Business Intelligence for Risk Management: A Review

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Abstract

This paper provides a quick review about business intelligence approaches and techniques in risk management. The important research articles from 2007 to 2021 are involved in this review. We found a little contribution from researchers in this research direction, however the vital role of business intelligence in risk management. Moreover, we provide a novel business approach for risk management. This approach includes deploying the trendiest techniques in this era which are social media and big data analysis. Social media represents the source of identifying risks through the discussions of social media users as well as big data analysis techniques which represent the control tool for potential risks. The new approach will help firms and organizations in many sectors to manage risks efficiently and make the best decisions. Further, we provide the challenges of the new framework and the further research points.

Keywords: Risk management; Business intelligence; Social media big data analysis.

1. Introduction

Risks are founded in every manifestation of our lives which may cause bad effects on individuals, stakeholders and the whole community. Risk management raised as a vital tool to manage and handle risks and used widely in academia and industry in the past several decades. It can be defined as the process of identifying, assessing, handling and monitoring risks to reduce the uncertainty in investment decision making. Traditional risk management centralizes on risks coming from physical or legal causes such as natural catastrophes or fires, accidents, death and lawsuits. Other types are appeared such as financial risk management which deals with risks that can be controlled by employing traded financial instruments and enterprise risk management which presents a tool to maximize the systems' value that is commercial and socialist, from a systematic point of view [1].

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Most business intelligence tools have been deployed to enhance risk management process, and the risk management tools can be impacted positively from business intelligence approaches. To illustrate, artificial intelligence techniques such as neural networks and support vector machines have been utilized in wide range for building the early warning systems to monitor the financial state of firms [2]. Agent-based theories are using in risk management for supply chain sector [3]. The deploying of business intelligence techniques in risk management is useful to managers of firms and academic researchers. However, the all of the applied business intelligence systems in risk management are inefficient to deal with huge amount of data and depends on traditional data sources.

This paper aims to survey the most impacted research articles that applied business intelligence models in risk management. We noticed that the articles that have been published to solve risk management problems through the previous decades are low in number however the importance of this direction. Furthermore, we present a new business intelligence framework for risk management. This framework helps to identify and manage risks based on the new trends that are social media and big data analysis. Besides, the challenges and new research points are included.

The rest of the paper includes: Literature review about the related articles is discussed in Section 2. In Section 3, we present the proposed approach. Some challenges based on the new framework are provided in Section 4. In Section 5, we give some points about the further work and conclusion.

2. Related Work

In [4], the authors examine the effect of Business intelligence systems on the profitability and risks of firms by conducting survey on 278 manufacturing firms in the US that had employed Business intelligence from 2005 to 2014. They illustrated the improving in the profitability of firms as well as minimizing risks in profit returns instantaneously after the operational use of BI systems. In [5], the authors applied business intelligence systems to minimize the Hazard, Vulnerability and Risk in Cuba. They built a decision support system and combined it with the developed data warehouse that enables analyzing studies in a holistic manner and from different aspects. Moreover, the information of hydrometeorological hazards is deployed in a single database that was designed in a multidimensional way.

In [6], the authors utilize business intelligence (BI) approach for multidimensional data analysis in complicated projects. The results considered that the obvious possible improvement of the BI system during the process of handling risks process for a complex project. In [7], the author suggested business intelligence approach with an artificial neural network model for credit risk management in banking sector. This model can credit approval estimation at Jordanian commercial banks depending on the characteristics of applicant. The results showed that the artificial neural networks as a promising tool in classification problem. In [8], the authors proposed a framework based on business intelligence to analyze the real estate market as well as estimate the price of the properties in order to minimize the potential risks. The findings indicated that the framework improve and enhance the efficiency of decision making process.

In [9], the authors examined the risks in Enterprise Resource Planning (ERP) projects by using Fuzzy Cognitive Maps. This tool helps in modelling uncertainty and relevant events that leads to progress in forecasting problem through simulations. The findings illustrated that the proposed tool is more effective in managing ERP maintenance project risks. In [10], the authors developed a novel approach for stock trading by employing Kansei evaluation combined with the model of a self-organizing map. The objective of this approach is to collect the several decisions of experts, accomplish the maximum returns of investment and minimize the losses. The results demonstrated that the suggested approach enhance the returns of investment and decrease losses specially when dealing with multiple market conditions. In [11], the authors focused on introducing a security risk

