Indonesian Journal of Electrical Engineering and Computer Science
Vol. 30, No. 2, May 2023, pp. 1120~1127
ISSN: 2502-4752, DOI: 10.11591/ijeecs.v30.i2.pp1120-1127

Supply chain strategy during the COVID-19 terms: sentiment analysis and knowledge discovery through text mining

Muhammad Khahfi Zuhanda[1], Yuan Anisa[1], Desniarti[2], Muhammad Hafiz[3], Anil Hakim Syofra[4], Rezzy Eko Caraka[5], Maengseok Noh[6]
[1]Faculty of Engineering, Universitas Medan Area, Medan, Indonesia
[2]Faculty of Teaching and Education, Universitas Muslim Nusantara Al Washliyah, Medan, Indonesia
[3]Faculty of Science and Technology, Universitas Pembangunan Pancabudi, Medan, Indonesia
[4]Faculty of Teaching and Education, Universitas Asahan, Asahan, Indonesia
[5]Research Center for Data and Information Sciences, National Research and Innovation Agency (BRIN), Jakarta, Indonesia
[6]Data and Information Sciences College of Information Technology and Convergence, Pukyong National University, Busan, South Korea

Article Info

Article history:

Received Jun 4, 2022
Revised Jan 11, 2023
Accepted Jan 14, 2023

Keywords:

COVID-19
Knowledge discovery
Sentiment analysis
Supply chain
Text mining

ABSTRACT

The coronavirus pandemic has affected not only health but also the economy. The use of big data in finding information can be used to gain profits that logistics companies can utilize to survive during the pandemic. This study conducted text-mining research on service consultant sites in the logistics sector. This study aims to present frequency diagrams, analyze sentiment using the National Research Council (NRC) lexicon, present bigrams, and seek knowledge about strategies to minimize shipping costs and maintain inventories of manufactured goods. The words "supply", "chain", and "COVID-19" are words that are used frequently throughout the article. The results of this study showed that the words that often appear from word excavation are the words "supply", "chain", "logistics", "kpis," and "inventory". Then emotion trust becomes an emotional word that often appears in articles. The words "Supply" and "pandemic" are the words that seem the most positive and negative words, respectively. The words "COVID-19", "safety stock", and "inventory management" are words that often appear together. The result of discovery knowledge is that logistics consultants offer emotions of trust and provide many insights on minimizing shipping costs and maintaining inventory during a pandemic.

Corresponding Author:

Muhammad Khahfi Zuhanda
Faculty of Engineering, Universitas Medan Area
Medan, Indonesia
Email: khahfi@staff.uma.ac.id

1. INTRODUCTION

In recent years, the coronavirus disease, commonly called COVID-19, has attacked millions of people and resulted in more than 6 million deaths worldwide. COVID-19 is not only shooting from a health but also an economic perspective. Restrictions on social activities and lockdowns significantly affect supply chain (SC) flow in every line [1]. The government's limiting activities increase shipping costs, and production stocks are also depleted due to restrictions on work activities. Entrepreneurs in the logistics sector must be able to rack their brains to survive during the pandemic.

Bureau of logistics is a private company in SC management consulting and logistics. The company is experienced in the field of end-to-end SC. The company was founded in 1997 and has grown into several companies that focus on consulting, education, and benchmarking SC and logistics. To date, the company has branches in 25 countries.

Logistics consultants play a role in helping companies in the SC and logistics sector in making the right decisions. Bureau logistics has a website www.logisticsbireau.com. Many articles are on the site, especially regarding SC strategies during a pandemic. Knowledge searches from logistics consultant websites can help companies understand quickly and gain useful knowledge. What knowledge can be gained from extracting data from the site? What sentiments often arise from the author in articles on the website? Moreover, what are the SC strategies used to reduce shipping costs and overcome product shortages during a pandemic? With this background, this paper aims to discover the knowledge of the logistics bureau website during the recent pandemic. This topic is theoretically essential to understanding how logistics consultants suggest strategies and what sentiment words often appear in their articles during a pandemic.

