppable and rapid development of data analytics has generated a new range of services for the banking sector and provided the remarkable capability to specialize and individualize its products (Mcafee & Brynjolfsson, 2012). As the banking industry competition is relatively high, the companies need to recognize their existing clients very well by learning the customers' behaviours from acquired data in the internal system to offer better-tailored services. Cohen (2018) mentioned that current clients' data could also attract similar new customers to enhance its market share. Research conducted by Mcafee & Brynjolfsson (2012) for 330 public North American firms indicated that the top third

companies using data-driven decision-making in their industry performed more productively and profitably than their competitors. This performance disparity remained robust when labour contributions, capital, purchased services, and traditional IT investment was considered.

Big data's proliferation provides favourable conditions for expanding financial institutions' business scope and serving customers in the banking industry. However, how to navigate the challenges brought by big data is also a question that the banking industry needs to consider carefully (Bedeley & Iyer, 2014; Corporation, 2015; Hassani et al., 2018a; Hung et al., 2020). The growing variety of data leads to an increasing challenge for decision-making (Corbett, 2018). Simple data collection and integration are not sufficient for banks to effectively use these data. The challenge is to transform the data into strategic levers to improve customer satisfaction and, thus, its performance by tuning the information quality and big data analytics (Fosso Wamba, Akter, & de Bourmont, 2019; Fosso Wamba, Akter, Trinchera, et al., 2019). Only deep mining can explore the hidden information and provide customers with better financial products and services. The utility of big data in finance links to several obstacles, such as how to realize fast and efficient processing of big data set for multi-source data? How to deal with the fragmented data generated by financial technologies and the risk caused by rapid response demand? How to make full use of data analysis and mining to obtain more significant economic benefits? (Amakobe, 2015; Hassani et al., 2018b; T. S. Mohamed, 2019). Thus, the critical claim applied to banking operations is creating solutions to unlock the vital information hidden in big data.

In this study, we discuss how the presence of big data has been shaping the banking sector. The views of various researchers, fellows, and others related to big data and banking activities have been collected and analyzed. This study tests the existing concepts and introduces a comprehensive understanding of the current research on big data based on the qualitative method. Utilizing big data has been explored from different financing perspectives to bring a clear picture to the readers. The study focuses on the various dimensions of big data in banking and finance activities. As big data is still a new and emerging research topic, where researchers are trying to establish some fundamental theorem, this study will provide the crucial concepts, which lead to the essence of big data in the banking industry.

2. Background Of This Study

2.1. Big Data

Laney (2001) introduced the most common definition of big data based on a paradigm of the three V’s, known as Volume, Velocity, and Variety. In terms of data volume, it is estimated that 1.7 megabytes of new information will be generated every second for every person over the world by 2020 (Cohen, 2018). In terms of velocity, big data involves data creation speed, which is even more critical than the volume for many applications. Tick by tick data or nearly real-time information allows companies to be much more agile than their competitors (Mcafee & Brynjolfsson, 2012). The third one variety, which is the most interesting of the three V’s, that is, big data comprises the data's different natures (Sicular, 2013). For example, big data comes in messages, texts, images, updates, videos, web searches, financial

transactions, emails, posts on Facebook, Twitter, and other social networks. Several scholars claimed to add two more V's in the definition of big data, that is, variability and virality. Variability refers to the contextualisation of the data, while the virality requires the growth of big data to be exponential (Giacalone & Scippacercola, 2016). While all three former V's are growing, the variety has become the most essential and vital driver of big data investment. This trend will be continued as more firms are seeking to integrate more sources of information. The possibility of utilizing more data from indirect sources that are not closely related to the company's primary products can be enormous (Lee, 2018). These peculiar features and specifications lead to the two forms of big data storage including structured data and unstructured data. The data are also measured on different scales or are qualitative. Thus, big data is not just a massive amount of data, but it is a system to manage different types of data at a time (Giacalone & Scippacercola, 2016).

2.2. Data-driven banking

The progressive regulations and technological developments, particularly information technology and big data, have led to digital banking operations and virtual banking systems worldwide (Mcafee & Brynjolfsson, 2012; OECD, 2020). Also, data driven services by the service provider is always expected by the customer in real time (Motammarri et al., 2017), that is why, the market is moving fast and sustaining the market dynamics, which ultimately supports banking operations' digital growth for a more extended period and toward better banking systems. However, the regulations, transformation, technological advancements, and innovations will not work unless incumbent institutions entrants a data-driven approach with high financial performance and more significant profits (Fosso Wamba et al., 2020; Glass & Callahan, 2014; Hale & Lopez, 2019; Hung et al., 2020; Mohiuddin et al., 2021). The data innovation increases market competition in different aspects of the banking industry (Jagtiani & Lemieux, 2018; Rabhi et al., 2019), promoting the entire banking system with diversified opportunities. Even the data-driven approaches help to perform better in merger-acquisition (Zhu et al., 2020), predict the success of banking telemarketing (Moro et al., 2014), banking supply chain (Gasser et al., 2017), and banking performance (Brynjolfsson et al., 2011). Big data involve banking in different ways, mainly through big data's core characteristics, including volume, variety, and velocity (Adam et al., 2014; Feng & Shanthikumar, 2018; Gutierrez, 2017). Volume refers to the enormous quantities of data that banks try to connect to improve data-based decision-making. Banking data increases mainly from different possible sources such as consumer loans, commercial loans, demand deposits, mortgage loans, teller automation, credit desk, transaction files (ATM). This also boosts customer's demand for increased competition, better products/service, new technology usages, technology diffusion, and other factors. Besides, banks have already transferred their data systems to digital database management systems (Bedeley & Iyer, 2014) because small databases fail to keep massive data volume. Keeping up with big data volume allows banks to process its' information faster with worth value and at the same time avoid different potential embarrassing scandals due to lack of data. Variety relates to banking operations by maintaining multiple types of banking data. The bank retains various transactional records, including internal and external sources of potential data such as social networking data, business operations data, and other high-

frequency data. It also refers to managing structured, semi-structured, and unstructured data (Bedeley & Iyer, 2014; Chen, 2019). Finally, velocity relates to banking operations with persistent data generation in every moment. As banking is the most crucial industry worldwide, millions of customer transaction histories are highly frequent every minute (Skyrius et al., 2018). In the traditional sense, banks can only grasp customers' financial behaviours related to the banking business. They cannot obtain emotional or behavioural data of customers' hobbies, living habits, and consumption tendencies in social life. Also failed to make linkage of customers' emotional or behavioural data with business data. With the rapid development of data innovations, the banking industry has gradually strengthened its connection with big data sources, screened out useful information, integrated multi-channel data, and enriched customer profiles to achieve sustainable operations. The sustainability of banking operations ensures the highly secured banking operations that will lead to safe banking for all insiders and outsiders. These are crucial for social and economic development (Guimaraes & Sato, 1996; M. M. Hasan et al., 2019b; van der Gaast & Begg, 2012; Weinberg, 1998). Big data is still in the exploratory stage of operating model in the banking industry. The analysis and processing of big data, especially unstructured data, still lack effective software and hardware supports. Under this circumstance, commercial banks' big data technology decisions are at risk of making the wrong choices, being too advanced, or too lagging. The application and development of big data is a general trend. Still, premature investment in large amounts, selection of software and hardware that are not suitable for your actual situation, or too conservative inaction will have an adverse impact on the development of commercial banks (Balachandran & Prasad, 2017; Shamim et al., 2019; Soltani Delgosha et al., 2020).

