

The PeduliLindungi Application and Twitter User Sentiments: Strengthening Smart Living during the COVID-19 Pandemic in Indonesia

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Abstract

Technology has contributed greatly to efforts to combat the COVID-19 pandemic. Taking smart living as its concept, this study examines the Indonesian government's COVID-19 tracking application, PeduliLindungi. This application was implemented to promote safe and healthy living during the pandemic and required by all persons seeking to travel or use public spaces/facilities. Given that the practice of working from home has become commonplace, Twitter offers a source of abundant data on public opinions regarding the PeduliLindungi applications and its service quality. This study analyzes Twitter users' sentiments regarding the application within the context of strengthening smart living. Using a lexicon-based sentiment analysis, this study employs the VADER model against datasets collected during two different periods, i.e. 2021 and 2022. This study shows that the Indonesian government effectively used Twitter to answer questions and share information related to COVID-19 and PeduliLindungi with the public. Nevertheless, Twitter users expressed negative sentiments toward PeduliLindungi than positive ones due to concerns with data security and constraints encountered when using the application.

Keywords: PeduliLindungi, Smart Living, Sentiment Analysis, Twitter, COVID-19

Introduction

COVID-19 (Coronavirus Disease 2019) has become a global pandemic faced by countries around the world, including Indonesia. It is an infectious disease caused by SARS-CoV-2 that was first detected in Wuhan, China, in December 2019. The World Health Organization (WHO) declared COVID-19 a Public Health Emergency of International Concern (PHEIC) on January 30, 2020 (WHO, 2021a). Indonesia is the world's fourth most populous country, and thus was expected to

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be more greatly affected by the pandemic (Djalante et al., 2020). By August 18, 2021, the country had reported 3,908,247 positive cases, the highest in Southeast Asia. In terms of mortality, meanwhile, Indonesia ranked third in Asia, reporting 121,141 deaths (WHO, 2021b).

The "Smart City" concept refers to spaces for coexistence whereby people employ technology to adapt to rapidly changing conditions and realize implement economic, social, and environmental sustainability (Branchi et al., 2014). This concept also requires a complete understanding of the community and government, thereby enabling them to anticipate and deal with problems. During the COVID-19 pandemic, several areas experienced rapid changes in the use of information and communications technology (ICT)-based virtual spaces, including the education, business, health, industry, and tourism sectors (Rachmawati et al., 2021b; Alalwan et al., 2021; Ide, 2021; Yang, 2022). Such spaces relied on the Smart City concept to migrate all activities online, thereby facilitating the emergence of virtual spaces and removing space/time barriers (Rachmawati, 2018; Rachmawati, 2019). This concept facilitated efforts to deal with COVID-19 because its technology encouraged transparency and maximized public health (Allam et al., 2020). Das and Zhang (2021) show that Singapore's resilience during the pandemic could be attributed to its successful technology governance, a mobile society, bottom-up digital solutions, and the involvement of innovative individuals.

In response to the spread of COVID-19 in Indonesia, the Ministry of Communication and Information (Kominfo) released a mobile application, PeduliLindungi, to assist relevant government agencies in tracking the spread of the virus (PeduliLindungi). Health data such as PCR/antigen test results and vaccination histories were integrated in real-time on this application, thereby preventing the use of falsified COVID-19 test results (Ministry of Health, 2021). Thusly, the PeduliLindungi application provided the Indonesian government with a health communication tool for helping the public prevent the spread of COVID-19.

The PeduliLindungi application was implemented in every Indonesian city and district as a realization of Smart Living—one of the six dimensions of the Smart City concept proposed by Giffinger et al. (2010)—and provided a means of facilitating the public in obtaining information and health services (Rachmawati et al., 2021b; Allam et al., 2020). At the same time, it proactively involved Indonesians in preventing the spread of COVID-19 through community participation features whereby users shared their location data while traveling—thereby facilitating contact tracing (PeduliLindungi). At the same time, though, the PeduliLindungi drew extensive public complaints. Given this duality, it is necessary to analyze the PeduliLindungi application and provide an evaluation that could be used by developers to improve application performance.