This investigation is very important to understand the SC strategy implications of this phenomenon, which makes this research important. With this background, this research explores the insights that can be obtained from articles on the www.logisticsbireau.com website through machine learning. The methods that we use in this study include text mining, cleaning text, analyzing text using R Studio, and searching for knowledge by reading articles.

In analyzing the text, we present the number of words that frequently occur in a frequency chart. Then we present it in the form of a word cloud. Emotional sentiment theory and lexicon are used to base the analysis. Web scrapping through machine learning (R Studio) was carried out to collect 16 article posts from the site from 2019 to 2022 containing SC strategy and COVID-19. Sentiment lexicon-based analysis was used to evaluate the sentiment scores of the sample articles. After analyzing the frequency, we try to explore science by reading articles to get strategies to minimize container shipping costs and maintain stock availability.

In recent years, text mining on websites and social media has been carried out by many people, including [2]-[4]. Mining texts regarding SC have also been discussed by [5]-[7]. Much research has been done on SC and linkages with COVID-19 throughout 2019-2022 [8]. Strategies to minimize risk are also discussed by Trautrims *et al.* [9] and Zuhanda *et al.* [10] present the 2E-VRP model to minimize logistics shipping costs. Goncalves *et al.* [11] discuss the handling of stock availability.

There were many studies on SC strategies during the COVID-19 pandemic. However, there is still little research on SA during the SC pandemic. Several studies related to SA showed by in Table 1. Most articles are still analyzing sentiment used via social media, namely Twitter. However, few still examine articles on sites that are experts on SC and logistics. The opinion of experts in the SC field will provide a new perspective and knowledge about the strategy of the SC during the pandemic.

Table 1. Summerize of related work

Num.	Ref.	Source Text	Method
1	Akundi *et al.* [12]	Twitter	SA and opinion analysis
2	Shipley *et al.* [13]	Blog, forum, and Twitter	SA
3	Sperry *et al.* [14]	Twitter, survey, forum	SA
4	Treiblmaier and Mair [15]	Interview professional	Word clouds, SA, topic models, correspondence analysis, and multidimensional scaling.
5	Khatua *et al.* [16]	Twitter and Facebook	SA

There are still relatively few studies looking to analyze the relationship between the word bigram and text mining, related publications that explore bigram are [17], [18]. To get critical knowledge from the article's content, searching for learning by reading articles related to the question is necessary. After obtaining the answers to the research questions, they are presented in a Sankey diagram. Some publications that visualize Sankey diagrams include [19], [20]. For this purpose, the remainder of this paper is structured as follows. Section 2 offers the research methods. Section 3 draws results and discussion. Conclusions are presented in section 4.

2. METHOD

2.1. Text mining

In this study, data collection was carried out through web scrapping on the www.logisticsbureau.com site with the keywords "supply", "chain", and "COVID-19". The purpose of extracting this text is to obtain text data which will later be collected using machine learning to gain insight from articles on websites. Furthermore, the data in the title and content of the articles were collected and arranged into a table. Data is collected in the form of tables which are stored in .csv format. To prepare for extracting text from a website, install the rvesr and dplyr packages in Rstudio. Then install SelectorGadget in Chrome; SelectorGadget is an open-source tool that helps create and find CSS selectors on sites. Several studies that conducted web scraping data mining include [21]-[23].

2.2. Cleaning text

After the article text has been collected, to be able to be analyzed, it is necessary to clean the words. In cleaning the text on the article, namely pre-processing the data, first removing the words that often appear for spaces such as "\n", “punctuation”, the text is changed to lowercase, separated the words text, and removed stopwords. In language, stopwords are words that can be ignored because they do not affect the meaning and information in a sentence if they are omitted. In splitting the text, the text is converted into a separate list of strings. Eliminating stopwords makes word sets from articles better to analyze for valuable insights [24], [25].

We will present the process of cleaning text, for example, an example of one of the content texts that has been extracted from the website "\nKnown as the ferrymen of Wuhan, thousands of motorbike riders ...". From this sentence, we show the process of stages as can be seen in Table 2 cleaning up to into word for word. From this process, it will be processed in the next stage for analysis using machine learning.

