Sentiment Analysis on the Impact of Artificial Intelligence (AI) Development to Determine Technology Needs

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Abstract— Artificial intelligence (AI) has become a hot topic in recent years in Indonesia. To determine the influence of AI developments in determining technology needs, a sentiment analysis needs to be carried out. Sentiment analysis is a process used to help identify the contents of a dataset in the form of opinions or views (sentiments) in text form regarding an issue or event that is positive, negative, or neutral. The algorithm applied in this research is the multinominal Naive Bayes classifier method. The Multinominal Naive Bayes Classifier method was chosen because it has quite high processing speed and accuracy when used on large, varied, and large amounts of data. In this research, the sentiment results were "negative" for the topic of data security and privacy with a testing accuracy of 75%, "positive" for economic topics with a testing accuracy of 50%, "negative" for industrial topics with a testing accuracy of 58%, "positive" for field topic jobs with a testing accuracy of 75%, “negative” for transportation topics with a testing accuracy of 50%, and “negative” for education topics with a testing accuracy of 67%.

Keywords— Artificial Intelligence, Multinominal Naïve Bayes Classifier, Sentiment Analysis

I. INTRODUCTION

In this rapidly advancing era, known as the digital age, technology is something of utmost importance. The world is currently experiencing a technological era [1][2]**.** Artificial intelligence (AI) has become a hot topic in recent years in Indonesia. The rapid development in the field of AI has had a significant impact on various aspects of life, including industry, education, healthcare, and the public sector [3][4]. The use of AI is becoming increasingly widespread and diverse across various fields, making sentiment analysis towards AI important in the context of Indonesia [5]. Artificial intelligence is generally associated with a tool to identify problems and solve complex issues across various domains, including business, corporations, and government [6][7]. The main concept of artificial intelligence is to create a tool or machine that can think like a human [8].

Recently, people have been actively commenting on developments in artificial intelligence (AI) on Twitter. After scraping, it was discovered that several main topics were discussed, namely security and privacy, the economy, industry, employment, transportation, and education. To understand the impact of AI development in determining technological needs, sentiment analysis must be conducted [9][10]. Manual sentiment analysis of artificial intelligence can be time-consuming and labor-intensive. Therefore, automated sentiment analysis using artificial intelligence is necessary to streamline the classification process, making it easier for stakeholders to use in the future [11][12]. Sentiment analysis is a process used to help identify the content of a dataset consisting of opinions or views (sentiments) in text form regarding an issue or event, determining whether it is positive, negative, or neutral [13]. The basic task in

sentiment analysis is to classify the polarity of the text within a document, sentence, or opinion. Polarity indicates whether the text in the document, sentence, or opinion has a positive or negative aspect [14]. Armed with the aforementioned information, computers can be taught to become intelligent and automatically provide predictions and decisions for a given problem. This is known as machine learning. One technique in machine learning is data mining [15]. There are several algorithmic techniques in the application of data mining, one of which is the multinomial Naïve Bayes classifier [16]. The algorithm applied in this study is the multinomial Naive Bayes classifier method. The Multinomial Naive Bayes classifier method was chosen due to its speed in processing and relatively high accuracy when used on large, diverse datasets [17].

Previous research conducted on sentiment analysis using the Naïve Bayes method includes a study conducted by [15][16]. According to a study conducted by Suryani (2022) on sentiment analysis using the Naïve Bayes Classifier method, a high level of accuracy was achieved, reaching 87.1%. The study suggests that as more data is tested, the classification accuracy tends to increase [20]. In the study by P. Asri et al. (2021), which also utilized the Naïve Bayes Classifier algorithm, it was concluded that the Naïve Bayes Classifier yielded a high accuracy result of 94.33% [21].

Based on the description above, researchers will conduct sentiment analysis on Twitter regarding the influence of AI development in determining technology needs in the fields of data security and privacy, economics, industry, employment, transportation, and education using the Multinomial Naive Bayes Classifier algorithm. . Through this research, it is hoped that it can provide information regarding society's response to technology needs.

II. METHOD

This study utilizes sentiment analysis, which is a process of analysis obtained from various social media platforms and the internet [22]. Sentiment analysis is a method of gathering opinions from the general public using social networks, where there are discussions about public services and current issues. Sentiment analysis involves extracting public opinions about specific topics, products, or services from unstructured text data [23].

