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BIG DATA ANALYTICS FOR PREDICTION USING SENTIMENT ANALYSIS APPROACH

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ABSTRACT

Extraction of public opinion is a way of gathering knowledge based on short texts written by users to provide attitudes. This condition encourages a lot of research using social media, especially the sentiment analysis approach in conducting initial identification or predictions. Social media is a dynamic medium to get public opinion which is very cheap and very large in number. This research aims to provide a review of predictions using sentiment analysis, one of the analytical methods in big data analytics. Sentiment analysis techniques are used to predict customer review, market, health, and social behavior. The sentiment analysis approach sourced from social media is able to contribute to making predictions in the form of an early warning system of problems so that it can help decision-makers based on big data analytics.

Keywords: *Big Data Analytics, Predictive, Sentiment Analysis, Social Media*

1. INTRODUCTION

This paper will highlight discussion by reviewing research papers with big data topics and focusing on how big data to be accessible, usable, and valuable. Big data technology, which is part of Industry 4.0, provides many opportunities and challenges to continue to explore in order to solve increasingly complex human problems [1][2][3]. Big data has become a new approach to processing data in the industrial era 4.0, which is very large, complex, and fast-changing. The massive data supply in the industrial era 4.0 made data a significant part, which resulted in the world's dependence on these natural resources. It has been identified and highlighted by various studies that show the power and impact of Big Data on modern life.

Before known as Big Data, this technology was often called Very Large Databases (VLDBs). However, as more and more data became available, VLDBs were improved to manage data to be more structured and unstructured. The presence of very diverse data types, both structured and unstructured, data categories consisting of video, text, numbers, and images, the amount stored, and fast data processing are triggers for the emergence of big data technology. The emergence of Big Data provides solutions for the rapid development of data storage

infrastructure, data processing, programming algorithms, data exploitation, and data visualization. Big Data is defined as the volume of data available in various levels of complexity, which are generated at different speeds and various levels of ambiguity, which cannot be processed using traditional technology [1] [3] [4]. Big data can be defined as an extensive data set with an increasingly diverse and complex structure [5]. It will help the industry to grow faster because of the use of big data in decision making [3][6].

Big data is a new perspective in the field of information technology that provides a strong impetus for the next generation of the technology industry [7] [8] [9]. Big Data is a new approach to understanding data with volume, value, veracity, and velocity characteristics. Big Data has big growth data sets that include heterogeneous formats: structured, unstructured, and semi-structured data. Therefore Big Data has complex properties that require sophisticated technology and sophisticated algorithms[10]. Now all organizations are trying to capture, create, and use data to improve their organizations' performance. Executives, academics, and business analysts need to be aware of significant changes in this industry 4.0 era, which will change the way organizations are managed and change the

economy and society. This revolution has introduced several management changes company. This condition forces them to have more data to use than before. This data may be internal or external, structured, or unstructured. The company or organization will use new technological solutions for processing these data to become sources of detailed information for changes in the organization [11] [12].

From a macro perspective, big data is considered a subtle bond that connects and integrates the physical world, human society, and cyberspace. The physical world reflects cyberspace, which is manifested as big data, the Internet of Things, and other information technologies, while human society produces large data-deliver non-functional properties. The non-functional properties are data quality, data integration, model compliance, or regulatory compliance [13][14]. Considering this, it is advantageous for researchers in big data to explore the knowledge that develops in the future. However, the opportunity always follows several diverse challenges in the field of big data, among others computational complexity, information security, and based mapping in cyberspace through mechanisms such as human-computer interfaces, machine interfaces, and cellular Internet [8][15]. This situation will provide an increase in the volume of data that is very large and universal. Big data technology and analytical processes describe the existing data set, including revealing hidden values. Various data types from various sources that are increasingly large and rapidly changing is a challenging problem that demands fast resolution [16][17].

Computational Major challenges facing big data research require developing innovative data management techniques capable of analyzing big data [8][17]. The birth of big data cannot be separated from the term social network that has provided a massive data supply in the form of sound, text, images, video streaming every second. The relationship between big data and social networking is evident but complicated. Big data and social networking are interdependent because most data is generated from social networking sites, but big data is not always useful. The biggest challenge of big data is not in collecting it but in managing it and making it reasonable[18][19]. Big data analytics is one of the opportunities presented by big data

architecture's proliferation based on massive data. However, there are important questions about whether and how big data will improve the results of predictive modeling [20][21]. The purpose of this paper is to provide an analytic review of big data and models that are widely used by researchers and their applications in estimating or predicting with sentiment analysis approach various research objects, especially with data sources from social media.