Table 2. Cleaning process

Num.	Step by Step	After Cleaned
1.	Remove “\n”, “punctuation”, “URL” + change to lower case	"known as the ferrymen of wuhan, thousands of motorbike riders…”
2.	Separate words	"known”, “as”, “the”, “ferrymen”, “of” , “wuhan”, “thousands”, “of” “motorbike” “riders”, …
3.	Remove stopwords	"known”, “ferrymen”, “wuhan”, “thousands”, “motorbike”, “riders”, …

2.3. Analyze text via Rstudio

In the next stage, after the text is cleaned, the process analyses the number of word frequencies [26]. After cleaning and separating words, we can see the terms that often appear on the website. And after obtaining the number of words that frequently occur, then presented in the form of a word frequency diagram. After that, we can show it as a word cloud to easily understand the words. The next process in this paper is to analyze the emotional score of the text extracted from the website article. In this step, this study uses the National Research Council (NRC) lexicon method to define the number of emotional scores from the text [27], [28].

Next, we present the relationship of words to create a bigram network visualization [29]. Bigram analysis extracts and counts words that appear together in the cleaned text. A bigram is a sequence of two words that appear simultaneously. From this result, related words that often arise and are presented in a diagram will be obtained. The classification of emotions carried out will be used to answer questions. Q1: What types of emotions often arise from the articles presented on the website during the COVID-19 pandemic?

2.4. Theoretical fundamentals and creating research questions

Word frequency analysis presents words that are often used in the text. We can derive useful things from calculating the frequency. One of them is that you can understand the keywords of the content on the website that is being analyzed. This provides an overview of the situation or something the author wants to present. And you can quickly understand the content of the article without having to read it thoroughly.

The emotional analysis is the basis for the current state of affairs. Is that good or bad? Several types of emotions influence decision-making. The use of words by the author reflects the content of the delivery to be conveyed. Analysis of the kinds of emotions classified as "sad", "happy", "believe", "fear", and others describe the current state of affairs.

In recent years the classification of these types of emotions can be done by machine learning. There are several methods for classifying emotions, including the lexicon analysis method. Three types of lexicon analysis can be used, namely Bing, AFINN, and NRC [30]. The BING lexicon technique labels words into positive and negative categories. Meanwhile, the AFINN lexicon method labels words with a score between -5 and 5. AFINN's negative score represents negative sentiment and vice versa, a positive score. The NRC lexicon method classifies words into the categories of eight emotions and two sentiments [31]. The classification of emotions carried out will be used to answer questions. Q2: What types of emotions often arise from the articles presented on the website during the COVID-19 pandemic?

3. RESULTS AND DISCUSSION

What do you get from digging from 16 articles on the website? This paper presents visualizations of sample articles in several ways. This study uses two packages in Rstudio, wordcloud and ggplot to visualize the data. To build a graphical representation, we use the wordcloud package. Meanwhile, ggplot is used to represent the top 25 frequently used words from 16 articles analyzed from the website.

The word frequency analysis of data collected from articles on the www.logisticsbureau.com site illustrates what the SC consulting site discusses. Then, it provides an opportunity for in-depth analysis of the frequency of words that often appear. Figure 1 presents the frequencies of the 25 words that appear most frequently in public discussions on site. Here, we note that the words 'supply', 'chain, 'logistics', kpis', 'inventory', 'business', 'shipping', 'cost', and 'time' are the highest frequency words. This result does not involve stopwords, which are words that have little meaning for analysis.