The Internet may be deemed a virtual society, being not only about data, information, and services, but also about interactions among people, organizations, and automated systems (Indurkha & Damerau, 2010). Internet users can communicate with each other, expressing their views and opinions about anything easily and instantly. Such opinions offer a new type of data that can be mined. Sentiment analysis, or opinion mining, offers a method of computing textual data to obtain information on opinions, sentiments, and emotions (Indurkha & Damerau, 2010). Within the context of mobile applications, sentiment analysis contributes an understanding of users' emotions or behavior towards the application. Through users' comments and opinions, it becomes possible to ascertain the sentiment orientation of the public (Kaur & Gumber, 2014; Ji et al., 2016).

As a result of the COVID-19 pandemic, most Indonesian people experienced forced digitalization, whereby they were required to suddenly change from conventional habits to modern ones utilizing information and communication technology (Rachmawati et al., 2021a). The COVID-19 pandemic, coupled with a national Work from Home (WFH) policy, limited the mobility of Indonesian people and led them to spend more time on the internet. Social media platforms played an important role in disseminating information to the public during the crisis (Puri et al., 2021); indeed, 90.13% of internet users used social media in January 2021, an increase of 13.2% over the previous year (Wearesocial, 2021). One of the most widely used social media platforms is Twitter, where a person can write anything—including opinions on the PeduliLindungi application—in 280 characters or less. Indonesia is the country with the sixth-most Twitter users, being home to 15.7 million active users in July 2021 (Statista, 2021). Twitter provides a medium whereby public responses and activities during the COVID-19 pandemic were disseminated. For this study, Twitter has provided an abundant source of research data related to public sentiment regarding the PeduliLindungi application.

Previous research on PeduliLindungi discussed public acceptance in accelerating the handling of COVID-19. It found that the use of the application would increase due to ease of use, and thus improve public acceptance (Kurniawati et al., 2020). However, few studies have discussed the PeduliLindungi application; fewer still have utilized textual data, such as those collected from social media during the COVID-19 pandemic. In this study, we attempted to collect new information related to the PeduliLindungi application from Twitter in the context of strengthening smart living.

The main purpose of this study was to analyze Indonesian Twitter users' sentiments towards PeduliLindungi and extract information from the results of the sentiment analysis. To achieve this goal, we recorded Indonesian-language tweets discussing the PeduliLindungi application in two different time periods.

Methods

This study was conducted by collecting and compiling collect and construct our dataset from tweets published between 2021 and 2022, then conducting sentiment analysis (see Figure 1). All sentiment analysis processes were performed using the Python programming language and visualized using tables.



Figure 1. The four phases of sentiment analysis conducted in this study

The dataset used consisted of a series of Indonesian-language tweets posted in a one-month period after the government's release of the PeduliLindungi application (i.e., from August 20 to September 20, 2021) and tweets posted in a one-month period after the first booster vaccines were

issued in Indonesia (from January 12 to February 12, 2022). Tweets with the keyword "pedulilindungi" were recorded using the Twitter Streaming API. A total of 53,197 tweets were recorded, with 41,447 tweets recorded between August 20 and September 20, 2021, and 11,752 tweets recorded between January 12 and February 12, 2022.

Before processing the raw data, preprocessing was necessary. In text mining, preprocessing is very necessary because the input used for analysis is unstructured text data (Hermawan & Bellanar, 2020). In this study, preprocessing process was done through the following stages:

1. Randomly selecting 1,000 tweets and classifying selected tweets as expressing positive, negative, or negative sentiments. This labelling was intended to evaluate the performance of the VADER model used.
2. Cleaning unnecessary words or characters to produce more accurate analysis results. In this study, user mentions, links, and hashtags were removed so as not to interfere with the translation process.
3. English-language translations of Indonesian-language cleaned data were produced using Google Translate through a library called deepTranslator. This process was done because VADER's sentiment analysis model only supports English tweet data. Google Translate has spell-checking capabilities to correct spelling errors in texts. The keyword "pedulilindungi" in the previous text was changed to "PL" so that it would not be translated into English.
4. Tokenizing, or breaking sentences into their constituent words. Tokenizing was done on the original Indonesian-language cleaned data to reduce the risk of a mistranslation. This process allowed the initial creation of a word cloud.
5. Stop word removal, or removing insignificant words from the Indonesian-language cleaned data, based on tokenizing results. This process was done manually, with the assistance of a library called Sastrawi.
6. Stemming, or converting words to their base form. This process was done with the help of the Sastrawi library