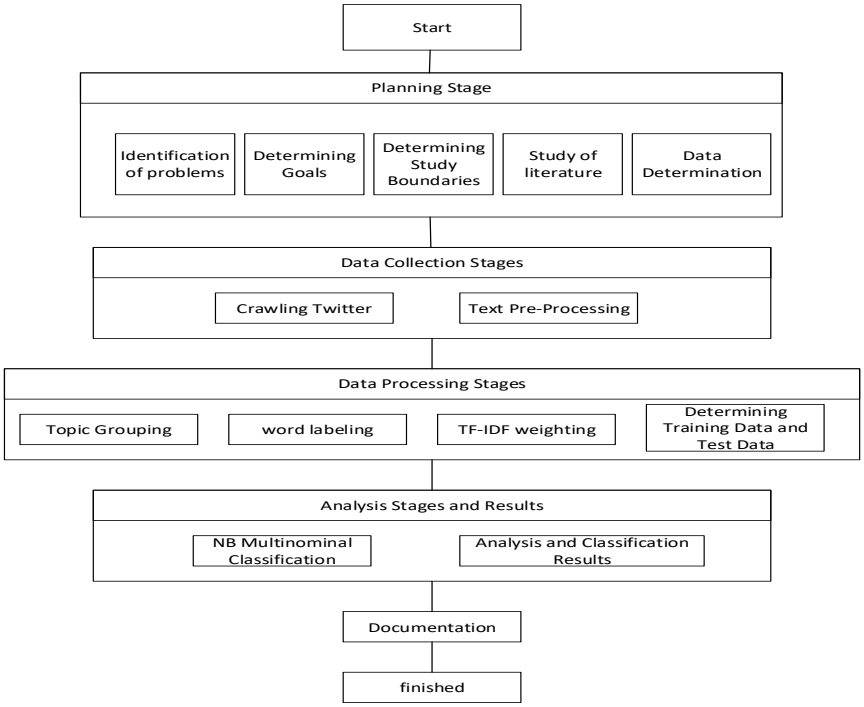

Figure 1. Research Methodology

The data utilized in this study consists of tweets scraped from Twitter regarding GPT chat, collected between January 1, 2019 and March 1, 2024. Subsequently, the obtained data underwent processing and cleaning using Google Colab. In this research, labeling and topic determination are carried out by Indonesian language experts. After labeling, the subsequent process proceeds until the modeling process using the multinomial Naïve Bayes algorithm, enabling the attainment of results and testing accuracy in this research. The multinomial Naïve Bayes can be formulated as follows [24]:

Formula 1.

$$P(p|n) \propto P(p) \prod_{1 \le k \le nd} P(t_k|p) \quad (1)$$

Where P(tk|p) represents the probability of a text document (tk) appearing, where n is the total number of documents and p represents polarity. Then, to calculate its polarity or documents that have similarities, it is formulated as follows.

Formula 2

$$P(tk|p) = \frac{count(tk|p)+1}{count(tp)+|V|} \quad (2)$$

Where (tk | p) represents the count of tk appearing in text documents with polarity p, and the sum of (tp) denotes the total number of tokens in news articles with polarity p.

A. Data Collection Process

The data used in this study consists of tweets from the social media platform Twitter regarding artificial intelligence. The data collection phase involved scraping Twitter to obtain comments about the influence of artificial intelligence development on technological needs. This process involved extracting comments related to the influence of artificial intelligence development on technological needs from Twitter.

Table 1 Data Collection Process

NO.	created_at	username	Tweet
1.	Sat Jun 03 23:19:09 +0000 2023	sekolahkripto	Fakta#8 AI bisa meningkatkan keamanan dalam hal privasi data. AI mampu menganalisis pola dan perilaku mencurigakan dalam data (data pengguna atau transaksi). AI mampu mengembangkan algoritma enkripsi yang lebih kuat dan efisien.(9) https://t.co/dwhFagVmjr
2.	Fri Sep 15 15:48:36 +0000 2023	jaIjinesoyomodu	Demi bukan masalah takut yang gimana-gimana. Tapi kaya takut banget semua lahan kerja nantinya dikuasai AI. Sekarang aja banyak kejahatan yang beralasan ekonomi" kurang karena nganggur dan lain-lain. Kalau lahan kerja dikuasai AI semua? Ga kebayang deh ðŸ˜”"
…	…	…	…
3610	Tue May 23 23:30:45 +0000 2023	MoxyHosting	carbon robotics adalah perusahaan teknologi yang mengembangkan robot industri dengan teknologi ai dan otomatisasi yang dapat membantu meningkatkan efisiensi amp produktivitas di berbagai sektor mobileapps uiux it iot robotics data tech fintech cloudstorage bigdata

B. Data processing process

1. Data Cleaning: The text data will be cleaned initially to remove symbols, hashtags, usernames, and URLs, as well as duplicate comments.
2. Topic Categorization: Out of the 1918 cleaned data, it is divided into several topics based on the content discussed in the data. Topic categorization is carried out by Indonesian language experts.
3. Labeling: The labeling was carried out by Indonesian language experts, Indonesian language lecturers at UIN Sultan Syarif Kasim Riau.