Figure 2 is a word cloud of words collected from 16 articles on the www.logisticsbureau.com website. The word cloud visualization can be interpreted that the more significant word is the word that appears more often than the other words. The articles collected can be analyzed the author's sentiments regarding the supply chain, freight costs, and product availability issues. The emotions of words in the text were analyzed using all corpus review data using the NRC word-emotion association lexicon [32]. Table 3 presents the emotional scores of the 5 article titles using all of the corpus review data using the NRC lexicon. The table presents the classification of eight emotions and two sentiments using the NRC lexicon method from 5 sample articles. And then, it will add the total of each emotion and sentiment. Table 4 shows the total emotional score of all the extracted articles. The word anger emotion appears 4.99% (160), anticipation emotion is 9.88% (317), disgust emotion is 2.52% (81), fear emotion is 7.51% (241), joy emotion is 5.61% (180), sadness emotion is 6.26% (201), surprise emotion is 3.46% (111), trust emotion is emotion 16.20% (520), negative sentiments as much as 13.62% (437), and positive sentiments as much as 29.95% (961).

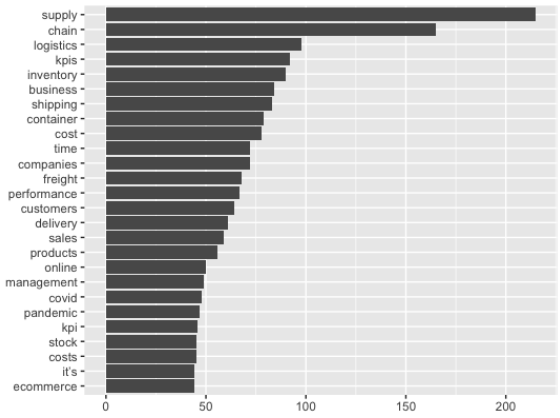


Figure 1. The top 25 most common words

Figure 2. Word cloud

Table 3. Emotions score

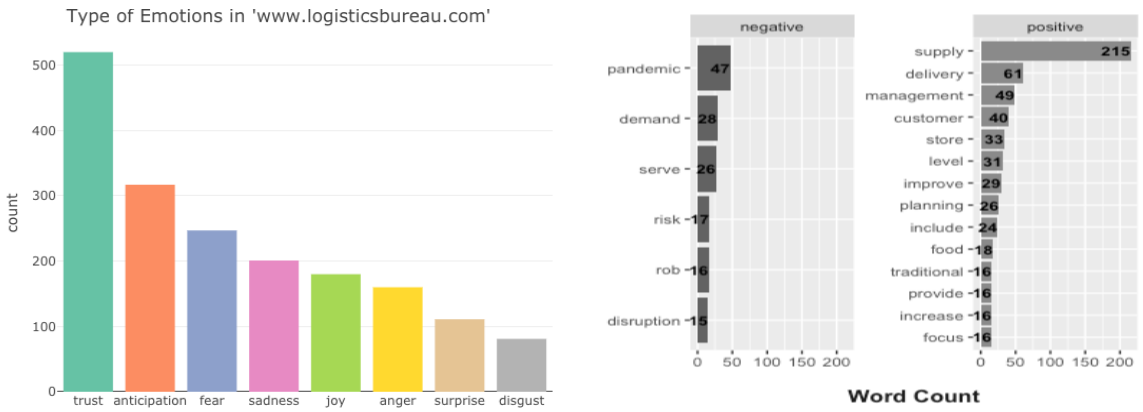
Num.	Title article	Emotions Score									
		anger	anticipations	disgust	fear	joy	sadness	surprise	trust	negative	positive
1.	"COVID-19 Pandemic Triggers Surge in Global Food Delivery Industry"	4	5	3	8	3	5	3	12	13	24
2.	Why Containerised Freight Shipping is Daunting for SMEs"	6	19	3	16	11	14	4	28	23	54
3.	"The Challenge of Freight Container Utilisation and Why it Matters"	4	18	2	6	14	10	11	34	17	60
4.	"Container Freight Costs and Forecasting: Intrinsically Linked and Frustratingly Challenging"	9	19	5	15	9	9	6	33	23	48
5.	"Post-COVID Ecommerce is Booming, But Logistics Issues Abound"	18	34	10	28	21	22	12	54	49	116

Table 4. Total emotions score

Num.	Type of Emotions	Total	Num	Type of Emotions	Total
1.	Anger	160	6.	Sadnes	201
2.	Anticipation	317	7.	Surprise	111
3.	Disgust	81	8.	Trust	520
4.	Fear	241	9.	Negative	437
5.	Joy	180	10.	Positive	961