The main purpose of sentiment analysis is to automatically identify whether a text conveys a positive, neutral, or negative impression, especially when using large amounts of data. To achieve this goal, this study employed a lexicon-based sentiment analysis approach: the VADER (Valence Aware Dictionary for Sentiment Reasoning) model, which classifies text based on the polarity of the lexicon that conveys sentiments and is specifically designed to identify sentiments in social media texts (Hutto & Gilbert, 2014). The VADER model does not provide a direct classification of the output, but rather provides polarity values that range from -1 to +1; as such, researchers must determine their own polarity limit values based on the characteristics possessed by the obtained dataset. In this study, we established three types of classification: positive (> 0.6), neutral (-0.1 to 0.6), and negative (< -0.1). These numbers were identified through trial and error, which enabled researchers to obtain more accurate sentiment prediction results when exploring the data thoroughly. The accuracy of calculations was verified by comparing the VADER sentiment classification of 1,000 randomly sampled tweets with the true labels determined manually by the researcher (see Table 1). Classification results had an accuracy of 79%, with an f1-score for "positive", "neutral", and "negative" sentiments of 52%, 85%, and 69%, respectively (see Table 2).

Table 1. Confusion matrix: VADER Sentiment analysis

	Predicted Negative	Predicted Neutral	Predicted Positive	Precision
True Negative	127	59	10	74%
True Neutral	42	596	43	83%
True Positive	2	59	62	54%
Recall	65%	88%	50%	

Table 2. Classification Results: VADER Sentiment

	Precision	Recall	f1-score
Positive	54%	50%	52%
Neutral	83%	88%	85%
Negative	54%	65%	69%
Accuracy			79%

Evaluation was conducted to calculate the performance of the system built for this study, namely the performance of sentiment analysis using a VADER Sentiment model with customized polarity limits. Various means may be used to evaluate the performance of a model. One of these is examining the f1-score. Based on the f1-score obtained, the model can best classify neutral sentiment; this is followed by negative and then positive sentiments. Indeed, this model is not very effective in classifying positive sentiment. The VADER Sentiment model uses a lexicon approach wherein each word contained in a text is deemed to have a polarity value based on its lexical value. We identified some misclassifications. Some may be attributed to tweets conveying information/news about PeduliLindungi (neutral sentiment) that contains words with a strong positive polarity (see Table 3, number 1). Even with the assistance of spell-checking, as performed by Google Translate, the model cannot properly classify texts that contain spelling errors or use too many abbreviations (see Table 3, number 2, underlined). The model has difficulty identifying the sentiments behind humorous and satirical expressions (see Table 3, numbers 3 and 4). The model also cannot properly classify text with overly complex sentences, as seen in Table 3, numbers 2 and 5; these examples are classified as conveying negative sentiments because the words "shocked" and "ashamed" have a strong negative polarity.