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analysis model to explore the causal relationships between the factors of risk as well as analyzing the complexity and uncertainty of weakness propagation by using a Bayesian network (BN). This approach can find the propagation path with the maximum probability and highest path risk exposition. The findings indicated that the presented model is efficient in building beforehand plans of security risk management for information systems. In [12], the authors gave a calibration method for stock market of the kind of agent-based continuous double auction by utilizing scaling analysis. Based on artificial and real stock markets, they carried out a scaling analysis of the absolute returns as well as demonstrated volatility correlations in the form of power laws in all of the markets such that the power-law exponent may be changeable. The results illustrated that the proposed approach can duplicate the couple of basic and actual characteristics of real stock markets.

In [13], the authors showed that employing Business intelligence helps in reducing risk. This happens by providing updates reports, smart graphs that deliver the information with clearest way. In [14], the authors explored the relationships among risk and the indicators of performance in business processes. They provide scenarios and evaluated in business cases. In [15], domain ontologies is deployed to describe the growth a system for content mining. Domain ontologies provides the ability of relevant information extraction for the process of analyzing financial and operational risk as well as business intelligence application. The findings refer to the high quality results of extraction process. In [16], the authors discuss and review the applications of business intelligence specifically in managing risks in banking.

Table 1: survey about the research articles of business intelligence in risk management

Author/s	Title	Year	Findings	Method
Yiu, L. D., Yeung, A. C., & Cheng, T. E.	The impact of business intelligence systems on profitability and risks of firms	2021	Improving in the profitability of firms as well as minimizing risks in profit returns instantaneously after the operational use of BI systems.	Survey
Milanés-Batista, C., Tamayo-Yero, H., De Oliveira, D., & Nuñez-Alvarez, J. R.	Application of Business Intelligence in studies management of Hazard, Vulnerability and Risk in Cuba	2020	Minimize the Hazard, Vulnerability and Risk in Cuba	Business intelligence systems
de Oliveira, A., & de Almeida, J. R.	Business Intelligence Application for Multidimensional Analysis of Risks in Complex Projects	2019	Obvious possible improvement of the BI system during the process of handling risks process for a complex project	Business intelligence (BI) approach
Alzeaideen, K.	Credit risk management and business intelligence approach of the banking sector in Jordan	2019	The artificial neural networks as a promising tool in classification problem.	Business intelligence approach with an artificial neural network model
Abutahoun, B., Alasasfeh, M., & Fraihat, S.	A framework of business intelligence solution for real estates analysis	2019	The proposed framework improve and enhance the efficiency of decision making process.	Business intelligence (BI) approach
Lopez, C., & Salmeron, J. L.	Dynamic risks modelling in ERP maintenance projects with FCM	2014	The proposed tool is more effective in managing ERP maintenance project risks.	Fuzzy Cognitive Maps

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Pham, H. V., Cooper, E. W., Cao, T., & Kamei, K.	Hybrid Kansei-SOM model using risk management and company assessment for stock trading	2014	The suggested approach enhance the returns of investment and decrease losses specially when dealing with multiple market conditions.	Kansei evaluation combined with the model of a self-organizing map
Feng, N., Wang, H. J., & Li, M.	A security risk analysis model for information systems: Causal relationships of risk factors and vulnerability propagation analysis	2014	The presented model is efficient in building beforehand plans of security risk management for information systems	Bayesian network
Li, Y., Zhang, W., Zhang, Y., Zhang, X., & Xiong, X.	Calibration of the agent-based continuous double auction stock market by scaling analysis	2014	The proposed approach can duplicate the couple of basic and actual characteristics of real stock markets	Scaling analysis
Maynard, D., Saggion, H., Yankova, M., Bontcheva, K., & Peters, W.	Natural language technology for information integration in business intelligence	2007	The high quality results of extraction process	Domain ontologies

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3. The proposed business intelligence framework for risk management

This section includes a new framework that integrates most trends in these days to risk management approaches. This framework consists of four phases namely, risks identification, risks assessment, risks control and risks monitoring which is shown in Figure 1 as the following:

