

Assessing Digital Adoption Capability in Public Healthcare Services Through Online User Reviews and Popularity Trends

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Abstract. This study analyzed online user reviews and popularity trends to assess digital adoption capability in public healthcare services in Indonesia. Sentiment analysis and topic modeling were applied to reviews of the National Health Insurance (JKN) mobile application to identify key themes and sentiments. Google Trends data was used to examine search popularity. The results revealed predominantly negative reviews expressing issues with registration, login, and information accuracy. Positive reviews confirmed the app's helpfulness and convenience for some users. Review topics focused on basic functions like registration status and did not reflect new service modules. Search trends showed limited variation in keywords over time, suggesting stagnant digital development. The findings indicate shortcomings in the app's technical aspects and data quality and a lack of transparency in service expansion. Leveraging big data analytics of online reviews and searches offers valuable insights to strengthen public service performance. This study contributes a novel empirical assessment of digital adoption capability using public feedback. The real-time monitoring approach can support public service providers to enhance quality, accountability, and transparency. Further research should examine reviews in other public services and countries.

Keywords: Public Service, Online User Reviews, Popularity Trends, Digital Adoption Capability, Big Data Analysis, Health Insurance

1. Introduction

Public services and performance have a close relationship in the context of providing services that meet the needs and expectations of society. Performance in public services is related to how these services are run, measured, and improved to achieve better results. Performance is the most central topic in strategic management (Hitt, Ireland, & Hoskisson, 2017). Nelson and Winter (Richard R. Nelson, 1983) say that organizations need to improve innovative performance to adapt to environmental changes to survive. Nelson and Winter explain this by focusing on issues related to changes in technology and routines. This concept is supported by Hannan and Freeman (1989) through their views on the need for organizations to adapt and constantly change to maintain their relevance in line with changes in the competitive environment. In Indonesia, public service innovation refers to a combination of technological and administrative innovation dimensions, and most often occurs to address social problems in the health and education sectors (Pratama, 2020).

Health is a major human sector and a fundamental priority for life, and inadequate health insurance is one of the biggest obstacles to healthcare access (Call et al., 2014). Lack of health insurance coverage can hurt health (Facts et al., 2015; Moher, Liberati, Tetzlaff, Altman, & Group, 2009). The research results of Baicker (2013) and Buchmueller (2005) show that having health insurance is associated with increased access to health services. Based on Law No. 24 of 2011 concerning the Social Security Administering Body (BPJS), starting in 2014 the government has implemented JKN to realize Universal Health Coverage (UHC) (World Health Organization, 2021). Indonesia has succeeded in reforming health financing policies through the implementation of the JKN scheme (Pisani, Olivier Kok, & Nugroho, 2017). For the size of an archipelagic country with geographical and historical diversity, as well as high disparities in economic capacity, Indonesia succeeded in covering more than 222 million people as JKN participants in March 2020. However, this participation achievement has not been commensurate with the quality and utilization of services, as research findings show. carried out by the Gadjah Mada University team (Candra et al., 2020) which stated that the JKN policy was still partially implemented, this was also supported by Dartanto (Dartanto et al., 2020) who stated that the use of health services had a negative correlation with the level of compliance of informal sector workers. To overcome this, BPJS launched the JKN mobile application for participants to use to access the information and services provided. Since this application was launched online in 2016 on the Google Play Store website, it has received many reviews from collateral participants. Reviews or feedback from users can provide public service providers with valuable insight into how those services are perceived by the communities they serve. Gofen's findings (Gofen, 2015) indicate that if newly introduced services gain social acceptance, existing provisions may change, as well as existing service provisions being reformed to meet citizens' demands. Re-engineering is needed to effect change in public services (McNulty, 2003).

Many people express their views about products and services on online platforms or websites freely (H. Liu, Jayawardhena, Osburg, Yoganathan, & Cartwright, 2021). It is important to strengthen the 'direct accountability' of service providers to users, in the form of community participation to strengthen their 'voice' through complaint systems (Houtzager & Acharya, 2011) and online reviews. This large number of reviews is a very valuable asset from which to draw information and source new insights about the services provided. Pooja's study (Pooja & Upadhyaya, 2022) shows the contribution to existing knowledge in management research by providing a holistic understanding of the construct of "online review credibility" and helping to understand what factors lead to consumer trust in the credibility of online reviews. The insights gained will provide managers with adequate cues to design an effective online review system (Pooja & Upadhyaya, 2022). With the increasing popularity of user reviews submitted online, many researchers are interested in understanding reviews and reviews of products or services (Chih, Hsu, & Ortiz, 2020; W. Liu & Ji, 2018; Mumuni, O'Reilly, MacMillan, Cowley, & Kelley, 2020). There are various reasons why reviews with large amounts of data can contribute to knowledge and information, such as diverse insights (David D'Acunto, Annamaria Tuan,

2020), patterns and trends (Ajah & Nweke, 2019), pros and cons (Le & Liaw, 2017), informed decision-making (Andrew McAfee, 2012; Dahl, Milne, & Peltier, 2019; Fanelli, Pratici, Salvatore, Donelli, & Zangrandi, 2023; Jeble, Kumari, & Patil, 2018), avoiding pitfalls (Lamata, 2020), learning from experts (Hansen & Quinon, 2023).