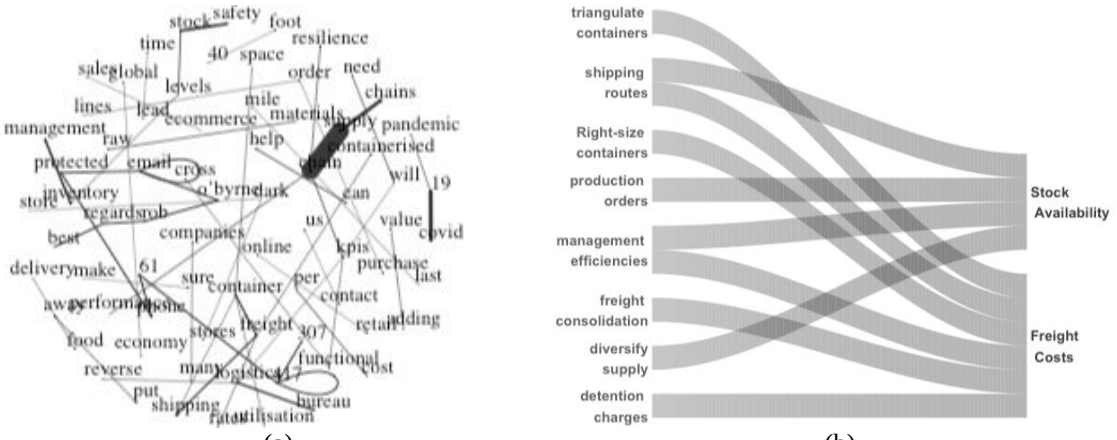
The calculation of emotions will be presented in a bar chart, as shown in Figure 3. The visualization of SA using Rstudio, which can be seen in Figure 3(a), shows that emotion trust is a word often used in writing, followed by anticipation, fear, sadness, joy, anger, surprise, and disgust. Figure 3(b) shows the frequency of SA containing positive and negative words. The words containing the top positive sentiments that often appear are "supply", "delivery", and "management". While words that have negative sentiments are "pandemic", "demand", and "serve". The visualization in the image shows that the use of positive words is used more than negative words. From the top 20 words, there are sentiments containing 6 negative words and 14 positive words.

Figure 4 presents a network of words. Figure 4(a) presents a bigram network of frequently occurring words. A thick network indicates the word is related and is used more often than other words with a thin network. Furthermore, to gain knowledge about minimizing shipping costs and maintaining stock availability. We read the text and summarized it into a diagram. Figure 4(b) is a Sankey diagram from an analysis of the contents of the articles on controlling stock availability and minimizing freight costs. From the chart, we can interpret strategies to reduce container shipping costs by adjusting container sizes, minimizing shipping routes, combining shipments, cutting SC flows, and minimizing containment costs to maintain product stock and maintain strategic measures. To take and optimize delivery routes, control production orders, SC efficiency, and diversify the SC.



(a) (b)

Figures 3. Sentiment analysis using NRC lexicon: (a) visualization of type of emotion and (b) visualization of negative and positive words



(a) (b)

Figures 4. Knowledge discovery: (a) bigram network and (b) sankey diagram strategy supply chain

4. CONCLUSION

Going back to the question in the introduction, what do we get from extracting text mining from a website? We gain insight into the emotional sentiment used in the article. The article builds many emotions of trust and uses a lot of positive sentiments in the article. The words "supply", "chain", "logistics", "kpis," and "inventory" are words that are used frequently throughout the article. The words "COVID-19", "safety stock", and "inventory management" are words that often appear together. From extracting this big data, we gain insight into strategies to minimize container shipping costs by adjusting container sizes, minimizing shipping routes, combining shipments, cutting SC flows, and minimizing containment costs to maintain product stock and always maintain strategic measures. To take, optimizing delivery routes, control production orders, SC efficiency, and SC diversification. Future research will make efforts to minimize delivery routes by examining the problem of vehicle routes. The result of discovery knowledge is that logistics consultants offer emotions of trust and provide many insights on minimizing shipping costs and maintaining inventory during a pandemic.