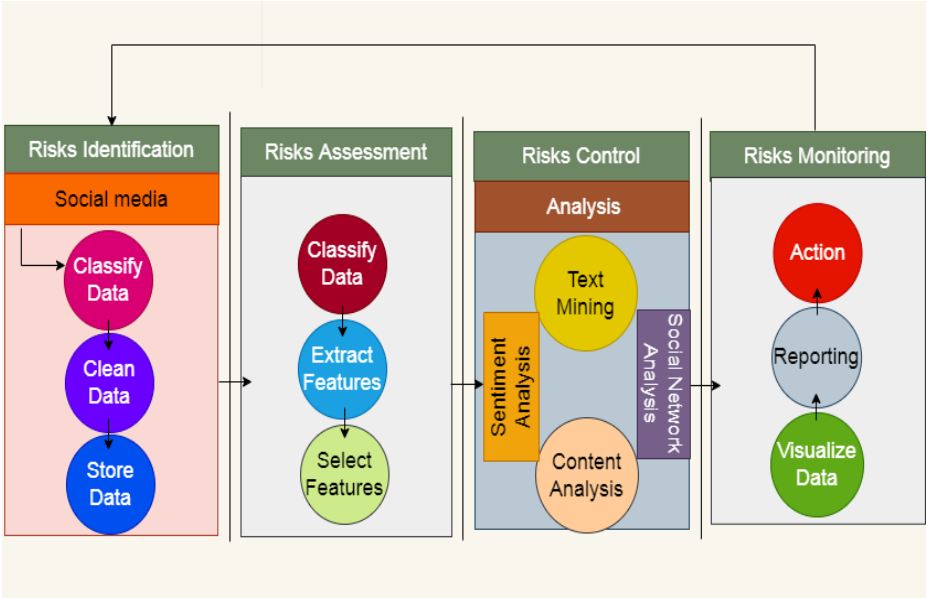

Figure 1: Business intelligence framework for risk management

This framework starts with identifying the potential risks by using social media platforms. This can be done by recognizing the opinions and behavior of users on social media platforms such as Facebook, Twitter and YouTube. The first phase involves three steps that are collect data, clean data and store data.

A different types of gathering data tools are available to collect data form social media platforms. Twitter API is recommended data collection tool to deal with texts in Twitter that can gather huge amounts of tweets. For videos on YouTube, YouTube API is desirable data gathering tool for collecting enormous amounts of videos. Also, Facebook API is an efficient tool to gather several types of data from Facebook platform such as texts, images and videos. Furthermore, including actions as emotions and shares for posts are important to identify and evaluate the possible risks.

Cleaning data is a significant step to produce effective feedback for managers. In this step, the collected data from social media platforms contains valid and invalid data that should be manipulated. The invalid data as deceptive information, missing data, inconsistent data (e.g. common stop words and stemming terms) and so on, and the manipulation process includes cleaning the collected data from invalid data types. Many techniques and approaches are provided to minimize invalid data as possible [17, 18, 19]. For instance, the authors in [17] developed an approach to handle deceptive information that spread on social media platforms. Also, missing data issue regarding big data is studied and many techniques and approaches are provided [18]. For inconsistent data, an approach is based on removing inconsistent data and employing term frequency-inverse document frequency weights to represent each term [19].

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The cleaned dataset is now ready to be stored by deploying systems of big data storage. In these systems, accessing and querying a huge amount of data can be done flexibly and efficiently. For instance, NoSQL Databases are an efficient tool to store and manage high-dimensional data. They are flexibly reading and writing data, enabling mass storage and reduced management and operational costs. Many classes of NoSQL databases including key-value pair, document, column-oriented and graph databases help programmers in data modeling to be appropriate to the format of the data in their application [20, 21]. Also, Apache Hive is another proficient tool for big data storing and managing that considered a data warehouse system [22].

Evaluating the potential risks in organizations is proposed in this phase by studying the behavior of users on social media websites. This behavior can be observed in the numbers of likes, comments, shares on posts in addition to number of hashtags. Consequently, extracting behavioral features from the collected dataset plays vital role in analyzing the mood of users and assessing the potential risks. It declares how, where, how much and how long users of healthcare organizations are generally revealed to a potential risk. This phase involves three steps: data classification, feature extraction and feature selection.

Social media platforms are rich with multimedia data such as texts, images, videos and sounds, and that may be in different structures such as structured, semi-structured and unstructured. The classification process is based on dividing data into similar groups of data to reduce the complexity and the dimensionality of social big data. Some techniques are provided to conquer this problem such as Quantum support vector machine [23] and Hybrid neural networks [24].