2.1. The present landscape of big data and business

The rapid development of connected mobile networks, the Internet of Things, and social networks has resulted in the exponential growth of diversified data. Semi-structured and unstructured data source channels have become more complicated, leading to the modern digital information era. As the demand for data innovation increases daily, big data analytics software's revenue is also growing rapidly. In 2011, the revenue was 32.14 billion USD and almost doubled in 2018 (Liu, 2020). Also, big data and business analytics revenue are increased worldwide year to year. The global market value of big data and business analytics was valued at $168.8 billion in 2018. However, it is predicted to grow to nearly $274.3 billion by 2022, with a five-year CAGR (compound annual growth rate) of 13.2 per cent[1]. Global information is also snowballing, generating hundreds of billions of data every day (M. M. Hasan, Popp, et al., 2020). These contain past, present, internal operations, and external activities of different industries. Every day's trillions of data provide numerous opportunities to the people, such as effective communication at a lower cost, using global information systems to work together from different places, making decisions, monitoring the transaction process, and providing control measures. Global information systems also help overcome differences in distance, time, language, and culture and cooperate effectively. Cooperation can be improved through groupware software, group decision support systems, extranets, and electronic meeting facilities. For these reasons, the amount of information is boosting globally (see Figure 1).

According to Figure 1, the last decade was the booming decade for data innovation. The global information was almost two zettabytes in 2010 which remarkably increased to 59 zettabytes in 2020. The information has been producing rapidly after 2019, and it will be more than six times in the following decades. Moreover, according to Analytics Insight, 2019 was an important year in the landscape of big data. After merging with Cloudera and Hortonworks at the beginning of the year, the use of big data is on the rise globally, and organizations have begun to accept the importance of data operations and orchestration to their business success. The current value of the big data industry is US$189 billion, an increase of US$20 billion over 2018, and will continue to increase, reaching US$247 billion by 2022. Big data trends are the data scientist, data officers, and managers will be the centre of attraction; big data analytics will significantly impact investment and cloud-based operations; machine learning will get the focus (Dialani, 2020). These trends will capture the market with a significant amount of money, such as the value of data innovation in cognitive computing will reach nearly $18.6B. Data innovation in application infrastructure will reach almost $11.7B, public safety and homeland security will reach about $7.5B. The real-time data will also be considered a fundamental value proposition in every case, segment, and solution. Besides, the market-leading companies are also rapidly integrating data innovation technologies with IoT infrastructure[3]. Therefore, it is highly crucial to consider data management in any innovation-decision and corporate activities.

As a single sector, data innovation is mostly related to the banking industry, discrete manufacturing, professional services, process manufacturing, and federal government activities (Adam et al., 2014; Hassani et al., 2018b; Hussain & Prieto, 2016; Leskovec et al., 2015; Parashar, 2020; Y. Sun et al., 2019; Yadegaridehkordi et al., 2020). According to Figure 2, the banking industry is the biggest single entity from where data or innovation revenue comes from, accounting for nearly 14% of total revenue. Discrete manufacturing is the second biggest sector, which contributed to almost 11.3% of total revenue. Professional services stay at the same level as process manufacturing at 8.2% of total revenue. As the banking industry is the biggest one, identifying the advantages and challenges of data innovation is very important for every phase.

2.2. Present Literature

This study also presents a brief of existing literature on big data and banking research. Figure 3 focuses on the issues that are highly discussed on this study area. According to Figure 3, the highlighted keywords of big data and banking research are big data, banking, big data analytics, fraud detection, risk management, data mining, challenges, commercial banks, internet of things, cloud computing, and so on.

Many researchers discussed the concept of big data on industrial usage in different periods, however, mainly the discussion came in front after 2014 onwards. According to these bibliometric findings, we have found that most of the research were published after 2018, thus, we consider this is a very uprising issue of publication. Here, Figure 3 presents the notable contributions on big data and banking.

More specifically, Table 1 presents the top cited publications in this field, here we have mentioned only those publications meet the criteria of minimum 10 citation available on web of science database. However, in the Figure 4, we have specified the number of occurrences to 5.

Table 1: Notable contribution on this study area

Article Title	Journal Abbreviation	Citation	Article Title	Journal Abbreviation	Citation
(Zhong et al., 2016)	COMPUT IND ENG	186	(Wenzel & Van Quaquebeke, 2018)	ORGAN RES METHODS	18
(T. M. Choi et al., 2017)	IEEE T CYBERNETICS	93	(Goel et al., 2017)	IEEE INT CONF BIG DA	17
(Gepp et al., 2018)	J ACCOUNT LIT	47	(Cockcroft & Russell, 2018)	AUST ACCOUNT REV	15
(Hassani et al., 2018a)	J MANAG ANAL	37	(Gai et al., 2016)		14
(Herland et al., 2018)	J BIG DATA-GER	26	(Evangelatos et al., 2016)	PUBLIC HEALTH GENOM	12
(N. Mohamed & Al-Jaroodi, 2014)		25	(Bauder & Khoshgoftaar, 2018a)		11
(N. Sun et al., 2014)	IBM J RES DEV	25	(Bakken & Reame, 2016)	ANNU REV NURS RES-SE	11
(Muhammad et al., 2018)	INFORM SYST FRONT	25	(Bauder & Khoshgoftaar, 2018b)	HEALTH INF SCI SYST	11
(Hariri et al., 2019)	J BIG DATA-GER	24	(Bauder et al., 2018)	PROC INT C TOOLS ART	10
(Sobolevsky et al., 2014)	IEEE INT CONGR BIG	23	(Calvard & Jeske, 2018)	INT J INFORM MANAGE	10
(Li et al., 2018)	ANN OPER RES	23	(Park et al., 2019)	J RETAIL CONSUM SERV	10
(Pérez-Martín et al., 2018)	J BUS RES	20	(M. M. Hasan, Popp, et al., 2020)	J BIG DATA-GER	10

Source: Authors' compilations (Collected from WoS database)

Footnote:

[1] https://www.statista.com/statistics/551501/worldwide-big-data-business-analytics-revenue/

[2] The total amount of data created, captured, copied, and consumed in the world is forecast to increase rapidly, reaching 59 zettabytes in 2020. The rapid development of digitalization contributes to the ever-growing global data sphere

[3] https://www.globenewswire.com/news-release/2020/03/18/2002786/0/en/Global-Big-Data-Market-Insights-2020-2025-Leading-Companies-Solutions-Use-Cases-Business-Cases-Infrastructure-Technology-Integration-Industry-Verticals-Regions-and-Countries.html

[4] Note: The statistic shows the leading industries based on their share of the global big data and analytics market in 2019. That year, banking will be responsible for producing 13.9 percent of big data and business analytics revenues. In total, the market is forecasted to grow to 189.1 billion U.S. dollars in revenue in that year (https://www.statista.com/statistics/616225/worldwide-big-data-business-analytics-revenue/).