2. BIG DATA

Big data technology revolutionized the IT industry by providing flexibility in how computer resources are consumed and by providing available services that consumers use. Therefore, cloud computing represented a crucial step towards fulfilling the future computing generation of seeing computing as a service in which the economy of scale theory helps to push down the cost of computing resources effectively. In reality, big tech companies have exploited cloud computing technology by offering their cloud customers excess supporting foundations, phases, and applications. The big tech companies established their own data centers and cloud-based services worldwide for their supporting infrastructure, platforms, and applications to their cloud consumers. These cloud services can be provided according to the Infrastructure as a Service (IaaS) model, the Platform as a Service(PaaS) model, or the Software as a Service (SaaS) model.

Big Data analysis applications can be implemented within each of the three cloud services models :

1. With the IaaS model, a lot of virtualized assets can be given to developers to implement their Big Data analysis system or to run their Big Data analysis applications
2. With the PaaS model, a supporting platform can be given to developers that need to fabricate their own Big Data applications or expand existing ones, at long last
3. With the SaaS model, a very much characterized Big Data examination process or a ready-to-use data analysis tool can be provided as an Internet service to end-users, who may

legitimately utilize it through a web browser.

Table I provides an illustration of Big Data Framework technology which is widely

supported by the best programming languages, this shows that Big Data framework technology will be a solution for Big Data Analytic processing.

Table I. Summary of the main feature of Big Data Analysis Frameworks

Framework	Model	Supported languages	Underlying engine	Availability
Hadoop	PaaS	Java, Python	Hadoop	Open-source
Spark	PaaS	Scala, Python, Java, R	Spark, Yarn	Open-source
H2O	PaaS	REST, R, Python	H2O	Open-source
SciDB	PaaS	SQL	SciDB	Open-source
AzureML	SaaS/PaaS	REST	Microsoft Azure	Proprietary/Microsoft
R	SaaS/PaaS	R	R	Open-source
SparkR	SaaS/PaaS	R	Spark	Open-source
Mahout	SaaS/PaaS	Java, Scala	Hadoop, Spark	Open-source
Spark MLlib	SaaS/PaaS	Scala, Python	Spark	Open Source
Samsara	SaaS/PaaS	Java, Scala	Spark, Flink, H2O	Open Source
Apache SystemML	SaaS/PaaS	R, Python	Spark	Open Source
Google ML	SaaS	Python	Google Cloud Dataflow	Proprietary/Google
Amazon ML	SaaS	N/A	Apache MXNet, TensorFlow, PyTorch	Proprietary/Amazon
BigML	SaaS/PaaS	Python	BigML PredictServer	Proprietary/BigML
Tensorflow	SaaS	Python, Haskell, Java, Go Julia, R, Scala	CUDA, TPU	Open Source
KeystoneML	SaaS/PaaS Procedural + Library	Scala	Spark	Open Source

Source: Elshawi, R., Sakr, S., Talia, D., & Trunfio, P. (2018). Big Data Systems Meet Machine Learning Challenges: Towards Big Data Science as a Service. Big Data Research. doi:10.1016/j.bdr.2018.04.004

Big data technology for companies impacts data supply with huge volumes with varied data types and unstructured. The problem that the company is worried about is not the volume of data that is very much and unstructured data. Companies must face challenges relating to internal integration (e.g., transactional records) and external data (e.g., social networking data). New paradigm technology is needed to overcome new challenges caused by big data characteristics [22][23].

3. BIG DATA ANALYTIC

Big data analytics as a new paradigm for utilizing big data sources and advanced analytics has already found its way into some social science disciplines [24]. Big data analytic is a future management revolution that has received significant attention from practitioners and academics because of its operations and strategic potential in transforming business [25]. Future research's open opportunities can focus on

developing explanatory theories and predictions that cover all cross-functional aspects for better understanding and growth of knowledge in this domain [26][26][28](Fosso Wamba et al., 2015). The integration of two big data and cloud computing technologies allows quick access to emerging applications.