Classified groups of data from the previous step involve many features need to be extracted and then collect all features in a group for the following steps. The process of feature extraction includes transforming the input data such as texts and images into features have numerical characteristics which is effective for machine learning algorithms processing. It reduces the number of variables in the original dataset and starts with set of weighted data and produces derived values. Different methods can be employed to extract features such as Frequency term, Class term, Nuance, Term frequency Inverse Document, Term Inverse Document, Time Term frequency-inverse, N-Gram, Lexicon-based features, Bag-of-Words technique and Principle Component Analysis (PCA) [25].

In the feature selection process, the aim is to reduce the dimensionality and complexity of the data by minimizing the number of attributes in the set of extracted features. This helps in fasting the computations of the forthcoming steps and minimizing the time and cost. Features can be selected based on their scores in several statistical tests according to their correlation with the outcome variable. Wrapper methods assess the "usefulness" of features depending on the performance of classifier. In addition, embedded methods are used to select features whereas embedded methods are less than in computational cost. Embedded methods include the capabilities of filter and wrapper methods which are implemented by many algorithms such as Chi-Square (CHI) and Information Gain (IG) [26]. Other techniques can be used such as unsupervised learning and semi-supervised learning techniques [27].

In the controlling stage, we focus on handling the risks of organizations by deploying several techniques such as text mining, social network analysis, sentiment analysis as well as modeling. The results of the control stage are visualized by different techniques for the decision-makers.

Text mining is a common technique that is used in order to extract knowledge from unstructured data on social media platforms such as texts, images, audios and videos [28]. A detailed survey on text mining on social media is presented by [29, 30]. In addition, the authors in [31] used text mining techniques to compare disorder communities data related to their eating habits based on fitness tracking technology. Three types of eating related disorder data are collected within three years from comments posted on social media. The data are composed of six subreddits, fitness, and

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weight management. The results validate that subreddits with pre-disorder are less recovered compared with eating disorder subreddits with the highest frequency of fitness tracker terms. The authors in [32] explored whether computerized language analysis methods can be utilized to assess one's suicide risk and emotional distress in Chinese social media. The framework for social media content is proposed by [33]. The authors used the empirical study to test the framework during the FIFA World Cup 2014.

Social network analysis (SNA) is based on finding the social relationships between different users from social media using the network theory of nodes and connections [34]. Social network analysis has emerged as a key technique in social media applications, such as fraud detection and sociology. This analysis has also gained a significant following in medicine, anthropology, biology, and information science. SNA has become a popular topic of speculation and study. SNA has undergone a renaissance with the ubiquity and quantity of content from social media, web pages, and sensors [35]. Social networks are embedded in many sources of data and at many different scales. Social networks can arise from information in sources, such as text, databases, sensor networks, communication systems, and social media [36].

Sentiment analysis is a class of NLP, text analysis, and statistics. The idea is to find the sentiment of the text by classifying them into positive, negative, or neutral. This analysis is usually used for binary decision making, i.e., users like or dislike something, or the product is good or bad [37]. Sentiment analysis, which is also named opinion mining, includes categorizing consumer attitudes, emotions, and opinions of a company's product, brand, or service. In social media, sentiment analysis has various uses. For instance, this analysis can be applied to identify the feelings of consumers in a marketing and customer service department, which results in uncovering whether consumers are satisfied or dissatisfied with a product [38].

Modeling social media analytics deals with managing and evaluating informatics tools for social media data collection, monitoring and analyzing [39]. It is extracting process that provides a suitable pattern for data analyses during conversations and interactions. The analytical processes in social media analytics are divided into three phases, namely capturing phase, understanding phase and presentation phase.

In the monitoring stage, visualized insights from the previous stage provide the managers of organizations with valuable feedback about the current risks and how to avoid them. After gaining the feedback, potential actions are expected to apply. So, these actions will affect the performance either in positive or negative form. Hence, the process of risk management is repeated and closed to identify and manage risks.

4. Challenges of the business intelligence framework

There are many challenges to the proposed framework some of these challenges are stated in the following figure:

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Figure 2: Challenges of the proposed business intelligence framework

Building effective tools for collecting data that have different structures and types with huge amounts is still a big challenge. Moreover, the creation velocity of data on social media platforms is increasing every second. In addition, some of the challenges for API gathering tool are API handling and scaling process with flexible manner and reliability [40].

Social media users generate massive data that is unstructured and involves different formats (e.g. texts, images, audio and videos). Data quality encounters several challenges such as inaccurate data, duplicate data, missing data and fake news. All of these can affect badly on the insights as well as feedback that provides to the decision-makers.