[5] Note: VOSviewer is used to experiment the bibliometric data, maximum number of occurrences is specified here 2, thus of the 466 keywords, 51 meet the threshold

[6] Note: VOSviewer is used to experiment the bibliometric data, maximum number of occurrences is specified here 5, thus 38 meet the threshold

3. Methodology

This study is completed by following a qualitative research methodology. Usually, qualitative research is a method or perspective to study things based on the properties of social phenomena or things and the contradictory changes in the movement, and the inherent stipulations of things. Commonly the literature reviewing helps most find out the gaps of the qualitative research and highlight the research boundary (Tranfield et al., 2003). This study sets the deductive logic and trending trends relating to big data and banking operations perspectives (Lamba & Singh, 2017). The main aspects of things based on certain present literature on this study's primary idea should be grasped directly to conduct this qualitative research. Whatever the structured processes of this qualitative research methodology are mentioned in the following sections.

3.1. Study selection

This study has followed specific selection measures to identify studies for our review. Some precise criteria such as study should be an empirical, significantly analytical and qualitative strategy, and so on (Lê & Schmid, 2020). Following these strategies helped us construct the initial processing or framework for self-contained components that finally led to the study selection process. Whatever, initially, we had to collect literature in the study selection process. This collection process focused not only on any specific area but also on big data in different business aspects. Whatever there was no specified schedule for the

data collection process for this study. As big data and banking are not so long-standing, getting more than 5 to 10 years of data was somewhat difficult.

3.2. Database selection

The data of this research has been collected from secondary sources. Initially, this study used Scopus and Web of Science database as the main sources of the research search engine (M. M. Hasan, Yajuan, & Khan, 2020; M. M. Hasan, Yajuan, & Mahmud, 2020). Also, these two databases are the most accepted and well-known databases all over the world with more than 20000 journals in Scopus and 12000 journals in the web of science (Lamba & Singh, 2017). All articles may not have significant contributions with much acceptability. That's why mainly this study focused on Elsevier, Taylor & Francis, Springer, emerald, Wiley, Sage, Informs, and some other search engines to collect more relevant articles with much acceptance. It was just because the literature relating to big data and banking is not well established.

3.3. Data collection

This study focused on banking aspects, and industrial elements, particularly the finance industry, was emphasized here. Mainly purposive sampling method was used here because our research area focused on particular fields (M. M. Hasan et al., 2019a). This study also followed Tranfield et al. (2003) for the data collection process of qualitative research. After collecting the data, initial screening was done to sort out the necessary literature relating to the banking industry; in some cases, literature relating to big data and finance, business, management, and other industries has been prioritised here. Besides, some web contents have also been collected and noted for important reading. As big data analytics is not an old concept, and it's considered the concept of this decade, contents from the webpage also helped extend the discussion in different viewpoints. After initial screening, the targeted articles relating to the research field have been selected for further reading. In this section, most important factor is article coding. As this study focused on different views of big data and banking industry, article coding helps a lot to make the study process easier than earlier.

3.4 Keyword selection

Keyword Searching is one of the most important issues in the initial stage of a study. This study has focused on the articles' title, abstract, keywords, and the main body that were highly related to the topic (Hutzschenreuter et al., 2020). First of all, we searched "big data" AND "banking", and we have found 456 articles, and "big data" AND "banks" and found 700 articles in the SCOPUS database and 668 articles in WoS. The keywords searching area was specified within the article title, abstract, and keywords were initially search with the keywords. However, when we limited the searching elements within the article's title, we found only 39 articles (SCOPUS) and 20 (WoS) related to a different aspect of banking. We expanded our search with more keywords such as big data in finance, big data in financial risk management, big data and decision making, big data challenges in banking, the impact of big data on banks, big data acquisition in banking, big data, and risk management, fraud detection through risk management in banking, banking management, data application in bank, digital banking, data-driven

baking, and so forth on the prespecified research search engine that mentioned in *data collection* stage as the number of articles relating to big data was not enough for a good qualitative article.

This study also followed searching some keywords of other areas. These are big data innovations, big data in retailing, big data in supply chain management, big data in management, big data in decision making, big data in industrial practice, big data and IoT, and so on to find qualitative findings from the related literature (Adam et al., 2014; Bradlow et al., 2017; Fisher & Raman, 2018; Lamba & Singh, 2017; Lee, 2018; Leskovec et al., 2015; Oguntimilehin A & Ademola EO, 2014).

3.5. Data inclusion and exclusion

Data inclusion and exclusion process are also crucial for a qualitative study. This study followed the data inclusion and exclusion process from Lamba & Singh (2017). This study extended the data inclusion and exclusion process from Hutzschenreuter et al. (2020), highlighting definite inclusion and exclusion processes. Whatever, in some cases, it is not easy to find out precisely targeted articles related to this research's primary motives just for the unavailability of much literature. It's still a highly demandable and trending issue; however, some works that have been published in highly prestigious journals failed to cover the problem with proper explanations. After collecting the raw articles, first of all, those articles were divided into two parts based on the concept of whether articles meet the objectives of this study or not. Afterwards, the initial screening, related and even partial related articles were selected for further processing, planning for the search protocol, that leads the abstract and heading reading and makes a good segment of the related articles for further process. Some literature has been excluded particularly those articles don't focus on benefit and focus on big data and banking, as well as those publications don't focus on the real applications of big data on banking. After the inclusion and exclusion process, this study followed the segmenting process considering the real scenario of banking industry.

3.6. Research framework

The academicians widely use a structured research framework, researchers, university graduates, and so forth on their research and always stay up-to-date with the variations of a new qualitative research framework structure (Molasso, 2006). A research framework is essential to classify the qualitative research structure from the literature review data (Abdulla et al., 2019). It also helps in data coding and interpretation (Collins & Stockton, 2018). Based on these concepts, this qualitative study's methodology is followed by a structured research framework followed by the authors' two previous studies, Hasan et al. (2019) and Hasan, Popp, & Oláh (2020). This qualitative research method's structured process is illustrated in a framework that explores this study's complete step-by-step process. The framework is given in Fig. 5.

4. Findings

4.1. Data-driven opportunities in banking operations

Big data influences dramatically many aspects of the financial service and banking industry, including the financial market (Shen & Chen, 2018), internet credit service company (Zhang et al., 2015), internet finance (Yang et al., 2017), management, analysis, and applications (Y. Sun et al., 2019), credit banking risk analysis and risk management (T. Choi & Lambert, 2017; Pérez-Martín et al., 2018). Based on these concepts, the implications of big data on the banking sector are discussed in the below subsections.

4.1.1. Bank management, analysis, and applications

Big data in banking is becoming one of the most promising areas in the banking sector. It is expressively changing the business models in financial services companies and banks (Cerchiello & Giudici, 2016; Parashar, 2020). The big data of banks mainly comes from daily financial transactions, customer information, and business records. The volume of data is large, and the growth rate is fast, with the amount of data that has jumped from terabyte to petabyte level (Mcafee & Brynjolfsson, 2012). Simultaneously, there are many types of financial data from various business systems within the bank, involving core, credit, anti-money laundering, wealth management, funds, credit card, and other business data, which is not uniform as structure. Some technological applications such as data storage and management technology, data integration, processing and presentation technology, data analysis, and mining technology are used to conduct in-depth mining and research of daily banking data and discover potentially valuable information from massive customer information, financial product information, and financial transaction information. Thus, big data has influenced banking management, analysis, and applications for different products and services. Managers can carry out precision marketing and risk prevention and control based on the algorithm's prediction results to ensure the bank's business development's a better direction.