4. Tokenization: This stage involves splitting the text in the data into individual words or tokens.
5. Stop Words: Stop words are words that do not carry sentiment, such as conjunctions like "and," "but," "or," "from," "then," and so on. In the Indonesian language, there are 16 types of conjunctions.
6. Stemming: Stemming is a process to find the base form of a word by removing all affixes, including prefixes, infixes, suffixes, and confixes, from derived words.

Table 2 Data pre pocessing process

NO.	Stemming
A.	**Data Security and Privacy Topics**
1	['microsoft', 'rilis', 'pyrit']
2	['alas', 'putus', 'larang', 'guna', 'cerdas', 'buat', 'ai']
…	…
38	['eh', 'kayak', 'kalo', 'ai', 'berat', 'deh', 'kalo', 'udah', 'ai', 'militer']
B.	**Economic topics**
1	['budi', 'arie', 'setiadi', 'ai', 'salah', 'sokong', 'tumbuh', 'lesu', 'ekonomi', 'global', 'hubung']
2	['pakar', 'ekonomi', 'prof', 'emeritus', 'zakariah', 'abdul', 'rashid', 'pelabur', 'pelabur', 'tumpu', 'industri', 'buruh', 'mahir', 'punca', 'ringgit', 'lemah', 'beliau', 'pelabur', 'orientasi', 'modal', 'masuk', 'modal', 'modal', 'digital', 'ai']
…	…
524	['nilai', 'kerja', 'asn', 'bas', 'ai', 'tumbuh', 'ekonomi', 'tinggi', 'sejawa', 'turun', 'stunting', 'tinggi', 'sejawa', 'dukung', 'ikn', 'bangun', 'jalan', 'tol', 'bersamajuara']
C.	**Industry topics**
1	['ai', 'industri', 'panggil', 'org', 'fill', 'up', 'that', 'spot', 'lg', 'murah']
2	['industri', 'bener', 'kerucut', 'ai', 'ya', 'negara', 'negara', 'lomba', 'lomba', 'invest', 'software', 'hardware', 'energi']
…	…
185	['industri', 'gim', 'dunia', 'tembus', 'us', 'miliar', 'topang', 'ai', 'blockchain', 'beritasatu', 'debatcapres', 'debatcaprescawapres']
D.	**Employment topics**
1	['dosen', 'gimana', 'analogi', 'ra', 'mashok', 'blas', 'masalah', 'curi', 'karya', 'digenerate', 'ai', 'lapang', 'kerja', 'ojek', 'konvensional', 'ojek', 'online', 'beda']
2	['us', 'bbrp', 'lapang', 'kerja', 'ambil', 'ai']
…	…

159 ['kembang', 'ai', 'robot', 'cerdas', 'yg', 'dampak', 'hadap', 'ancam', 'hilang', 'lapang', 'kerja', 'kerja', 'yg', 'kenal', 'ambil', 'alih', 'robot', 'cerdas']

E. Transportation topics

1 ['tahu', 'industri', 'ai', 'engineer', 'paham', 'teknologi', 'terap', 'industri']

2 ['teknologi', 'baru', 'kereta', 'cepat', 'solusi', 'ai', 'amd', 'kria', 'k', 'cepat', 'inspeksi', 'jalur', 'jr', 'kyushu', 'siap', 'transportasi', 'aman', 'efisien', 'teknologikeretacepat', 'inovasiamd']

… …

109 ['nunggu', 'teknologi', 'ai', 'pasuk', 'sistem', 'transportasi', 'surabaya', 'ga', 'tugas', 'manusia', 'nya', 'serba', 'teknologi']

F. Education topics

1 ['pusing', 'nyari', 'jurnal', 'internasional', 'pakai', 'ai', 'nih', 'kasih', 'tau', 'website', 'jurnal', 'pakai', 'source', 'yusron', 'didik', 'indonesia', 'sekolah', 'ajar', 'pendidikanindonesia', 'education', 'mahasiswa', 'pendidikankarakter', 'bimbel', 'guru', 'edukasi']