REFERENCES

[1] S. Singh, R. Kumar, R. Panchal, and M. K. Tiwari, "Impact of COVID-19 on logistics systems and disruptions in food supply chain," *Int J Prod Res*, vol. 59, no. 7, pp. 1993-2008, 2021, doi: 10.1080/00207543.2020.1792000.

[2] R. Ferreira-Mello, M. André, A. Pinheiro, E. Costa, and C. Romero, "Text mining in education," *Wiley Interdisciplinary Reviews: Data Mining and Knowledge Discovery*, vol. 9, no. 6. 2019. doi: 10.1002/widm.1332.

[3] L. Hickman, S. Thapa, L. Tay, M. Cao, and P. Srinivasan, "Text preprocessing for text mining in organizational research: review and recommendations," *Organ Res Methods*, vol. 25, no. 1, pp. 1-33, 2022, doi: 10.1177/1094428120971683.

[4] S. Kumar, A. K. Kar, and P. V. Ilavarasan, "Applications of text mining in services management: A systematic literature review," *International Journal of Information Management Data Insights*, vol. 1, no. 1. 2021, doi: 10.1016/j.jjimei.2021.100008.

[5] C. Y. Chu, K. Park, and G. E. Kremer, "A global supply chain risk management framework: An application of text-mining to identify region-specific supply chain risks," *Advanced Engineering Informatics*, vol. 45, 2020, doi: 10.1016/j.aei.2020.101053.

[6] A. Meyer, W. Walter, and S. Seuring, "The impact of the coronavirus pandemic on supply chains and their sustainability: a text mining approach," *Frontiers in Sustainability*, vol. 2, 2021, doi: 10.3389/frsus.2021.631182.

[7] S. M. Shah, M. Lütjen, and M. Freitag, "Text mining for supply chain risk management in the apparel industry," *Applied Sciences (Switzerland)*, vol. 11, no. 5. 2021, doi: 10.3390/app11052323.

[8] P. Chowdhury, S. K. Paul, S. Kaisar, and M. A. Moktadir, "COVID-19 pandemic related supply chain studies: A systematic review," *Transp Res E Logist Transp Rev*, vol. 148, pp. 1-26, 2021, doi: 10.1016/j.tre.2021.102271.

[9] A. Trautrims, M. C. Schleper, M. S. Cakir, and S. Gold, "Survival at the expense of the weakest? Managing modern slavery risks in supply chains during COVID-19," *J Risk Res*, vol. 23, no. 7–8, 2020, doi: 10.1080/13669877.2020.1772347.

[10] M. K. Zuhanda, S. Suwilo, O. S. Sitompul, and M. Mardiningsih, "A combination k-means clustering and 2-opt algorithm for solving the two echelon e-commerce logistic distribution," *Logforum*, vol. 18, no. 2, pp. 213–225, Jun. 2022, doi: 10.17270/J.LOG.2022.734.

[11] J. N. C. Gonçalves, M. S. Carvalho, and P. Cortez, "Operations research models and methods for safety stock determination: A review," *Operations Research Perspectives*, vol. 7. 2020, doi: 10.1016/j.orp.2020.100164.

[12] A. Akundi, B. Tseng, J. Wu, E. Smith, M. Subbalakshmi, and F. Aguirre, "Text mining to understand the influence of social media applications on smartphone supply chain," in *Procedia Computer Science*, vol. 140, pp. 87-94, 2018, doi: 10.1016/j.procs.2018.10.296.

[13] M. F. Shipley, R. Q. Cao, and R. A. McKee, "Sentiment analysis of behavioural attributes for effective supply chain relationships: A fuzzy goal-setting approach," *International Journal of Business Performance and Supply Chain Modelling*, vol. 11, no. 2, pp. 128-151, 2020, doi: 10.1504/IJBPSCM.2020.109202.

[14] D. Sperry *et al.*, "Trucking in the Era of COVID-19," *American Behavioral Scientist*, 2022, doi: 10.1177/00027642211066039.