Privacy is still a common problem when collecting data from the profiles of social media users. Some platforms such as Twitter that minimizes the restrictions on the data gathering process for the research purpose but the other platforms maximize them. So, the balance in maximization and minimization of restriction is important and required to protect the personal data of users and the help the researchers and firms benefit from these data. Some challenges are still not solved for privacy issues such as social identification and evaluation of test privacy-preserving services with actual data [41].

The assessment of risks stage consists of various challenges in its three steps. In the data classification step, it is difficult to classify data in the case of real-time analysis. Moreover, the classification techniques with high accuracy are required for an effective data classification process with minimum cost. In feature extraction and selection steps, scalability is another challenge such that the huge amount of data makes many methods of feature extraction is infeasible, especially the more complex nonlinear methods. Further, a global and local minimum is another issue in the feature extraction process [42]. Also, linked data is a problem in the feature selection process such that many linked data is unlabeled and it is difficult to assess the relevance of features without the guide of labeling data [43].

Due to the nature of big data, there are many challenges in processing the collected data that is complex and tremendous. The nature of big data refers to the big volume, big velocity, big variety and big value of data. The daily generated data from social media platforms is huge which may be 2.5 petabytes per hour from Walmart customer transactions. Retrieval and managing this data is a big issue in itself and brought new issues to data mining techniques [44]. Furthermore, the speed of generating data is high and increasing with time, which raises the difficulty of real-time analysis [45]. Also, the variety of data means the existence of multiple types of structures such as structured,

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semi-structured and unstructured, and many formats of multimedia data. This diversity brought a challenge in processing such data [44]. In addition, big value includes obtaining value from all this large-scale data by deploying efficient and lower cost tools which is considered a big challenge [46].

Visualization is an important step in making the obtained insights more obvious and flexible for the decision-makers. So, building effective and interactive tools to visualize a huge amount of complex and diverse data is still a big issue. Current visualization tools involve poor scalability, functionality and the time of response. Besides, when minimizing the dimensionality of data, leads to loss information problem which produces inaccurate insights. Further, the static graphical representation implies a lower visualization speed that needs high-performance requirements. Another challenge in the visualization process is a high rate of image change such that the user can not deal with the number of changes in data which provides unacceptable results because of the human reaction speed depending on it [47].

5. Conclusion

In this paper, we reviewed the most significant research articles in the research area of business intelligence in risk management. The vital articles that have been published starting from 2007 to 2021 are included. However this research area is essential, we found that a low contribution in this direction. Moreover, we presented a novel business intelligence approach for risk management. This approach is based on social media and big data analysis which can benefit to identify, assess, control and monitor risks. This approach helps the decision-makers to be aware of potential risks up-to-data and provides insights that will be significant in minimizing risks. Furthermore, the relevance challenges of the new approach are stated. In the future work, we will apply this framework for many applications such as healthcare, e-business, financial firms and so on. Furthermore many techniques can be applied such as artificial intelligence and meta-heuristic optimization techniques, and big data analysis techniques. In addition, many challenges that stated in Section 4, can be further research points.

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References

[1] Wu, D. D., Chen, S. H., & Olson, D. L., Business intelligence in risk management: Some recent progresses. Information Sciences, 256, 1-7, 2014.
[2] Alfaro, E., García, N., Gámez, M., & Elizondo, D., Bankruptcy forecasting: An empirical comparison of AdaBoost and neural networks. Decision Support Systems, 45(1), 110-122, 2008.
[3] Julka, N., Srinivasan, R., & Karimi, I., Agent-based supply chain management—1: framework. Computers & Chemical Engineering, 26(12), 1755-1769, 2002.
[4] Yiu, L. D., Yeung, A. C., & Cheng, T. E., The impact of business intelligence systems on profitability and risks of firms. International Journal of Production Research, 59(13), 3951-3974, 2021.
[5] Milanés-Batista, C., Tamayo-Yero, H., De Oliveira, D., & Nuñez-Alvarez, J. R., Application of Business Intelligence in studies management of Hazard, Vulnerability and Risk in Cuba. In IOP Conference Series: Materials Science and Engineering, Vol. 844, 012033, 2020.
[6] de Oliveira, A., & de Almeida, J. R., Business Intelligence Application for Multidimensional Analysis of Risks in Complex Projects. IT Professional, 21(6), 33-39, 2019.
[7] Alzeaideen, K., Credit risk management and business intelligence approach of the banking sector in Jordan. Cogent Business & Management, 6(1), 1675455, 2019.