Table 3. Examples of misclassified tweets

No.	Original Text	Machine-Translated Text	Predicted Sentiment	Actual Sentiment
1	"Pemerintah meminta masyarakat untuk percaya terhadap penggunaan aplikasi PeduliLindungi yang bagus dan aman karena selalu disempurnakan."	"The government asks the public to believe in using the PeduliLindungi application which is good and safe because it is always being improved."	Positive	Neutral
2	"semenjak itu <u>w lgsg</u> download apps pedulilindungi kan buat <u>kl</u> mau <u>kmn</u> mana. <u>trs plg dr st mo</u> groceries di mall <u>gt</u> , <u>w</u> udh pede karna dah punya appsnya yakan, eh tetep drama lg pas scan barcode ternyata profil <u>w blm</u> lengkap, lamaa <u>lg</u> diluar isi data dulu <u>pk</u> ktp"	"Since then, I've been downloading pedulilindungi apps, right where are you going? thx plg dr st mo groceries at the mall gt, I'm confident because I already have the apps, right, it's still drama when I scan the barcode, it turns out that my profile isn't complete, it's been a long time outside of filling in the data first on the ID card"	Positive	Negative
3	"Skr ini kalau mau tahu suami kelayapan kemana aja tdk perlu pakai aplikasi yg aneh2. Cukup lihat di story pedulilindungi aja "	"Right now, if you want to know where your husband is wandering, you don't need to use strange applications. Just look at the pedulilindungi story"	Negative	Positive
4	"Yah nama doang peduli lindungi wkwkw apa yang di lindungi?"	"Well the name only cares about protecting wkwkw what is being protected?"	Positive	Negative
5	"Kaget ditanyain kartu vaksin sama petugas krl untung kemarin dah download peduliLindungi. Kan malu kita kalo ngeluarin print2an."	"Shocked to be asked about the vaccine card by the officer, fortunately yesterday, I downloaded the pedulilindungi. We're ashamed if we issue prints."	Negative	Positive

Results

Sentiment Analysis of Tweets Made between August 20, 2021 and September 20, 2021

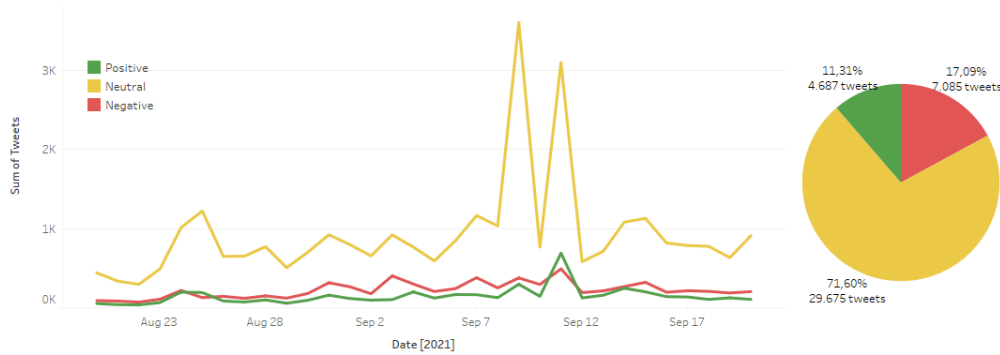


Figure 2. Recorded tweets over time, aggregated by polarity.

There were 41,447 tweets that mentioned the PeduliLindungi application between August 20 and September 20, 2021. As seen in Figure 2, 71.60 percent of tweets were identified as expressing neutral sentiment, 17.09 percent of tweets were identified as expressing negative sentiment, and 11.31 percent of tweets were identified as expressing positive sentiment. A spike in the number of tweets was seen on September 9 and 11, 2021. The significant increase in the number of tweets was a result of government and public campaigns for the PeduliLindungi application using hashtags such as #PLRedamPandemi and #PolriEdukasiProkes. A number of keywords were identified, as shown in Table 4 and visualized in word-cloud form in Figure 3.

Table 4. Top ten keywords related to PeduliLindungi in tweets, by classification

Positive		Neutral		Negative	
Word/Translation	Count	Word/Translation	Count	Word	Count
vaksin/vaccine	1,742	vaksin/vaccine	8,394	vaksin/vaccine	2,660
aman/safe	1,128	vaksinasi/vaccination	4,946	vaksinasi/vaccination	1,436
data/data	959	sertifikat/certificate	3,673	sertifikat/certificate	1,169
sertifikat/certificate	859	data/data	2,535	bocor/leaked	697
covid/covid	587	covid/covid	2,179	salah/error	504
pemerintah/government	453	scan/scan	1,844	daftar/registration	441

about issues with the application itself; reports included the inability to use QR scans, error reports, and difficulty using the application. Users also complained that the application's continuous access to location information was wasteful, and thus detrimentally affected battery life. Positive sentiments were mostly expressed as part of campaigns from related agencies. Other positive tweets expressed public trust and satisfaction with PeduliLindungi. Positive sentiments were also expressed by users inviting others to use the application, as well as those expressing public support and expectations for the PeduliLindungi application. Examples of tweets, per sentiment classification, are provided in Table 5.