There is a serious requirement to ensure safe data transmission to increase efficiency over the public channel in this context. Since the data obtained from different sources could be strictly private and confidential, there is also a great necessity to deal with the big data's privacy preservation. Srivinas (2018) has designed a data collection technique in a cloud computing environment called 2PBDC to handle privacy issues and secure communication between big data gateway nodes and cloud servers.

We know that the need for data analysis from complex data sets becomes very important. New opportunities are created by the availability of big data and advances in machine intelligence. Therefore, a series of investigation opportunities have exploded exponentially with the large and complex data sets available relating to all types of phenomena that researchers want to study. It starts from deconstructing the human genome to understanding Alzheimer's disease's pathology in millions of patients to observe consumer responses to various marketing offers in large-scale field experiments [10][27]. Big data analytics has become one of the main applications of the future capable of solving data problems from system parallel and distribution. The dataset's size exceeds exabytes, and its size increases rapidly, which poses significant challenges to software development methods and data storage platforms with computing capabilities, very diverse networks, and software stacks that fundamentally affect data analysis [28].

Explore the powerful combination of Big Data and Computational Intelligence (CI) in various areas where new solutions in real-world smart city problems could be developed, taking advantage of these powerful tools and techniques. Case study for smart transportation in smart city contexts and a new data modeling approach focused on biologically influenced universals. The Hierarchical Spatial-Temporal State Machine is called the generative modeling approach. This paper further explores the question of Various policy implications relating to Big Data, its

implementations, and implementation, security, valuation, and commercialization [5]. Authors use journal literacy to illustrate the limitations of big data analysis visualized in the word cloud.

Big data provides opportunities for estimating timely forecasts of a region's socio-economic growth. Mobile phone activities offer an enormous wealth of information that can be used alongside household surveys. In a study of poverty in Rwanda, poverty and wealth estimates rely on calculating features from call detail records (CDRs). However, mobile network operators are reluctant to provide access to CDRs because of business and privacy concerns. As their results, the CDR dataset combined with other publicly available satellite imagery-based datasets produced competitive results. A model using two CDR-based features, per capita mobile ownership and per phone call frequency, combined with standardized satellite nightlight data and population density, to estimate the multidimensional poverty index (MPI) at sector level was built.

3.1 Predictive Model

Predictive analytics is the process of using data analytics to make predictions based on data. This process uses data along with analysis, statistics, and machine learning techniques to create a predictive model for forecasting future events [21]. Big data has an opportunity where its architectural ability can perform predictive analytics based on massive data well. There is an important question that is whether and when big data will greatly improve predictive modeling [20] [29]. Predictive analytics big data is a part of big data analysis that has received much attention from researchers because of the many opportunities and challenges in finding a good model. Big data analysis is a procedure for investigating big data so that it can reveal hidden patterns, unknown relationships, and some other useful information that can be used to make better decisions [29]. Big Data Analytics is a method used to identify, diagnose, process, discover hidden patterns, find out the relationships between variables, and other insights about the object's context being investigated. It makes it challenging for researchers who want to add BDA to their methodological research plans because they have to carry out the stages of the process in Big Data

analytics, including being able to plan, process, interpret and evaluate their research studies [30] [24].

Analytic predictive is taken from the term statistics, machine learning, database techniques, and optimization techniques that must be able to predict the future by analyzing current and historical data [21][31]. The results of predictive analytics are summaries of information that is easily understood by humans. Predictive analytical methods have been applied in many fields to predict results from various events [32]. Much of the literature on predictive analytics does not expect anything about data but allows data to lead. It is because predictive analytics is a set of business intelligence technologies (BI) that reveal relationships and patterns in large volumes of data that can be used to predict behavior and events. It uses statistics, machine learning, neural computing, robotics, computational mathematics, and artificial intelligence to explore all data and find meaningful relationships and patterns.

Machine learning used by predictive analytics is a technique for training algorithms that can predict output based on multiple input values [33].