4.1.2. Banking supply chain

The banking supply chain, also known as supplier finance or reverse factoring, is a set of solutions that optimize cash flow by enabling companies to extend their payment terms to their suppliers while offering the option of early payment to their enterprise customers (Hung et al., 2020). Nowadays, all business activities can be tracked in cash and information flows, usually completed electronically between different bank accounts, either within the same bank or across different banks. These business activities can be used to establish a specific company's supply chain. They can then be extended to a more extensive supply chain network by including affiliated or upstream/downstream companies along their related supply chains. IoT-based risk management performance big data analysis is a useful instrument capable of predicting different SCF risks. It also provides a company to extend the SMEs supplier payment terms to optimize business cash flow for physical materials, goods, and services (Chen, 2019). Different factors influence this circumstance, such as taxable sales revenue, VAT payment frequency, and the number of counterparties for VAT invoice issuance. VAT invoice issuance frequency and firm age are correlated negatively with SCF clients' business failure, whereas VAT paid and industry clock speed are correlated positively with their business failure (Zhao et al., 2015). Moreover, banks use big data analytic to explore internal Business to Business (B2B) data to improve SCF and identify potential corporate

customers or to improve the business offering to existing corporate customers along the business's supply chain.

4.1.3. Bank risk management

Data is one of the most valuable assets of a bank. In the past, banks' risk management and decision-making were mainly based on subjective empirical judgments, supplemented by data support, resulting in poor risk management performance (Parashar, 2020). The rapid growth of massive data and the increasing maturity of big data technology have made it possible to manage risks in the banking industry based on big data analysis. Building an advanced risk management system has become one of the banks' core competitiveness (Hale & Lopez, 2019; Hassani et al., 2018b; YU et al., 2017). In this era of big data in which various data are available with the advance of information technologies, every financial company gets a billion data points in a day. Still, they are not using all of them in a moment (T. Choi & Lambert, 2017). In the disorderly mass of data, the big data information processing platform is employed to sensitively capture the signals of risks and opportunities, improve the efficiency of obtaining information, and serve the entire decision-making process. Big data is also becoming more crucial for financial risk analysis. It also elaborates and interprets the risk analysis information comparability faster than the traditional finance systems.

4.1.4. Financial fraud detection

Scammers can quickly exhaust personal financial accounts or steal thousands of dollars from credit cards. Worse still, organized criminal groups can execute well-designed plans and illegally dispossess millions of dollars[7]. Therefore, financial fraud detection is essential to minimize the risk for the organization. There are many frauds in the banking and financial services sectors, so the companies use improved and better fraud detection methods based on real-time analysis of big data (Amakobe, 2015; Delgosha et al., 2019). Banks and other financial service companies use algorithms based on real-time transaction data to obtain more accurate and less intrusive fraud detection methods. These technologies use large amounts of data generated from diverse sources at high speed. Generally, data from society and mobile sources are applied for forecasting and identification. Modern systems can detect fraud faster and consistently using machine learning algorithms (Lyko et al., 2016). Besides, big data allows banks to prevent unauthorized transactions by providing a safety and security level, which raises the security standard of the banking industry.

4.1.5. Customer insight and marketing analytics

"A 360-degree view of the customer is the concept of being able to view and analyses all of the data you have about every single customer in isolation, in one location"[8]. The 360-degree view works as groundwork, making the relationship between an organization's and customers experiential rather than transactional. The experimental relationship provides the concept as the key to long-standing customer-organization relationships with positive endorsements (Skyrius et al., 2018). This 360-degree view operates like a crystal ball by showing the inside look of the past, present, and future customer-organization relationships that are the big data management object. Therefore, it provides diversified

banking industry facilities such as analysis of bank loan risk, segmentation of different banks' clients, and client's sentiment analysis (Khade, 2016; Satish & Yusof, 2017).

Moreover, big data enables banks to gain insight into customers' consumption behaviour and patterns, thus simplifying their needs and needs[9]. By tracking each customer's transaction, banks categorize customers based on several parameters, such as standard services, preferred credit card spending, and even net worth. Customer segmentation allows banks to better target customers through relevant marketing activities tailored to customer needs. It also provides personalized product offerings facilities by analyzing the historical data of customer expenses and transactions.

4.1.6. Banking decision

Big data is considered a tool that allows a company or institution to generate, manipulate, and manage massive datasets within a prespecified timeframe. Big data helps progress transparency, audit ability, and executive oversight of any enterprise's risk (Srivastava & Gopalkrishnan, 2015), thus improving their decision-making ability. Access to useful and noiseless manual big data set is limited and costly, or even data might not be available in demand with appropriate digital format (Provost & Fawcett, 2013). In contrast, the digitalized big data set is a valuable support tool to increase business decision-making ability. Different comprehensive methods, analytical techniques, standards for describing and managing decisions are essential for banking success (Jonker et al., 2012). Big data helps to build a data application decision-making system under scientific management. From the analysis of management objectives, developing a data application decision-making system under scientific management requires an overall improvement of the data management mechanism in the "five levels" data management to effectively implement the scientific application of data Basic refined management decision-making. These are understanding data, standardizing data, analyzing data, organizing data, and applying data,

4.2. Challenges faced by banks in the era of big data

The banking industry has been undertaking digitization for several decades. Big data is changing the banking industry's operating model and business philosophy. Its 4V characteristics comprise different challenges for management, analytics, finance, and so on other various applications. These challenges consist of effectively organizing and managing banking sectors, finding novel business models, handling traditional banking issues (Y. Sun et al., 2019). Data-driven development methods will also have a disruptive impact on its future. For a long time, banks have focused on the collection and storage of enormous data. However, they are facing significant challenges when contemplating making full use of such data. In this paper, the significant challenges are summarized, given in the banking sector's typical characteristics in the era of big data.

4.2.1. Changes in banking operation

The advancement of information technology and Internet technology's development brings changes in the banking industry's operations and regulatory policies changes. It has lowered the industry entry barriers, allowing non-financial institutions to enter the financial system more and use their technological

advantages and blind spots in the regulatory approach to gain competitive advantages (Akter, Gunasekaran, et al., 2020). The data innovation and banking relationship will impact management virtualization and product virtualization (Hajirahimova & Ismayilova, 2018; Márquez & Lev, 2019; Perkhofer et al., 2019). For management virtualization, various documents and vouchers in the banking business will appear in digital files in an electronic and data management model, which will continue to impact the traditional commercial bank operation model. Besides, the product virtualization will also influence big data management, as different products will change their profit earning behaviour and be exchanged faster as various types of data signals. These changes significantly affect habituating with traditional banking (M. M. Hasan, Popp, et al., 2020; Ram & Yang, 2017).

4.2.2. Complex service management

With the rapid development of the e-banking business, big data promotes the formation of "new customers" with more choices and more independent requirements than before (Hassani et al., 2018b; Hung et al., 2020). Commercial banks must promote individualized services through active marketing for new customers and take the customer as the centre to prescribe the right medicine. These are considered the recent banking operations changes that were not present in traditional banking with manual activities in very narrow areas. Therefore, managing those expanded services makes sense in everyday banking operations. To grasp customers' requirements from multiple angles and directions, breaking the traditional indifference, passive product and service marketing methods, and providing customers with a complete data structure are vital needs to attend.