Table 5. Tweet examples per sentiment.

Polarity	Original Text	Translated Text
Neutral	"Guyss nanya dong kalo WNI balik ke Indonesia udah vaksin di luar negeri terus pengen ke mall tetep harus pake sertifikat yg dari Peduli Lindungi ya?"	"Guys, please, if an Indonesian citizen returns to Indonesia, has been vaccinated abroad, and wants to go to the mall, he still has to use a certificate from the PeduliLindungi, right?"
	""halo. Apakah tes antigen hasilnya terkoneksi dengan peduli lindungi? Apa beda yang regular dengan abbot panbio? Untuk penerbangan yang reguler bisa?""	"Hello. Is the antigen test result connected to PeduliLindungi? What's the difference between regular and Abbot Panbio? Can these work for regular flights?"
Negative	"Aku gak sg selalu ngeceki battery health, tpi barusan cek krn merasa kok belakangan baterai ku boros betol. Dan ternyata app peduli lindungi ini location nya nyala terus di background :((dari BH 96% bln lalu, skrg tiba2 90% sebel"	"I don't always check battery health, but I just did because I felt like my battery had been draining quickly lately. And it turns out that the PeduliLindungi app's location [tracking] keeps turning on in the background :((from BH 96% last month, now suddenly 90%, resentful"
	"Jadi ragu sama Peduli lindungi dan aplikasi sejenis berplat merah. Nggk pernah beres. Bocor adalah hal biasa."	"So I have doubts about PeduliLindungi and similar applications with a red plate [i.e., issued by the government]. It's never been done right. Leaks are common."

<p>Positive</p>	<p>"Keren juga ni aplikasi pedulilindungi sayangi keloni. Baru buka setelah sekian lama. Ada riwayat vaksin, unduh2 sertifikat, dll. Ntap 👍"</p>	<p>"It's also cool, the PeduliLindungi application "loves keloni". [I] just opened [it] after a long time. There is a history of vaccines, certificates for download, etc. Nice 👍"</p>
	<p>"Thank you God, thank you Pemerintah Vaksin ke 2 selesai tanpa keluhan seperti yang pertama. Mantap sekali 2 sertifikat vaksinnya langsung muncul di PeduliLindungi"</p>	<p>"Thank you God, thank you Government. The second vaccine was done, without any complaints like the first. It's great that the two vaccine certificates immediately appeared in PeduliLindungi."</p>

Sentiment Analysis, tweets issued between January 12 and February 12, 2022

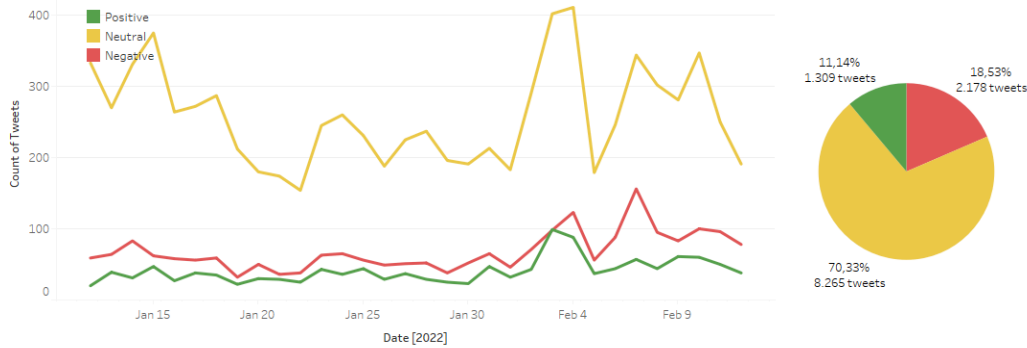


Figure 4. Recorded tweets over time, aggregated by polarity.