Doi : https://doi.org/10.54216/AJBOR.060202
Received: February 20, 2022 Accepted: April 04, 2022

[8] Abutahoun, B., Alasasfeh, M., & Fraihat, S., A framework of business intelligence solution for real estates analysis. In Proceedings of the Second International Conference on Data Science, E-Learning and Information Systems, 1-9, 2019.

[9] Lopez, C., & Salmeron, J. L., Dynamic risks modelling in ERP maintenance projects with FCM. Information Sciences, 256, 25-45, 2014.

[10] Pham, H. V., Cooper, E. W., Cao, T., & Kamei, K., Hybrid Kansei-SOM model using risk management and company assessment for stock trading. Information Sciences, 256, 8-24, 2014.

[11] Feng, N., Wang, H. J., & Li, M., A security risk analysis model for information systems: Causal relationships of risk factors and vulnerability propagation analysis. Information sciences, 256, 57-73, 2014.

[12] Li, Y., Zhang, W., Zhang, Y., Zhang, X., & Xiong, X., Calibration of the agent-based continuous double auction stock market by scaling analysis. Information Sciences, 256, 46-56, 2014.

[13] Işık, Ö., Jones, M. C., & Sidorova, A., Business intelligence success: The roles of BI capabilities and decision environments. Information & management, 50(1), 13-23, 2013.

[14] Sienou, A., Karduck, A. P., Lamine, E., & Pingaud, H., Business process and risk models enrichment: Considerations for business intelligence. In 2008 IEEE International Conference on e-Business Engineering, 732-735, 2008.

[15] Maynard, D., Saggion, H., Yankova, M., Bontcheva, K., & Peters, W., Natural language technology for information integration in business intelligence. In International Conference on Business Information Systems, 366-380, 2007, Springer, Berlin, Heidelberg.

[16] Curko, K., Bach, M. P., & Radonic, G., Business intelligence and business process management in banking operations. In 2007 IEEE 29th International Conference on Information Technology Interfaces, 57-62, 2007.

[17] Darwiesh, A., Alghamdi, M., El-Baz, A. H., & Elhoseny, M. Social Media Big Data Analysis: Towards Enhancing Competitiveness of Firms in a Post-Pandemic World. Journal of Healthcare Engineering, 2022.

[18] Ezzine, I., & Benhlima, L., A study of handling missing data methods for big data. In 2018 IEEE 5th International Congress on Information Science and Technology (CiSt), 498-501, 2018, IEEE.

[19] Tuarob, S., Tucker, C. S., Salathe, M., & Ram, N., An ensemble heterogeneous classification methodology for discovering health-related knowledge in social media messages. Journal of biomedical informatics, 49, 255-268, 2014.

[20] Han, J., Haihong, E., Le, G., & Du, J., Survey on NoSQL database. In 2011 IEEE 6th international conference on pervasive computing and applications, 363-366, 2011.

[21] Kaur, K., & Rani, R., Modeling and querying data in NoSQL databases. In 2013 IEEE international conference on big data, 1-7, 2013.

[22] Huai, Y., Chauhan, A., Gates, A., Hagleitner, G., Hanson, E. N., O'Malley, O., ... & Zhang, X., Major technical advancements in apache hive. In Proceedings of the 2014 ACM SIGMOD international conference on Management of data, 1235-1246, 2014.

[23] Rebentrost, P., Mohseni, M., & Lloyd, S., Quantum support vector machine for big data classification. Physical review letters, 113(13), 130503, 2014.

[24] Hernández, G., Zamora, E., Sossa, H., Téllez, G., & Furlán, F., Hybrid neural networks for big data classification. Neurocomputing, 390, 327-340, 2020.

[25] Mounica, B., & Lavanya, K., Social Media data analysis for intelligent transportation systems. In 2020 IEEE International Conference on Emerging Trends in Information Technology and Engineering (ic-ETITE), 1-8, 2020.

[26] Kumar, S. S., & Rajini, A., Extensive survey on feature extraction and feature selection techniques for sentiment classification in social media. In 2019 IEEE 10th International

Doi : https://doi.org/10.54216/AJBOR.060202
Received: February 20, 2022 Accepted: April 04, 2022

Conference on Computing, Communication and Networking Technologies (ICCCNT), 1-6, 2019.