Many studies confirm that machine learning technology is very efficient at predicting the behavior of dynamic corporate consumer patterns by reading historical data [34]. A predictive model analyzes the trends found in historical and transactional data to classify various threats and potentials to assess them [29]. The predictive algorithms process in big data analytics has the stages shown in Figure 1. Predictive analytics has to be consistent to guarantee the efficiency and accuracy of the data prediction. The initial step of prediction begins with determining the target data through identifying the initial data, how to collect data, and understanding the purpose of the desired data. Preprocessing data is used to integrate and enrich the analytical data process, then predictive modeling is carried out using a statistical or machine learning approach. The model used for prediction needs to be evaluated through testing to support decision-making. The next stage is implementing the prediction model and followed by monitoring the model which will provide the best performance evaluation of the existing model.

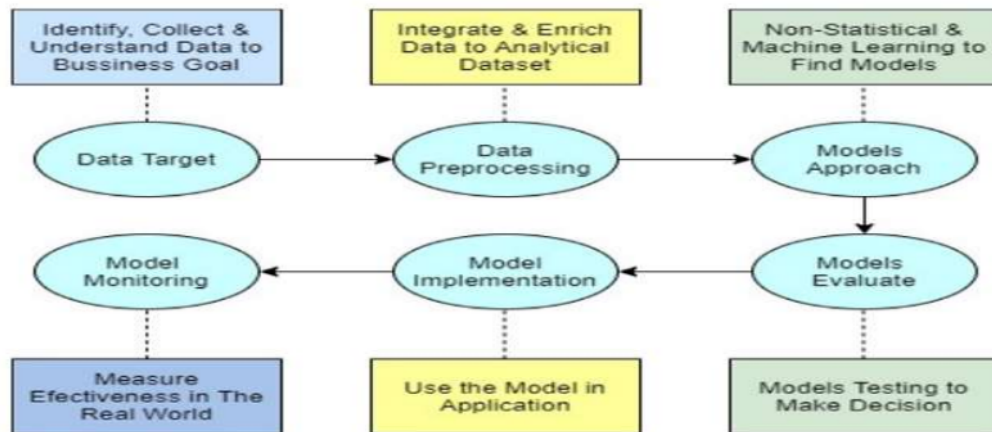


Figure 1. Predictive Algorithms Process

53 With the rapid development of the Internet and mobile Internet technologies, there is an exponential growth in the amount of data produced by various web applications and mobile applications. How to categorize the enormous data has become an effective testing hotspot. If the standard stand-alone mode is used, neither the memory nor the requirements nor computational power can meet the needs of big data

classification, while the combination of distributed processing systems and classification algorithms provides an effective way to solve big data classification. They were classifying concerns for broad data size [35].

3 One of the technical dilemmas in big data science is the nonexistence of a technology that can effectively handle and analyze vast rapidly-data and extract useful information. Another

challenge is the lack of intelligent approaches which can choose appropriate techniques to solve big data problems from several design choices to models and algorithm. Among several machine learning techniques in the HADOOP libraries, most of them are based on classical models and algorithms, may not be suitable for big data processing, but some techniques are suitable for big data classification, such as decision tree learning and deep learning, and may help to develop better-supervised learning techniques in the years to come. [36]. Big Data primarily has three characteristics, namely velocity, volume, and variety, and data can be categorized in three ways based on this characteristics-supervised, unsupervised and semi-supervised methods [37].

There are three kinds of classification, namely supervised learning, unsupervised learning, and semi-supervised learning. **Supervised learning** is administers learning provides a dataset of two highlights and marks. The errand of regulated learning is to build an estimator that, given the arrangement of highlights, will almost certainly foresee the name of an article. The calculation managed gets a lot of highlights as contributions alongside the related right yields, and the calculation learns to discover errors by contrasting its genuine output and correct yields. **Unsupervised Learning** used information that does not have authentic names, and the aim is to investigate the information and discover similarities between the objects. It is the system by which the information itself finds marks. On transactional data, unsupervised learning works admirably. **Semi-supervised learning** is a method that uses unmarked knowledge to plan. It is between unsupervised learning and controlled learning. Numerous analysts have found that unmarked information, when used in combination with a small measure of named information, can be produced [38].

4. SENTIMENT ANALYSIS APPROACH

The user expresses their opinions on various sites of social media. Sentiment Analysis (Opinion Mining) is the method of sensing the polarity of opinions about whether opinions are positives, negatives, or neutrals. A common use case for this technology is to discover how people feel about a particular topic. Before performing sentiment analysis on tweets, tweets need to be

pre-processed. Tweets pre-processing involves removing web links, hashtags, quotes, and punctuations. Sentiments analysis focuses on three fundamental segments, the conclusion holder or wellspring of the sentiments, the article on which the assumption is communicated, and the articulation of the evaluation [39].