Between January 12 and February 12, 2022, 11,752 tweets discussing the PeduliLindungi application were recorded. This number was much lower compared to the previous period, wherein 41,447 tweets were issued. As seen in Figure 4, 70.33 percent of the recorded tweets expressed neutral sentiments, 18.63 percent expressed negative sentiments, and 11.14 percent expressed positive sentiments. The most common keywords per classification are identified in Table 6, and visualized in word-cloud form in Figure 5.

Table 6. Top ten keywords related to PeduliLindungi in tweets, by classification

Positive		Neutral		Negative	
Word/Translation	Count	Word/Translation	Count	Word	Count
vaksin/vaccine	475	vaksin/vaccine	2651	vaksin/vaccine	601
hasil/result	244	booster/booster	1295	hasil/result	361
booster/booster	202	tiket/ticket	1132	pcr/pcr	338
vaksinasi/vaccination	190	vaksinasi/vaccination	994	negatif/negative	209
pcr/pcr	148	hasil/result	874	antigen/antigen	201
sertifikat/certificate	142	scan/scan	789	scan/scan	184
tiket/ticket	124	sertifikat/certificate	631	sertifikat/certificate	159
terimakasih/thanks	122	pcr/pcr	625	data/data	144
tes/test	120	daftar/register	542	booster/booster	142
membantu/helpful	83	muncul/appear	397	error/error	122

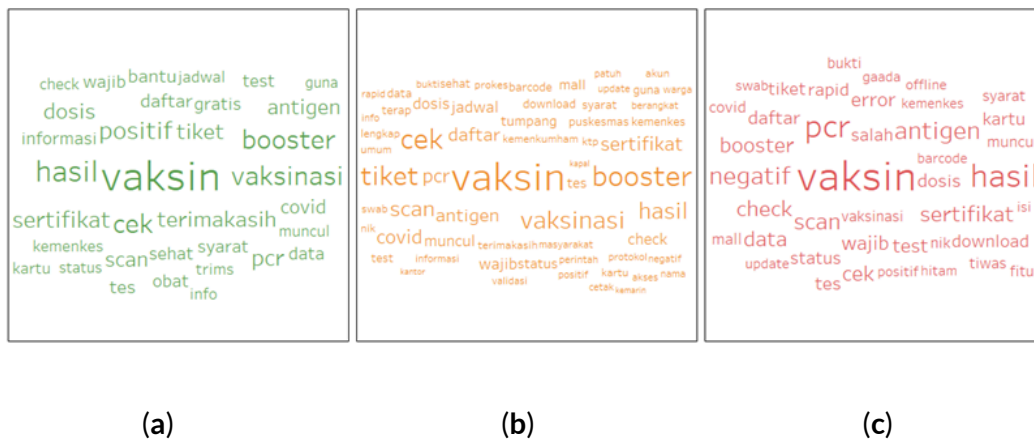


Figure 5. Word cloud for: (a) positive polarity, (b) neutral polarity, and (c) negative polarity. The word cloud displays the words used in the dataset; the more frequently the word was used, the larger its font in the word cloud.

As seen in the word clouds in Figure 5, most of the public tweets discussed vaccine boosters. The government began its advanced dose vaccination, or booster vaccination program, on January 12, 2022. This program was free of charge and intended for people who had received a full dose of vaccination no less than six months previously. Through the PeduliLindungi website and application, members of the public were able to check their tickets and booster vaccination schedules.

Of the recorded tweets, 70.33 percent (8,265 tweets) were identified as conveying neutral sentiments. As before, tweets identified as neutral were predominantly questions about the PeduliLindungi application as well as answers given by related agencies and/or community members. These commonly included reports of problems accessing booster vaccinations, problems integrating PCR/Antigen result data, and problems accessing vaccine tickets. The procedures for registering and using the application were not widely questioned, as the developer had overhauled its user interface through Version 4.02 (Android) on October 22, 2022. Tweets identified as neutral also included news about the application, especially the e-ticket function.

Meanwhile, 18.63 percent (2,178 tweets) were identified as expressing negative-sentiments. This figure is 1.68 percent higher than the previous one. Judging from the keywords in Table 6 and Figure 5, the public complained of their PCR/antigen results not being integrated and the PeduliLindungi application showing "black" even though the test results were negative. With this "black" status, they could not travel or enter public places. After Version 4.02 (Android), reports of the application detrimentally affecting battery life were non-existent. However, some tweets still questioned data security.