4.2.3. The highly competitive market for commercial banks

Through the analysis of big data, commercial banks can better understand customer consumption habits and behaviour characteristics and research and predict market trends more timely and accurately (Cabrera-Sánchez & Villarejo-Ramos, 2020; Zetzsche et al., 2019). In this case, the ability to obtain big data will determine the competitiveness of commercial banks. Although commercial banks themselves have a large amount of customer data and transaction data, collecting and processing more data creates competition among the competitors because of getting the advantages of data innovations (Fosso Wamba et al., 2018; Lioutas & Charatsari, 2020; Nekmahmud & Rahman, 2018). Therefore, competing with the comparatively larger firms sense more complicated than the earlier times in traditional banking. The choice of technology for big data involves decision-making risks

At present, big data is still in the exploratory stage of operating mode. The analysis and processing of big data, especially unstructured data, still lack helpful software and hardware supports. In terms of data processing, commercial banks have accumulated much experience in the application of structured data. However, unstructured and semi-structured data that widely exist in social networks, e-commerce platforms, and other media require more complex methods to deal with massive fragments. The transformed data is processed to obtain valuable data information. Under this circumstance, commercial banks' big data technology decisions are at risk of making the wrong choices, being too advanced, or too lagging. The application and development of big data is a general trend. However, premature investment

in selecting software and hardware that are not suitable for the bank's specific actual situation or too conservative inaction will hurt commercial banks' development (Balachandran & Prasad, 2017; Delgosha et al., 2019; Shamim et al., 2019).

4.2.4. Lack of professional data analysts

Most commercial banks have not established a mature data analysis team with high sensitivity to data's value, professional ability, and data analysis experience. Many data analysts are good at finding the causes of the problems that have occurred through data analysis and management, but they have not enough ability to discover unknown issues. Also, they have the problem of precisely predicting the value of big data and future data trends. Analysis of the current situation in commercial banks shows that there is a shortage of data analysts. Therefore, to construct a professional analysis team, the banking industry still has to go a long way (Court et al., 2015; Skyrius et al., 2018).

4.2.5. The cost of data

Commercial bank IT architecture mainly implements technical architecture and data architecture from the application's perspective. To better adapt and control the big data model, the banking industry needs to establish its own commercial big data platform. This big data platform must collect structured business data, manage all kinds of unstructured data, and even compare it with historical data, which requires banks to process data efficiently (Dey et al., 2013; Perkhofer et al., 2019). To achieve this banking industry's expected goal, it usually needs to make necessary cloud computing technology preparations, distributed computing technology, and redundant configuration technology. From this perspective, although big data in the banking industry has the prospect of bringing high benefits, at the same time, the cost is quite remarkable, and there is no way to avoid such kind of mandatory costs. In this regard, the banking industry must make scientific decisions (Balachandran & Prasad, 2017; Oguntimilehin A & Ademola EO, 2014)

4.3. Banking and data security

Database vulnerabilities, privacy breaches, and users' information leaking by internal employees have frequently occurred in companies (Bandara et al., 2020), more particularly in the banking industry. Thus, the structure of a data security system and data privacy system as an urgent need for the banking industry continues to address (Cockcroft & Russell, 2018; Jain et al., 2016). As banking industries accelerate into the industrial internet era, the new generation of information technologies and applications such as big data, artificial intelligence, cloud computing, continue to deepen, and the process of digitization and industrial upgrading is accelerating (Adam et al., 2014; Asadi et al., 2017; Bose et al., 2013; OECD, 2020; Orçun Kaya et al., 2019; Smith & Nobanee, 2020). However, under the wave of digitization, the continuous expansion of business boundaries has also led to frequent cybersecurity issues in the banking industry (Cohen, 2018; Orçun Kaya et al., 2019). Due to the lack of an organizational structure, management system, and other aspects compatible with data security, the banking industry is currently facing relatively severe data security risks (Bouveret, 2018; N. Gana et al., 2019). For example, attacks in the banking sector have shown an intensifying trend nowadays. The

hackers continuously target banks in different forms such as ransomware, malicious outsourcing, compromised remote site, Stuxnet, ICS insider, IT insider, Trojan horses, worms, and denial-of-service (DDoS) attacks (Andrew Ginter, 2018; Kumire, 2020). A very related example is stealing $101 million from Bangladesh's central bank conducted by the unidentified hackers on February 5, 2016 (M. Hasan, 2020; Zetter, 2016). As both the external and internal parties are related to the security issue, this study emphasizes that dealing with external cyberattacks, inner security awareness, and management vulnerabilities brought about by security risks have become a crucial part of the banking industry's development challenge.

4.3.1. Dealing with external cyberattacks

Cyber-attacks are an increasing threat to financial service providers, particularly in banking. Banks are lucrative targets that the cybercriminals typically attempt to get internal access, damage, or alter the targeted network systems to steal funds and fundamental financial data such as bank account details, credit card information, and so on. Many solutions introduced by banks to combat these attackers include (1) setting up a relatively complete network security system, (2) applying high regularity fines, (3) monitoring robust security systems, and (4) even in some cases the regulatory authorities impose heavy punishments for the firms that fall prey to cyber-attacks. However, the bank still cannot completely prevent network security incidents and impossible to ensure 100% security (Patterson, 2016).

4.3.2. Internal security awareness

Internal security awareness is also one of the most critical issues for banks. It directly helps the internal parties educate their banking operations, cautions about cyber-attacks, etc. It is also vital to make the customers aware of information security awareness by educating them about online banking activities, dangers of phishing, ACH and wire fraud, malware, and more through different materials such as articles, posters, videos, email campaigns, newsletters. Besides, training the internal parties regarding the high adaptability of technological devices is also very crucial.

4.3.3. Management vulnerabilities

Managing different types of vulnerabilities is also a highly crucial issue for banks. Day by day, how banks address those vulnerabilities is getting important in every level of banking operation. Singha (2020) mentioned some critical methods to manage and mitigate vulnerabilities. There are (a) identifying and categorizing the information assets such as confidential data, highly-restricted data, data for internal use, publicly used data based on the data value and level of sensitivity (b) implementing cybersecurity risk assessment process, (c) and educating the internal employees about the cybersecurity issues. It is also essential to prepare the IT expert team to prioritize the most critical parts of the network and network segmentation as a strategic policy. This study highly emphasizes that managing vulnerabilities should be a separate department with expert team combinations of expert and business intelligent corporates.

In response to the banking security issues, the banking industry must emphasize some core elements of the banking industry's data security system: transaction security, security compliance, network security

technology, information security, the entire life cycle of data, etc. Among them, transaction security is an essential factor that distinguishes the banking industry from other industries and an essential object of future security protection. Other elements of banking security systems are also prevalent everywhere in the banking industry. However, with the subsequent promulgation of many supporting laws, regulations, and industry regulatory standards in data security, the banking data security system's future must be protected from any kind of cyber-attack.