In machine learning, sentiment analysis has become a leading framework for scientific and commercial market research. It examines people's thoughts, views, actions, attitudes, and emotions towards individuals, organizations, goods, services, problems, and their qualities in written or spoken language [40][41]. Online data extraction and interpretation, polarity and subjectivity, feature collection, sentiment analysis of comparative sentences, opinion quest, and retrieval discovery are the majority of the sentiment analysis studies. Various machine learning classification techniques and sentiment analysis methods or emotion variance analysis tasks can provide false feedback or spam detection [39]. In some cases, the prediction of social media data; finally, it is argued that statistical modeling seems to be the most effective approach to applying social media data predictions. Social media emergence provides researchers with a new and abundant source of easily accessible data about people, culture, and potentially, the world at large [42] [43].

Precisely, social media data capture online activity by users who chat or connect on various issues and topics. The goal of this particular issue is to concentrate on novel prediction methods that are based on data collected from social media. Such data has proven very popular in recent years, with scholars interested in creating predictive models. Indeed, larger data could be more useful tools for predictive analysis [31]. Data-driven predictive modeling typically generates a training data model, for which the goal value (the label) is defined [20]. Understanding the limitations of predictive analytics is significant. First, in general, without a dataset for the training of sufficient size and quality, one can not make progress. Second, providing a good understanding of the phenomenon to be expected and historical examples of the phenomenon is important [31][44]. The field of analyzing sentiment has become so broad that an individual researcher will face many problems of all the activities in the area

and the overload of information when keeping track. An academic literature review should concentrate only on one specific field of sentiment analysis. It usually contains 10 and 100 articles, e.g., 24 papers have been reviewed by a recent systematic review of financial market prediction with sentiment analysis [45].

The study developed a predictive model for predicting crime trends, using Twitter content to predict the direction of crime rates in a prospective time frame. The model uses content, sentiment, and topic as predictive indicators to infer changes in the crime index. The study used a temporal topic detection model to infer predictive topics over time. The detection model builds dynamic vocabulary to detect emerging topics rather than considering vocabulary in bulk, using historical tweets. The results reveal a correlation between features extracted from the content as content-based features and crime trends. Overall, this study provides in-depth insights into the correlation between language trends and crime and the impact of social data as an additional resource in providing predictive indicators [46].

Predictions for Presidential elections in several countries such as the US, UK, Spain, and France are carried out using a sentiment analysis approach in Indonesia. The author uses tweets from Indonesian Presidential Candidates (Jokowi and Prabowo) and tweets from relevant hashtags for sentiment analysis collected from March to July 2018 to predict the Indonesian presidential election outcome. The author creates algorithms and methods to calculate important data, top words, train models, and predict sentiments' polarity. The results of these predictions are in accordance with four survey institutions in Indonesia, which prove that our method has produced reliable prediction results [47]. The paper addresses the technical aspects of Sentiment Analytics (techniques and types) and explores the non-technical aspects in the context of application areas. In the age of big data, the application of sentiment analysis has been used to categorize opinions into various sentiments and in the general evaluation of the public's mood. Also, various OMSA techniques have been developed in various data sets over the years and applied to different experimental settings [48].

This research compares sentiment analysis methods based on neural network (backpropagation neural network (BPN), probabilistic neural network (PNN) & homogeneous PNN ensemble (HEN)) by using varying levels of word granularity as features for classification of sentiment at the feature level. The incorporation of sentiment classification methods based on the neural network with principal component analysis (PCA) as a technique for feature reduction also provides superior efficiency in terms of training time [49]. Several studies presented in Table 2 regarding predictions using a sentiment analysis approach have contributed a lot to the fields of politics, finance, marketing, crime, medical, social, entertainment and sports. ANN or machine learning approach are found in all application domains except the crime domain. The sentiment analysis approach is one way to identify information early because it comes from social media whose data is very massive.