As in the previous period, tweets with positive sentiments mostly expressed the community's satisfaction with, support for, and appreciation of the benefits offered by PeduliLindungi. Positive sentiments also included invitations to other Twitter users to use the PeduliLindungi Application, as well as promotional campaigns by government/ related agencies. Examples tweets are provided in Table 7, disaggregated by sentiment classification.

Table 7. Tweet examples per sentiment.

Polarity	Original Text	Translated Text
Neutral	"Di Pelabuhan Kaliadem, 415 Wisatawan Scan PeduliLindungi Sebelum Berangkat ke Pulau Seribu"	"At Kaliadem Port, 415 Tourists Scan PeduliLindungi Before Departing for Seribu Island"

	"[askr] Guys kalau udah vaksin di luar negeri biar bisa terdaftar di peduli lindungi itu bisa gak ?? kalau bisa kira-kira caranya gimana?? atau harus vaksin lagi?? Terima kasih ya ✨"	"[askr] Guys, if you have been vaccinated abroad, is it possible to be registered in PeduliLindungi? If so, how do you do it? Or do you have to get vaccinated again? Thank you."
Negative	"udah keluar hasil pcr dan negatif, cuma di peduli lindungi nya masih belum ke update 😞 kata pihak rs dari pedulilindungi nya error tapi jujur ga 100% percaya sama pihak rs nya juga, soalnya gue baru dikirimin hasil pcr abis WA mereka dulu 😞"	"The PCR results have come out and are negative, but PeduliLindungi hasn't been updated yet. The hospital said there was an issue with PeduliLindungi, but honestly, I don't 100% believe the hospital, because I just sent the PCR results as per their [WhatsApp]."
Negative	"Metaverse?! E-KTP yg masih harus di fc tiap mau ngurus apa2 udah sesuai fungsi? Kebocoran data kesehatan kemarin apa kabar? PeduliLindungi yg sertifikat vaksinnya ga sesuai itu gimana kabarnya?"	"Metaverse?! [Like] the e-KTP that still has to be photocopied every time you want to take care of anything is working as intended? PeduliLindungi, with its vaccine certificates that don't match, how is it?"
Positive	"Sertifikat vaksin ketiga sudah masuk aplikasi pedulilindungi. Yaaay!!" "vaksin boosternya bayar ga tuh?" gratis! ga dipungut biaya apapun! makanya rajin-rajin buat cek jadwal dan tiket gratis yang bisa kalian dapatkan diaplikasi PeduliLindungi yaa #SiapBoosterGratis"	"The third vaccine certificate has entered the PeduliLindungi application. Yaaaay!!" "'Do you pay for the booster vaccine?' It's free! There's no charge! So be diligent to check the schedule and the free tickets that you can get in the PeduliLindungi application, #SiapBoosterGratis"

Discussion

Development in an area can be influenced by the use of information and communication technology therein. The advancement of telecommunications, especially the internet, along with the rise of personal electronic devices has changed all economic and social aspects of their everyday lives and mindsets (Das & Zhang, 2021). During the COVID-19 pandemic, greater attention was given to sustainably utilizing communication and information technology, as governments were urgently required to connect technology, leadership, management, and

interactive culture to navigate the health, economic, and social crises that emerged (Kunzmann, 2020). The COVID-19 pandemic changed lifestyles around the world in a few short months as technology was placed at the forefront of fighting the virus (Kylili et al., 2020). At the same time, the COVID-19 pandemic showed technological gaps and inequalities between cities and regions (Attaran et al., 2022). In Indonesia, one national program to navigate the pandemic was PeduliLindungi, an application developed by the Ministry of Information and Communication in collaboration with PT. Telkom Indonesia to provide public services.