Footnote:

[7]*It is mentioned that big data fraud detection is an advanced method to use consumer trends to detect suspicious activities and prevent those activities. Using bid data analysis to detect fraud requires expert knowledge in this field as well as high computer resources, however, due to the improvements in the programming languages as well as the server technology, fraud detection is easier than ever (link)*

[8] *MyCustomer, is one of the renowned marketing webportal, provides important tips for marketing professionals to enhance customer experience and improve customer journey. They mentioned that customers big data ensure that company easily understand everyone's needs, preferences, and concerns. However, they have also mentioned that the reality of being able to do this is more complicated (link).*

[9]*Mauricio (2016) mentioned that Big data enables banks to gain insights into customers' consumption habits and patterns, thereby simplifying the task of determining their needs and demands. This study also highlights the advantage of customer segmentation, which allows banks to better target customers through relevant marketing activities tailored to customer needs, Mainly the focus was "big data customer segmentation" (link)*

5. Discussion And Conclusion

Big data's proliferation provides favourable conditions for expanding financial institutions' business scope and serving customers in the banking industry. How to navigate the challenges brought by big data is also a question that the banking industry needs to consider carefully (Bedeley & Iyer, 2014; Corporation, 2015; Hassani et al., 2018b; Hung et al., 2020). Thus, this study employed a qualitative research methodology to identify the different aspects of big data implications for the banking industry.

The findings suggest three key insights. First, big data has significant effects on different dimensions of banking operations. Data mining technology has broad market prospects in decision support. It can be used for business management applications such as banking database marketing, banking customer segmentation, clients’ background analysis, customers’ credit scoring, fraud detection, and market analysis activities. Second, the banking sector faces increasing challenges in managing and applying big data technology related to banking operation changes, a more competitive market, risks in selecting big data technology for decision-making, lack of professional data analysts, and expensive costs. Thirds, big data management plays a crucial role in controlling and reducing banks' vulnerabilities when dealing with external cyberattacks as well as internal security awareness. Banking security has always been

prominent banks' attention. Although commercial banks have increased their data security management investment in recent years, factors such as long business chains and complex software and hardware systems have further increased the hidden dangers of big data. How to properly keep and safely and legally use big data is particularly important in those cases (Siddiqui & Qureshi, 2017; Yu & Guo, 2016a).

In conclusion, big data has been transforming the way banks operate. It is also evident that this transformation is only in its infancy. The potential of using big data to improve banking operations is enormous. The banks can increase their profit substantially. Although big data brings several benefits, some drawbacks are in order. One of the significant challenges for banks is to carefully exploit big data to improve their performance while minimizing security incidents. Identifying the solutions for these issues requires the total attendance of data scientists, marketers, lawyers, managers, and regulators.

Though the research is detailed and covers the relevant peer-reviewed literature gathered from peer-reviewed journals, there are still some limitations to the current work. This study used Scopus and Web of Science databases; these are popular among researchers to select relevant articles. The possibility that articles cited in this study are out of Scopus and Web of Sciences that might be relevant to the study scope has not been considered. This study highlights some challenges faced by banks in the application of big data. However, a comprehensive framework to overcome these obstacles has not been systematically addressed. Therefore, in the future, both highly developed theoretical and empirical research should be experimented with to accommodate the challenges of big data in the banking industry.

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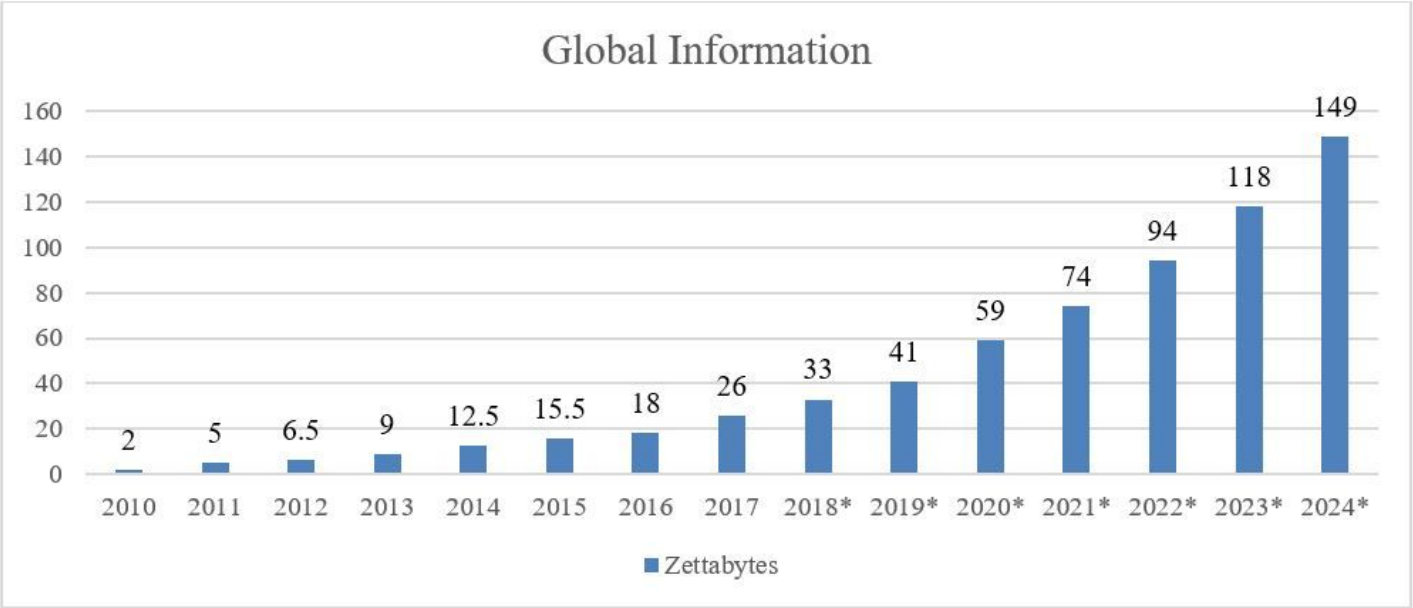
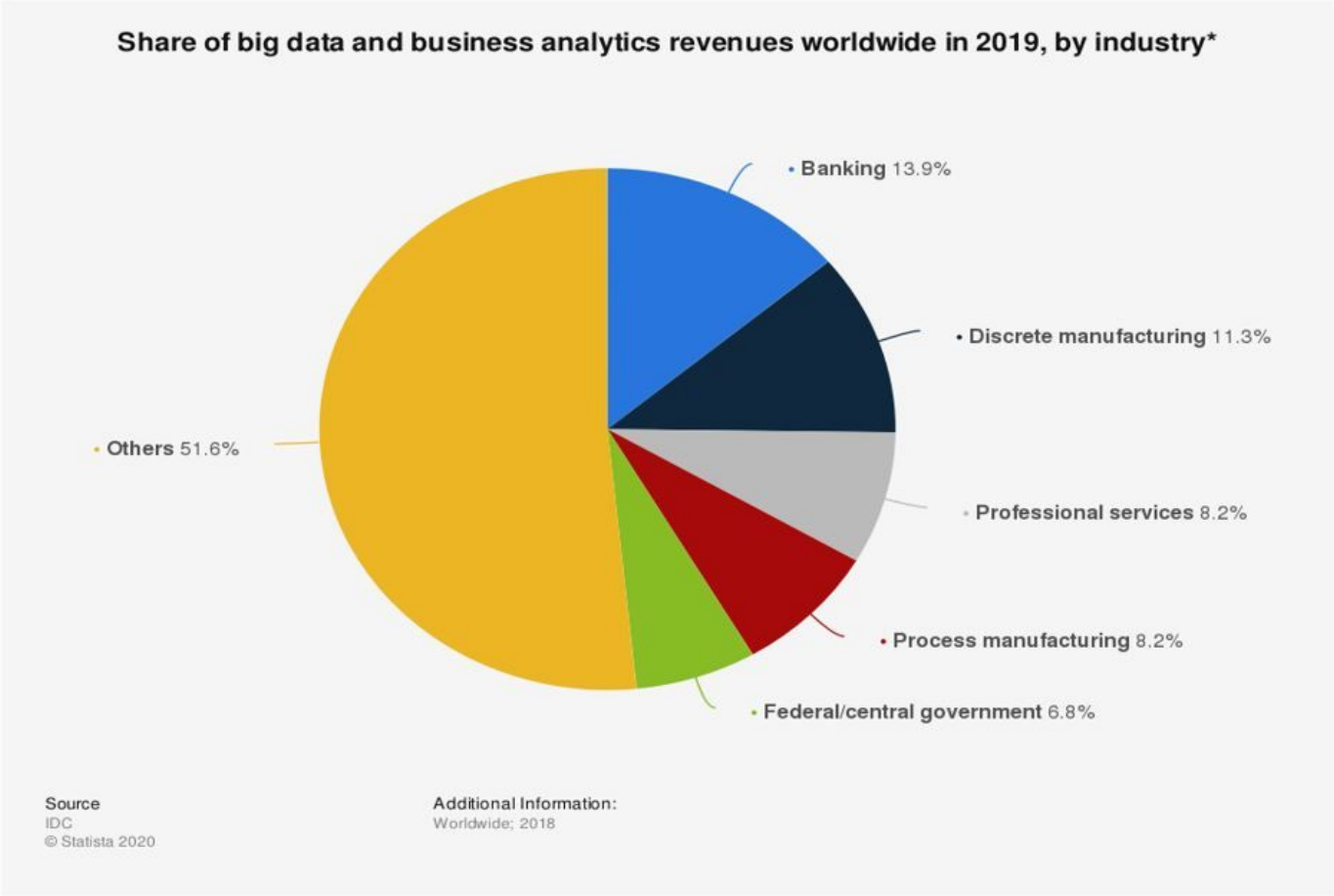
Figures