Table 2. Summary Application Domain in Sentiment Analysis Predictive

Application Domain	Method Approach	Type of Media	References
Politic	Supervised Learning (SVM, Naive Bayes, maximum entropy and ANN, exponential function.	Twitter	[41][47][50][51]
Financial/Market	ANN, ϵ -support vector regression, linear regression, SMeDA-SA	Corporate annual reports, financial micro-blog	[45][52][53][50][54][55][56][57][58][59][60][61][62]
Crime		Twitter	
Medical	Twitter-specific linguistic analysis, Kernel Density Estimation		[46][63][64]
Society	Regression, Machine Learning, NLP	Twitter	[42][65][66][67]
Entertainment, sports	Neural Network, SVM, Machine Learning	Twitter, Internet Movie Database	[61][68][69][70][71][72][73][74]
	Machine Learning,		

	ANN, Degree of Sentiment		[14][34][49] [75][76]
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5. PROPOSED METHOD

We study to conduct a literature review to answer our research. An analysis should answer an existing problem that would benefit from exposure to future theoretical foundations. We argue that sentiment analysis is part of the research field big data has been developed for predictive analysis approaches. Therefore, our

study design consists of several stages, namely collect paper, bibliography database, a filter of keywords, network analysis, and main path cluster of articles (Figure 2). The paper collection is done using Google Scholar. This paper takes all the relevance of big data analytics, big data for predictions, sentiment analysis, predictive models, including its approach and parameters. Data is saved to Mendeley as a bibliographic database. The next step is filtering keywords and continuing to analyze networks and clusters using VosViewer.

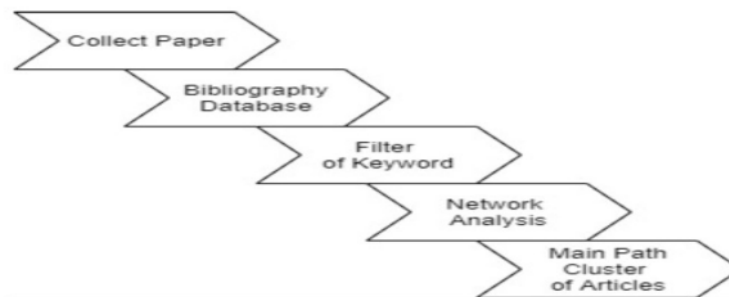


Figure.2. Research Survey Design Steps

6. DISCUSSION

Over the past ten years, research on the topic of prediction using sentiment analysis methods and text mining has attracted many researchers. According to Google scholars, it can be seen from the number of publications, which continues to increase, except decrease between 2018 and 2019 as shown in Figure 3. The number of research topics regarding sentiment analysis is more than text mining for prediction; this is also shown by research that discusses the evolution of sentiment analysis [77]. Research on sentiment analysis during the period 2011 - 2020 amounted to 322000 papers while those that discussed text mining were 65200 based on google scholar. Research on sentiment analysis approaches to making predictions or estimations based on social media data is currently being carried out by researchers worldwide (as already discussed before in Table 2). The summary of the sentiment analysis predictive survey is categorized based on domain, approach, and media type. Six domains were chosen they are politics, financial or market,

crime, medical, society, and entertainment or sport.

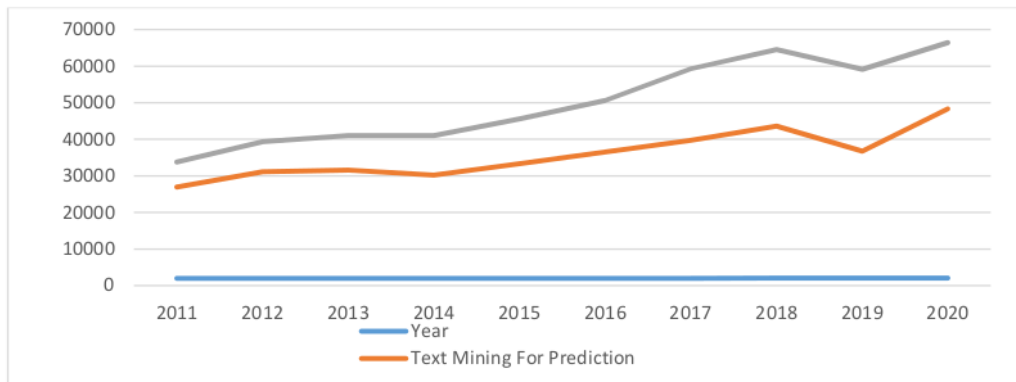


Figure 3. Annual Number of Papers

The principal path analysis identifying process is used as a citation network model. Network model analysis uses VosViewer, an open-source network analysis application. Figure 4 outlines the citation network of 100 articles divided into 4 clusters and shown in 4 different colors for each cluster. Nevertheless, each cluster has a

relationship or network between citations. Cluster 1 discusses sentiment analysis in general (blue color). Cluster 2 focuses on big data, especially social media, as sentiment analysis objects (red color). Cluster 3 focuses on sentiment analysis algorithms (green color), and cluster 4 focuses on predictive models (yellow color).