The conveniences offered by PeduliLindungi fulfilled one "Smart City" indicator, i.e., smart living, as it positively impacted the health sector by providing quick and easy access to information that helped promote a better quality of life (Varghese et al., 2021). PeduliLindungi offers users various benefits, such as creating safe and healthy public spaces, integrating health data, and easing access to health information. The check-in feature on the application quickly proved useful for minimizing face-to-face interactions, thereby limiting the spread of COVID-19 in public places by facilitating social distancing and preventing unnecessary gatherings. Data integration likewise eased public mobility while preventing the falsification of PCR, anti-gen, and vaccination test results; this, too, minimized the spread of COVID-19. Various health information, dealing with subjects such as COVID-19 test locations, vaccination, travel regulations, telemedicine, hospital availability, and statistics, was also made available.

Current technological trends, especially the proliferation of information and communication technologies, have contributed to decision-making (Gërguri-Rashiti et al., 2013). The internet provides a platform for people to voice their opinions on any topic involving emotions or sentiments, including those that would not be expressed in offline interactions. Social media platforms such as Twitter have facilitated communication within human communities and helped them share ideas, information, knowledge, and other data (Kim et al., 2014).

Public opinion data is readily available on social media, thereby allowing researchers to produce better discussions and conclusions. This provides the basis for opinion mining and sentiment analysis. The development of natural language processing (NLP) techniques makes it possible to analyze such data and measure public satisfaction with various services—such as PeduliLindungi. Through sentiment analysis, the developers of the PeduliLindungi application can identify shifts in overall user opinions on the products developed. In this study, for example, changes in user opinion were evidenced in the disappearance of tweets discussing battery usage and ease-of-use between the first and second periods of studies. This may indicate that updates successfully resolved the issues about which users complained. Through the data generated from this sentiment analysis, the developers of the application could be helped identify problems and updating priorities to ensure that the PeduliLindungi application can be maintained and utilized optimally.

Based on the results of the sentiment analysis conducted in this study, tweets expressing neutral sentiments were predominant in both periods studied. These neutral tweets contained questions, answers to said questions, and information related to the PeduliLindungi application. The Indonesian government effectively used social media platforms such as Twitter to answer questions and share information about COVID-19 with the public; this enabled it to cultivate public trust (Hasija, 2021). Tweets expressing negative sentiments, meanwhile, were more common than those expressing positive sentiments during both periods. Most of these tweets

communicated obstacles experienced by the community when using the PeduliLindungi application, or expressed the concerns of community members. Most of these negative tweets dealt with security of private data; this was triggered by contemporary reports of data leaks (Bestari, 2021), as a result of which the application violated several principles related to dealing with personal data (Raila et al., 2021). Developers and related agencies must thus further safeguard the security of user data, as only if the public is convinced of the security of their private data will public trust be fostered.

This research still has limitations. The sentiment analysis model used in this study had an accuracy of 79%. As such, we recommend that subsequent studies improve accuracy, perhaps using alternative techniques or models, as this will ensure that the results obtained are of higher quality. Future studies may use other variables to generate new insights; for instance, they may determine whether there is a significant correlation between the number of vaccinations, active cases, and the number of deaths compared to public perceptions of the PeduliLindungi application. Subsequent research may also be able to classify tweets based on different aspects, such as emotional content (happiness, sadness, anger, fear, disappointment, etc.) or functionality (appearance, ease, compatibility, etc.) to fully understand and express the sentiments contained therein. We recommend continuous analysis of public sentiments towards government-made products such as the PeduliLindungi application. Such sentiment analysis is expected to provide a reference for product formulation and evaluation, thereby ensuring that the products produced are more optimal and better targeted.

Conclusion

This study shows that the Indonesian government is effectively using the PeduliLindungi application to answer questions and share information related to COVID-19 with the public. However, Twitter users expressed negative sentiment towards PeduliLindungi rather than positive due to concerns about data security and obstacles faced when using the application. Negative sentiment towards PeduliLindungi is more prominent than positive due to users' concerns about data security and the obstacles they face in using the application. Future recommendations in the post-COVID-19 pandemic era, applications such as PeduliLindungi can be used to provide information on health services which are currently a major issue. For example, problems with air pollution and health, environmental health affected by disasters, traffic congestion and driving health and so on. User education is needed to increase digital literacy regarding the applications being prepared.

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