2 ['cerdas', 'buat', 'ai', 'jajal', 'masuk', 'kurikulum', 'didik', 'indonesia', 'capai', 'transformasi', 'teknologi', 'digital']

… …

903 ['platform', 'cerdas', 'buat', 'ai', 'kenal', 'masyarakat', 'dampak', 'hidup', 'manusia', 'bgmn', 'pengaruh', 'cerdas', 'buat', 'kembang', 'didik', 'tanah', 'air', 'besok', 'ruangpublikkbr']

a) TF-IDF Weighting: At this stage, TF-IDF assigns weight to each word. It calculates the importance of each word in a document by considering both the Term Frequency (TF) and Inverse Document Frequency (IDF).
b) Data Splitting into Training and Testing Sets: The division of data into training and testing sets is performed using the holdout technique, conducting experiments with various ratios such as 50:50, 60:40, 70:30, 80:20, and 90:10.

III. RESULT AN AND DISCUSSION

A. Data Security and Privacy Topics

Table 3 Topic Accuracy Results Data security and privacy

Sentiment	Number of Tweets	Percentage	Testing Accuracy
Neutral	12 Tweet	32%	
Positive	10 Tweet	26%	75%
Negative	16 Tweet	42%	

B. Economic topics

Table 4 Economic Topic Accuracy Results

Sentiment	Number of Tweets	Percentage	Testing Accuracy
Neutral	116 Tweet	22%	
Positive	210 Tweet	40%	50%
Negative	198 Tweet	38%	

C. Industry topics

Table 5 Industry Topic Accuracy Results

Sentiment	Number of Tweets	Percentage	Testing Accuracy
Neutral	29 Tweet	16%	
Positive	73 Tweet	39%	58%
Negative	83 Tweet	45%	

D Employment topics

Table 6 Job Field Topic Accuracy Results

Sentiment	Number of Tweets	Percentage	Testing Accuracy
Neutral	20 Tweet	13%	
Positive	87 Tweet	55%	75%
Negative	52 Tweet	33%	

E. Transportation topics

Table 7 Transportation Topic Accuracy Results

Sentiment	Number of Tweets	Percentage	Testing Accuracy
Neutral	22 Tweet	20%	
Positive	36 Tweet	33%	50%
Negative	51 Tweet	47%	

F. Education topics

Table 8 Education Topic Accuracy Results

Sentiment	Number of Tweets	Percentage	Testing Accuracy
Neutral	138 Tweet	15%	
Positive	568 Tweet	63%	67%
Negative	197 Tweet	22%	

In the multinomial Naïve Bayes In this study, K-fold cross-validation testing was performed on multinomial NB using a dataset of 1918 tweets from previously processed data. The data will be divided into training and testing data. K repetitions will randomly divide a set into k subsets, leaving one subset for testing data for each repetition and the rest for training data. The accuracy results for each topic with K-10 Fold can be seen in the following table:

Table 9 Percentage of k-fold cross validations

K-Fold	Topics					
	Data Security and Privacy	**Economic**	**industry**	**Employment**	**Transportation**	**Education**
K-Fold 1	25%	38%	37%	31%	54%	61%
K-Fold 2	75%	47%	42%	75%	73%	71%
K-Fold 3	50%	41%	26%	50%	54%	81%
K-Fold 4	50%	41%	31%	50%	45%	60%
K-Fold 5	75%	52%	58%	50%	45%	56%
K-Fold 6	75%	58%	44%	50%	37%	68%
K-Fold 7	75%	60%	44%	50%	28%	53%
K-Fold 8	0%	48%	55%	75%	54%	62%
K-Fold 9	33%	50%	55%	56%	45%	53%
K-Fold 10	0%	56%	50%	73%	70%	62%
Average	**45%**	**49%**	**44%**	**56%**	**50%**	**63%**

Here is a word visualization utilizing one of the word cloud features in Google Colab via GitHub. Below are the word cloud visualizations showing frequently occurring words for each topic:

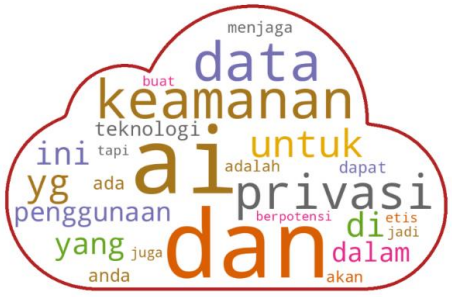

Figure 2. Wordcloud data security and privacy topics

In Figure 2 above, namely the WordCloud topic of data security and privacy, it can be seen from the entire dataset that several words frequently appear, namely the word AI at 49 and the word and at 43 in people's tweets about the influence of the development of artificial intelligence (AI) to determine technological needs on the topic of data security. and privacy.