[27] Chandrashekar, G., & Sahin, F., A survey on feature selection methods. Computers & Electrical Engineering, 40(1), 16-28, 2014.

[28] Aggarwal, C. C., & Wang, H., Text mining in social networks. In Social network data analytics, 353-378, 2011, Springer, Boston, MA.

[29] Reddick, C. G., Chatfield, A. T., & Ojo, A., A social media text analytics framework for double-loop learning for citizen-centric public services: A case study of a local government Facebook use. Government Information Quarterly, 34(1), 110-125, 2017.

[30] Salloum, S. A., Al-Emran, M., Monem, A. A., & Shaalan, K., A survey of text mining in social media: facebook and twitter perspectives. Adv. Sci. Technol. Eng. Syst. J, 2(1), 127-133, 2017.

[31] McCaig, D., Bhatia, S., Elliott, M. T., Walasek, L., & Meyer, C., Text-mining as a methodology to assess eating disorder-relevant factors: Comparing mentions of fitness tracking technology across online communities. International Journal of Eating Disorders, 51(7), 647-655, 2018.

[32] Cheng, X., Fu, S., & de Vreede, G. J., Understanding trust influencing factors in social media communication: A qualitative study. International Journal of Information Management, 37(2), 25-35, 2017.

[33] Thomaz, G. M., Biz, A. A., Bettoni, E. M., Mendes-Filho, L., & Buhalis, D., Content mining framework in social media: A FIFA world cup 2014 case analysis. Information & Management, 54(6), 786-801, 2017.

[34] Serrat, O., Social network analysis. In Knowledge solutions, 39-43, 2017, Springer, Singapore.

[35] Cybenko, G., Parallel Computing for Machine Learning in Social Network Analysis. Paper presented at the IEEE Parallel and Distributed Processing Symposium Workshops (IPDPSW), 2017.

[36] Campbell, W. M., Dagli, C. K., & Weinstein, C. J., Social network analysis with content and graphs. Lincoln Laboratory Journal, 20(1), 61-81, 2013.

[37] Ohbe, T., Ozono, T., & Shintani, T., A sentiment polarity classifier for regional event reputation analysis. In proceedings of the international conference on web intelligence, 1207-1213, 2017.

[38] Povoda, L., Burget, R., Dutta, M. K., & Sengar, N., Genetic optimization of big data sentiment analysis. In 2017 IEEE 4th International Conference on Signal Processing and Integrated Networks (SPIN), 141-144, 2017.

[39] Elkaseh, A. M., Wong, K. W., & Fung, C. C., Perceived ease of use and perceived usefulness of social media for e-learning in Libyan higher education: A structural equation modeling analysis. International Journal of Information and Education Technology, 6(3), 192-199, 2016.

[40] Lomborg, S., & Bechmann, A., Using APIs for data collection on social media. The Information Society, 30(4), 256-265, 2014.

[41] Bello-Orgaz, G., Jung, J. J., & Camacho, D., Social big data: Recent achievements and new challenges. Information Fusion, 28, 45-59, 2016.

[42] Storcheus, D., Rostamizadeh, A., & Kumar, S., A survey of modern questions and challenges in feature extraction. In Feature Extraction: Modern Questions and Challenges, 1-18, 2015, PMLR.

[43] Li, J., & Liu, H., Challenges of feature selection for big data analytics. IEEE Intelligent Systems, 32(2), 9-15, 2017.

[44] Sivarajah, U., Kamal, M. M., Irani, Z., & Weerakkody, V., Critical analysis of Big Data challenges and analytical methods. Journal of Business Research, 70, 263-286, 2017.

[45] Lee, I., Big data: Dimensions, evolution, impacts, and challenges. Business Horizons, 60(3), 293-303, 2017.

[46] Wang, F. Y., A big-data perspective on AI: Newton, Merton, and analytics intelligence. IEEE Intelligent Systems, 27(5), 2-4, 2012.

Doi : https://doi.org/10.54216/AJBOR.060202
Received: February 20, 2022 Accepted: April 04, 2022

[47] Gorodov, E. Y. E., & Gubarev, V. V. E., Analytical review of data visualization methods in application to big data. Journal of Electrical and Computer Engineering, 2013.

Doi : https://doi.org/10.54216/AJBOR.060202
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