Google as a search engine with online big data support is ranked first among all search engines for obtaining the highest traffic (Yu, Zhao, Tang, & Yang, 2019). Google has launched Google Trends, which can provide information on public sentiment regarding certain search keywords (X. Li, Ma, Wang, & Zhang, 2015). Specifically, the Google Trends scale from 0 to 100 is calculated by examining the proportion of a query's search volume to the total number of Google searches. According to Yu et al. (2019), Google Trends belongs to a particular type of big data that includes a wide range of information. Google Trends has been widely used to evaluate and predict economic activity (Götz & Knetsch, 2019), but few have used it to assess public services, especially digital adoption.

As big data, this review data refers to large volumes of data that continue to increase at a high speed (Andrew McAfee, 2012; Chen, Lin, & Wu, 2020). Revealing new knowledge and insights from big data is not easy, it requires a careful approach and selecting the right tools (Binsar & Mauritsius, 2020b). Choosing an analysis method that suits the type of data and business goals is a challenge in itself. Complex analysis requires a deep understanding of algorithms and analysis techniques (Hansen & Quinon, 2023).

In this article, we try to carry out an in-depth analysis using big data for sentiment analysis (Ankit, 2018; Basha & Somasundaram, 2019; Binsar & Mauritsius, 2020b) and topic modeling (Noto, Lo Verso, & Barresi, 2021). Sentiment analysis analyzes the language in reviews to determine sentiment (positive, negative, or neutral) (Le & Liaw, 2017) based on topics of interest. Meanwhile, topic modeling or text classification is carried out to identify the main topics mentioned in the review.

Finding new insights and knowledge from big data analysis of user reviews can be a very useful tool in improving public service performance. Sentiment analysis and population trends which are studied in this research are very active and interesting areas of research for further research and have been studied in recent years. The use of sentiment analysis and population trends has even spread from computer science to management science. The presentation of this research begins with an explanation of the need to understand opinions on public services, and digital adoption capabilities that facilitate the delivery of opinions in part 2, followed by a discussion of assessing opinions into positive, negative, and neutral labels as well as the need for analysis of popularity trends as a desired solution, and discussing research other related. Section 3 describes the proposed methodology and model. Next, section 4 explains the analysis of the results obtained from the model used. Discussion of the research results is explained in section 5, and this research ends with notes on conclusions and suggestions that can be carried out in further research in section 6.

2. Literature Review

2.1. Public Service

Society expects increased effectiveness, service quality, and access, so quality management is one of the core domains in the public sector context that must be improved (Elg, Wihlborg, & Örnérheim, 2017; Engwall, Kipping, & Üsdiken, 2016; Mauro et al., 2014). Organizational performance is also the concept of the success or effectiveness of an organization and an indication of how the organization works effectively to achieve its goals successfully (Jenatabadi, 2015). The healthcare sector (similar to other sectors) is increasingly dependent on digital innovation, context, and culture (Hospodková et al., 2021). Technology in this case plays an important role in improving the performance and delivery of public services ("Technology to Help Public Sector Performance," 1980), of course with appropriate service design to support performance management (Lewandowski, 2018).

Public services can be adopted through digital technology (Laurenza, Quintano, Schiavone, & Vrontis, 2018) and can ultimately affect the reliability and quality of health services (Apell & Hedefjäll,

2022). With these digital technology capabilities, small companies with strong digital capabilities will perform as well as medium-sized companies (Llinas & Abad, 2019). However, without proper design, the use of technology cannot improve the performance of public services. Varotsis (Varotsis, 2022) said telework affects public service performance in different ways. Telework does not increase the efficiency of public service performance, but the implementation of flexible work schedules thanks to telework has improved public service performance. Therefore, innovation is needed to produce sustainable public service performance for beneficiaries (Ali AlShehail, Khan, & Ajmal, 2022). Innovation has a role and determinant in public services with effective policy implementation that provides a more sophisticated and evidence-based approach to encouraging and sustaining public service innovation (Stephen P. Osborne, 11AD). Innovation produces improvements and benefits in public services, complex matters can be better understood (Gyllenhammar & Hammersberg, 2023).