Figure 3. Wordcloud economic topics

In Figure 3 above, namely the Economic Topic WordCloud, it can be seen from the entire dataset that several words frequently appear, namely the word AI at 698 and the word economy at 418, in people's tweets about the influence of the development of artificial intelligence (AI) to determine technological needs on economic topics.

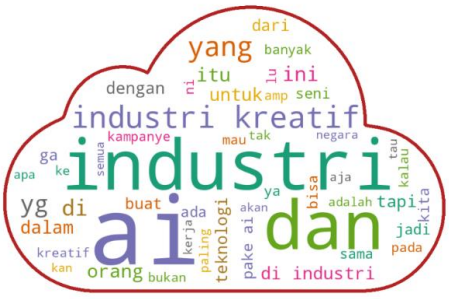

Figure 4. Wordcloud industry topics

In Figure 4 above, namely the Industry Topic WordCloud, it can be seen from the entire dataset that several words frequently appear, namely the word AI as many as 252 and the word industry as many as 155 in public tweets about the influence of the development of artificial intelligence (AI) to determine technological needs on industrial topics.

Figure 5. Wordcloud Job Field topics

In Figure 5 above, namely the WordCloud topic of employment, it can be seen from the entire dataset that several words frequently appear, namely the word AI as many as 153 and the word employment as many as 98, in people's tweets about the influence of the development of artificial intelligence (AI) to determine technological needs on the topic of employment.

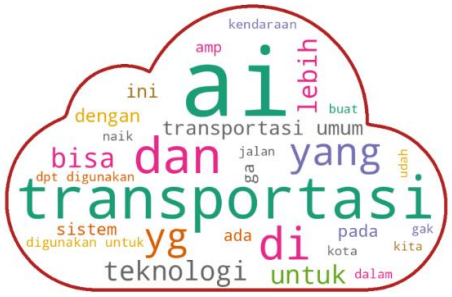

Figure 6. Wordcloud transportation topics

In Figure 6 above, namely the Transportation Topic WordCloud, it can be seen from the entire dataset that several words frequently appear, namely the word AI at 92 and the word Transportation at 79, in people's tweets about the influence of the development of artificial intelligence (AI) to determine technology needs on the topic of transportation.

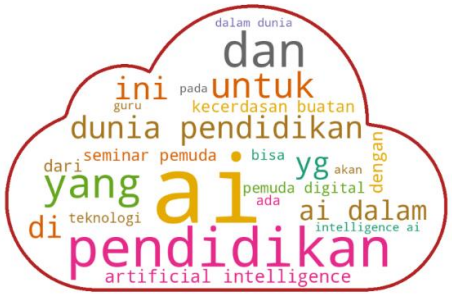

Figure 7. Wordcloud education topics

In Figure 7 above, namely the Education Topic WordCloud, it can be seen from the entire dataset that several words frequently appear, namely the word AI at 720 and the word education at 668, in people's tweets about the influence of the development of artificial intelligence (AI) to determine technology needs on educational topics.

IV. CONCLUSION

From the research that has been carried out, it can be concluded that this research was successfully carried out, with the results showing variations in sentiment on various topics related to future technology needs. On the topic of data security and privacy, the majority of negative sentiment (42%) emphasized the need for improved encryption and data protection policies. In the economic sector, positive sentiment (40%) shows optimism about AI's contribution to economic growth, but concerns about unemployment (38%) require workforce retraining policies. Within the industry, negative sentiment (45%) reflects the need for adaptive solutions for AI integration. Positive sentiment on the topic of employment (55%) shows hope that AI will create new opportunities, although there are concerns about negative impacts (33%). In transportation, negative sentiment (47%) signals the need for innovation to increase public trust in autonomous vehicles. In education, the dominance of positive sentiment (65%) indicates that AI is expected to improve the quality of education through personalized learning. This research highlights the importance of developing AI technology that is responsive to society's needs and concerns to ensure successful and sustainable adoption.

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