[15] H. Treiblmaier and P. Mair, "Textual data science for logistics and supply chain management," *Logistics*, vol. 5, no. 3, 2021, doi: 10.3390/logistics5030056.

[16] A. Khatua, A. Khatua, X. Chi, and E. Cambria, "Artificial intelligence, social media and supply chain management: The way forward," *Electronics (Switzerland)*, vol. 10, no. 19. 2021, doi: 10.3390/electronics10192348.

[17] S. Rajendran and J. Fennewald, "Improving service supply chain of internet services by analyzing online customer reviews," in *International Series in Operations Research and Management Science*, vol. 304, 2021, doi: 10.1007/978-3-030-69265-0_5.

[18] L. R. Novick and S. J. Sherman, "Tfype-based bigram frequencies for five-letter words," *Behavior Research Methods, Instruments, and Computers*, vol. 36, no. 3, 2004, doi: 10.3758/BF03195587.

[19] C. Chong *et al.*, "A visualization method of the economic input–output table: Mapping monetary flows in the form of sankey diagrams," *Sustainability (Switzerland)*, vol. 13, no. 21, 2021, doi: 10.3390/su132112239.

[20] R. C. Lupton and J. M. Allwood, "Hybrid sankey diagrams: Visual analysis of multidimensional data for understanding resource use," *Resour Conserv Recycl*, vol. 124, 2017, doi: 10.1016/j.resconrec.2017.05.002.

[21] F. A. Hudaefi, R. E. Caraka, and H. Wahid, "Zakat administration in times of COVID-19 pandemic in Indonesia: a knowledge discovery via text mining," *International Journal of Islamic and Middle Eastern Finance and Management*, vol. 15, no. 2, 2022, doi: 10.1108/IMEFM-05-2020-0250.

[22] D. Flores-Ruiz, A. Elizondo-Salto, and M. D. L. O. Barroso-González, "Using social media in tourist sentiment analysis: A case study of andalusia during the COVID-19 pandemic," *Sustainability (Switzerland)*, vol. 13, no. 7, 2021, doi: 10.3390/su13073836.

[23] J. Silge and D. Robinson, "Tidytext: text mining and analysis using tidy data principles in R," *The Journal of Open Source Software*, vol. 1, no. 3, 2016, doi: 10.21105/joss.00037.

[24] S. Sarica and J. Luo, "Stopwords in technical language processing," *PLoS One*, vol. 16, no. 8 August, 2021, doi: 10.1371/journal.pone.0254937.

[25] R. Rani and D. K. Lobiyal, "Performance evaluation of text-mining models with Hindi stopwords lists," *Journal of King Saud University - Computer and Information Sciences*, 2020, doi: 10.1016/j.jksuci.2020.03.003.

[26] M. Brysbaert, P. Mandera, and E. Keuleers, "The word frequency effect in word processing: an updated review," *Curr Dir Psychol Sci*, vol. 27, no. 1, pp. 45-50, 2018, doi: 10.1177/0963721417727521.

[27] D. M. E. D. M. Hussein, "A survey on sentiment analysis challenges," *Journal of King Saud University - Engineering Sciences*, vol. 30, no. 4, 2018, doi: 10.1016/j.jksues.2016.04.002.
[28] J. L. Gandía and D. Huguet, "Textual analysis and sentiment analysis in accounting," *Revista de Contabilidad-Spanish Accounting Review*, vol. 24, no. 2. 2021, doi: 10.6018/RCSAR.386541.
[29] T. Hachaj and M. R. Ogiela, "What can be learned from bigrams analysis of messages in social network?," in *Proceedings - 2018 11th International Congress on Image and Signal Processing, BioMedical Engineering and Informatics, CISP-BMEI 2018*, 2019, doi: 10.1109/CISP-BMEI.2018.8633108.
[30] J. C. Kim and K. Y. Chung, "Knowledge expansion of metadata using script mining analysis in multimedia recommendation," *Multimed Tools Appl*, vol. 80, no. 26–27, pp. 34679–3469, 2021, doi: 10.1007/s11042-020-08774-0.
[31] M. K. Hassan, F. A. Hudaefi, and R. E. Caraka, "Mining netizen's opinion on cryptocurrency: sentiment analysis of Twitter data," *Studies in Economics and Finance*, vol. 39, no. 3, pp. 365–385, Apr. 2022, doi: 10.1108/SEF-06-2021-0237.
[32] A. Mathur, P. Kubde, and S. Vaidya, "Emotional analysis using twitter data during pandemic situation: COVID-19," in *Proceedings of the 5th International Conference on Communication and Electronics Systems, ICCES 2020*, 2020, doi: 10.1109/ICCES48766.2020.09138079.