Source: IDC; Statista (Holst, 2021)[2]

Figure 1

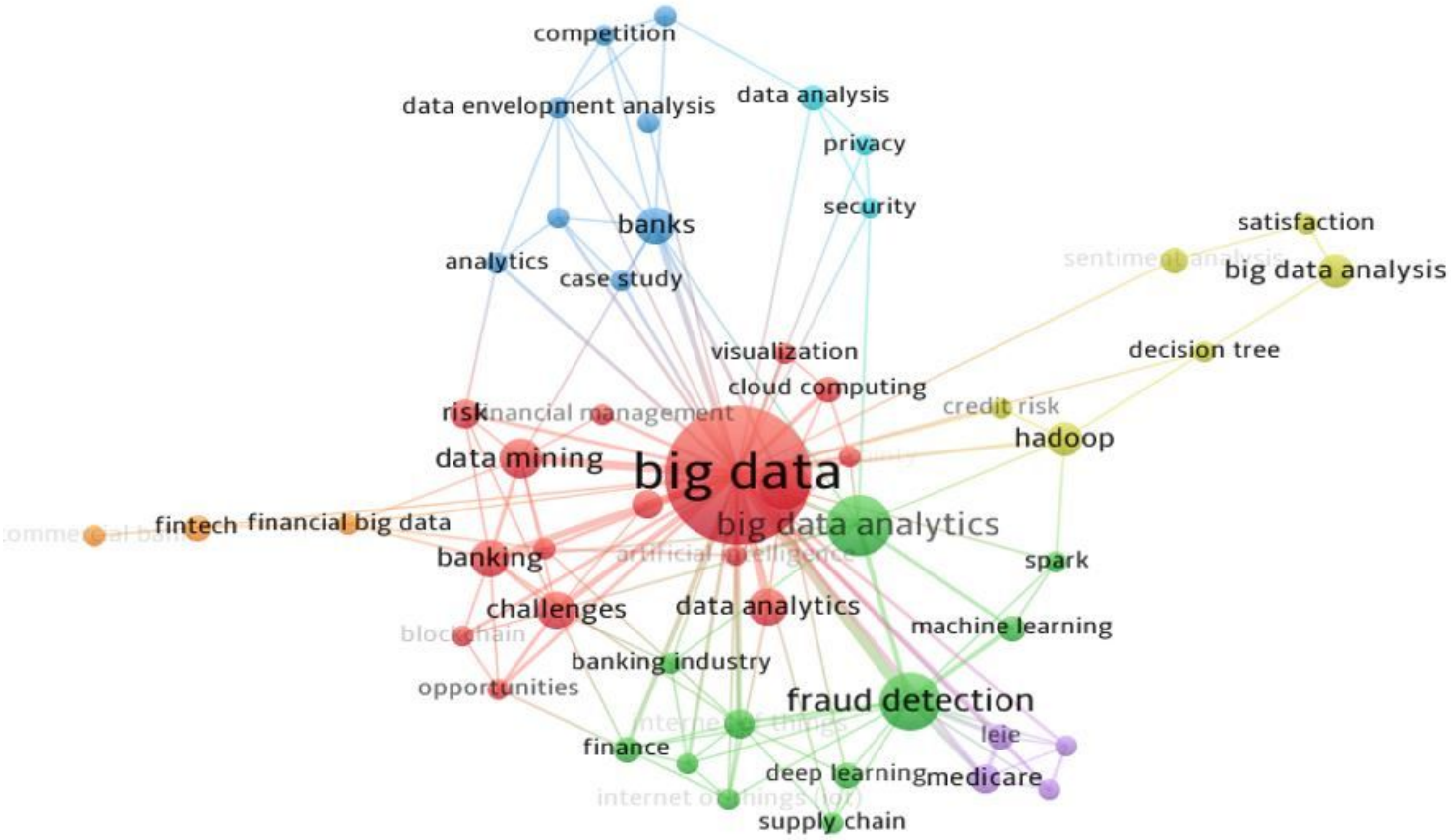
Amount of information globally 2010-2024



Source: IDC@ Statista[4]