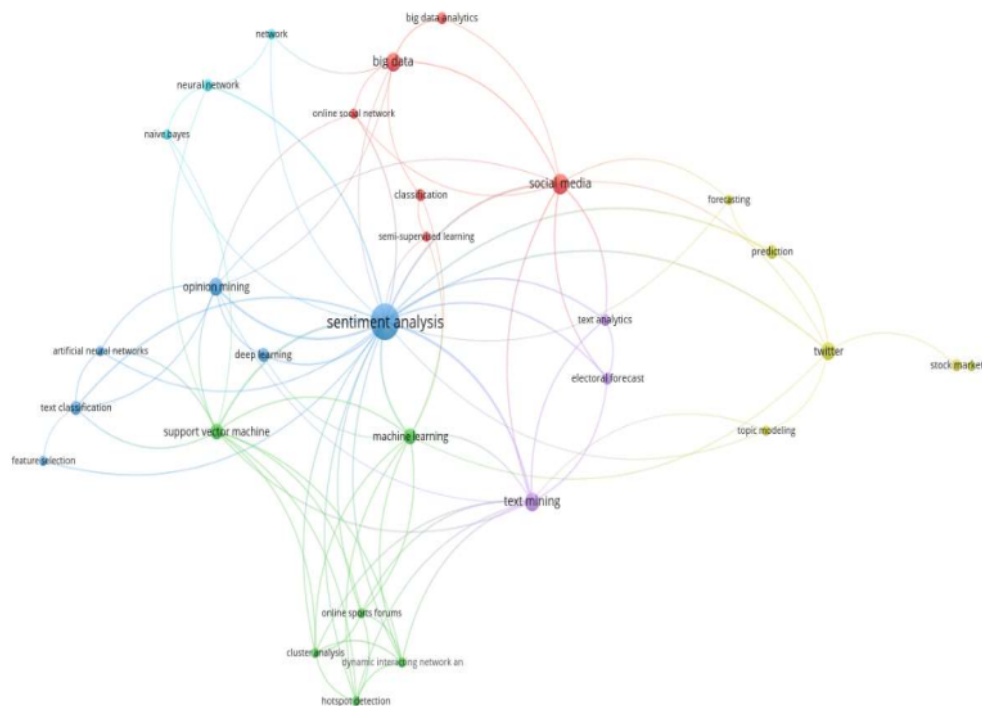


Figure.4. Network Visualization of References

By using reference visualization software (Figure. 4), it was found that prediction using a sentiment analysis approach is still an opportunity for research predictive using sentiment analysis approach in the field of big data analytics. Summary Table 2 about the predictive approach using sentiment analysis is widely used to detect public opinion on issues that have a broad impact, such as finance, crime, society, politics, sports, and entertainment. The most widely used algorithms for prediction are machine learning, artificial neural networks with an average accuracy of above 70%. The prediction method of statistical approaches uses a lot of linear regression and kernel regression.

7. CONCLUSION

In this paper, some of the things discussed are the role of big data in supporting decision-making in all aspects of human life quickly and effectively. The increasing use of social networking technology, will cause an increase in data supply, especially massive public opinion through social media applications. Public opinion in social media applications will be a source of dynamic data for public organizations to extract more information that can be used in decision-making, especially in predictions or estimates. Big data analytics is important in analyzing data sourced from social media. One of the most widely used analytical techniques in implementing big data analytics is prediction. The predictive approach in big data, especially social media data, which continues to develop is sentiment analysis. Sentiment analysis or opinion mining is a way of extracting information based on short texts written by users to provide attitudes or assessments of public organizations' services, products, and services. The number of predictive studies using sentiment analysis continues to increase. It is noted that this topic is still very relevant and is an opportunity to develop prediction methods in the field of big data analytics.

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