BIOGRAPHIES OF AUTHORS

Muhammad Khahfi Zuhanda received the Bachelor's Science, Master's Science, and Doctoral degree in mathematics from Universitas Sumatera Utara. He is currently works at the faculty of engineering, Universitas Medan Area. His research interests include mathematics modelling, data science, operational research, nonlinear programming, and optimization. He can be contacted at email: khahfi@staff.uma.ac.id.

Yuan Anisa received the Bachelor's Science and Master's Science degree in mathematics from Universitas Sumatera Utara. She is currently works at the faculty of engineering, Universitas Medan Area. Her research interests include mathematics statistics, operational research, optimization. She can be contacted at email: yuan@staff.uma.ac.id.

Desniarti received the Bachelor's Education degree in mathematics education from Universitas Muslim Nusantara Al Washliyah. And she received the Master's Science degree in mathematics from Universitas Sumatera Utara. She is currently works at the faculty of teaching and education, Universitas Muslim Nusantara Al Washliyah. Her research interests include mathematics education and statistics. She can be contacted at email: desniarti@umnaw.ac.id.

Muhammad Hafiz received the Bachelor's Education degree mathematics education from STKIP Budidaya Binjai. He received the Master's Science degree in mathematics from Universitas Sumatera Utara. He is currently works at the faculty of science and technology, Universitas Pembangunan Pancabudi. His research interests include mathematics education and statistics. He can be contacted at email: hafiz@dosen.pancabudi.ac.id.

Anil Hakim Syofra received the Bachelor's Education degree in mathematics education from Universitas Asahan. He received the Master's Science degree in mathematics from Universitas Sumatera Utara. He is currently works at Universitas Asahan. His research interests include mathematics education and statistics. He can be contacted at email: matematikafkipuna@gmail.com.

Rezzy Eko Caraka received the bachelor's degree from Universitas Diponegoro, the master's degree from The National University of Malaysia, and the Ph.D. degree from the Chaoyang University of Technology. He was a Post-Doctoral Researcher with the Department of Nuclear Medicine, Seoul National University Hospital (January 2021 to January 2022). He was the Research Assistant Professor at Department of Statistics, Seoul National University (January-April 2022). He has been an Adjunct Lecturer with the Faculty of Economics and Business at Universitas Indonesia (2021-presents), Adjunct Lecturer with Graduate School, Department of Statistics at Padjadjaran University (2021 to presents), Adjunct Lecturer with the Faculty of Business and Economics, Indonesian International Islamic University (2022 to present), and Senior Research Fellow with the Department of Mathematics at Ulsan National Institute of Science and Technology, South Korea (2022 to presents). His research interests include, but are not limited to, statistics, large-scale optimization, machine learning, big data analytics, data science, and sustainable development goals. He can be contacted at email: rezzy.eko.caraka@brin.go.id.

Maengseok Noh received B.S., M.S., and Ph.D. degrees from the Department of Statistics, Seoul National University, in 1996, 1998, and 2005, respectively. His thesis was on analyzing binary data and robust modeling via hierarchical likelihood. Since 2006, he has been a Professor at the Department of Statistics, Pukyong National University, Busan, Korea. His current research interests are application and software development for hierarchical generalized linear models, methodology development for zero-inflated poisson model with spatial correlation, and hierarchical approach non-Gaussian factor analysis. He can be contacted at email: msnoh@pknu.ac.kr.