Figure 2

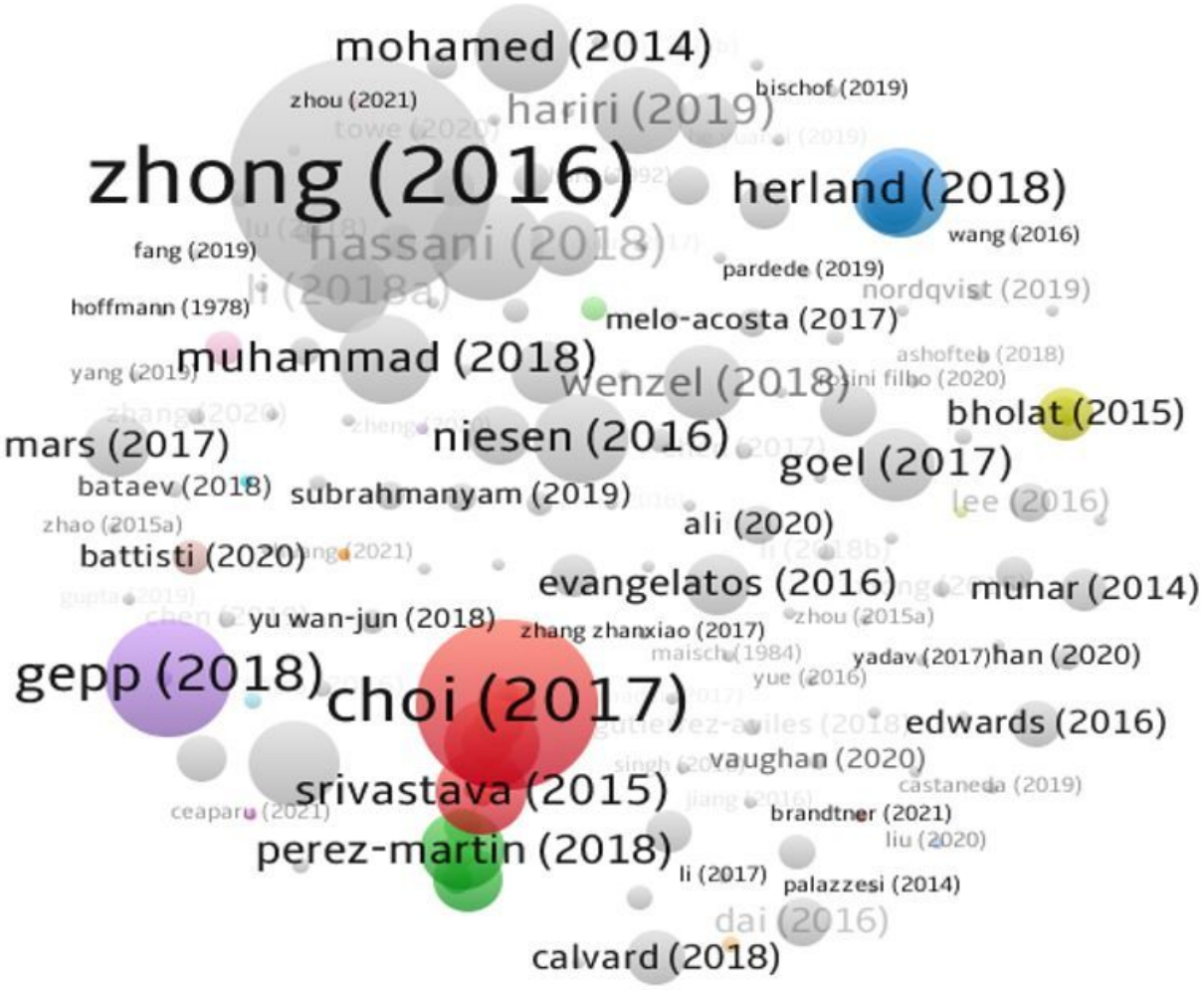
Share of big data and business analytics revenues worldwide in 2019, by industry*



Source: Authors' explanation (VOS viewer)[5]

Figure 3

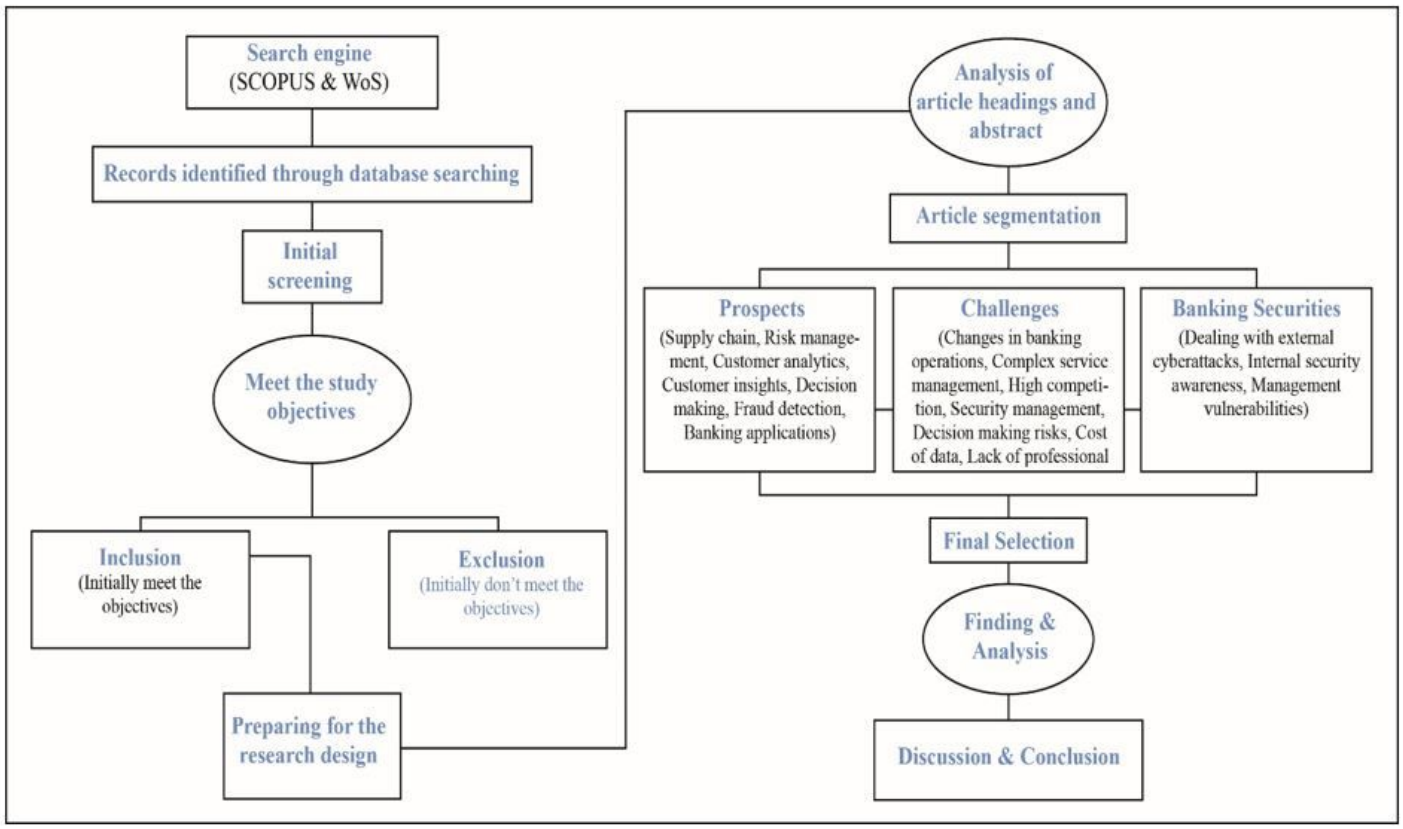
Focus of big data and banking research



Source: Authors' explanation[6] (VOS viewer)

Figure 4

Notable contribution on big data and banking research



Source: Author's compilation

Figure 5

Research framework of this study