In the public service system, community involvement is needed as an actor (Eriksson & Nordgren, 2018) to understand the extent of smooth implementation in the field. So that problems in the field can be overcome by aligning proposed improvements with the diversity of problems found (Edwards, Prætorius, & Nielsen, 2020; Komulainen, Nätti, Saraniemi, & Ulkuniemi, 2023). To create value for society, public administration decision-makers sometimes produce decisions that are not expected by society (Geuijen, Moore, Cederquist, Ronning, & van Twist, 2017; Prebble, 2021). Currently, there are many ways to involve the public in the process of improving public services, namely by using social media (Jalonen et al., 2021) as non-financial steps that can be taken into consideration (Gray, 2017; Vélez-González, Pradhan, & Weech-Maldonado, 2011). Creating greater social value for stakeholders is the fundamental mission of public service organizations and is more important than profits (Weerawardena & Sullivan-mort, 2001).

The Indonesian government has been relatively slow in responding to changing conditions in the health sector (Roziqin, Mas'udi, & Sihidi, 2021). Even though the public has higher expectations for the services provided compared to the actual experience of the health services they receive (Larasanty, Cahyadi, Sudarni, & Wirasuta, 2019). Public service innovation in the health sector in Indonesia is dominated by local governments with a combination of technological and administrative innovation dimensions to overcome community problems (Pratama, 2020), which can be measured through information technology resources (Pratama & Imawan, 2019). In an effort to reduce the burden on the government, themes related to data and digitalization are needed for big data connectivity (Sulistiyowati, Sukmana, Ratnasari, Ascarya, & Widiastuti, 2022).

2.2. Digital Adoption Capability

The use of Industry 4.0 era technology has provided operational benefits in increasing productivity and competitiveness (Deloitte Research Center for Energy And Industrial Group, 2019). Therefore, adopting digital technology has become a necessity for businesses and organizations to maintain or increase their competitive advantage (Alain Verbeke, 2021; Upadhyay, Mukhuty, Kumar, & Kazançoğlu, 2021). The adoption of the latest digital technology can overcome social challenges by increasing transparency (Friedman & Ormiston, 2022). The adoption of digital technology is strongly influenced by external factors that result in continuous changes in technology, giving rise to many innovations described using the Disruptive Innovation theory (Christensen, 1997; Christensen, Raynor, & McDonald, 2015). This change certainly provides benefits for some organizations. Therefore, every organization is required to be able to follow the flow and be flexible in technological developments.

Digital technology capabilities play a key role in increasing the effectiveness of healthcare entities in terms of innovation and providing healthcare. Digital technology capabilities are generally related to the knowledge and skills required for an individual to develop, use, adapt, absorb, and transfer technology (De Mori, Batalha, & Alfranca, 2016). Technology is changing the way organizations and individuals interact, create, and receive services to become more flexible, which can generate a need for continuous innovation that is increasingly dynamic and competitive (Jahanmir, Silva, Gomes, & Gonçalves, 2020; Zeike, Bradbury, Lindert, & Pfaff, 2019). Research conducted by Asokan et al. (2022)

has identified the ability to adopt technology in terms of big data analytics, digital twins, augmented reality, blockchain, 3D printing, artificial intelligence, and the Internet of Things. This research shows how technology can help improve employment practices, health and safety, and business practices in society's social performance including quality of life and social welfare, social governance, and economic prosperity and growth.

Healthcare services (similar to other sectors) are becoming increasingly dependent on digital innovation, whether in terms of treatment efficiency or diagnostic communication and optimization, change management is increasingly important in this area, as early involvement of all stakeholders, appropriately defined rules, adaptation to context and local culture (Hospodková et al., 2021). Therefore, it is important to have a skilled workforce capable of adopting and dealing with changes such as digital transformation. Important soft skills are needed to embrace digital transformation and its potential impact on successful implementation (Gulati & Reaiche, 2020). There are still many obstacles faced by doctors against the use of electronic medical records with the help of libraries, books, conference proceedings, data banks, and search engines such as Google (Ajami & Bagheri-Tadi, 2013).

The use of digital technology is process engineering, new technology, and digital business development, which must be customer-centered (Peter, Kraft, & Lindeque, 2020). The use or adoption of digital health technologies and applications can improve patient-pharmacist relationships through personal monitoring carried out by pharmacists (Ake & Arcand, 2020), helping patients access, modify, and share their medical information (Esmaeilzadeh, Dharanikota, & Mirzaei, 2021).

To digitize business processes in the health and care sector, new concepts and innovative solutions are needed. The digitalization of individual health enables data analysis methods to support healthcare professionals with important goals in the digitalization process for decision-making. Research conducted by Serbanati (2020) shows that the state or condition of digital health is equivalent to health itself. This research also shows the use of digital electronics will be able to interact with healthcare professionals, provide information about every aspect of an individual's health, proactively offer solutions, and help them diagnose and decide on appropriate treatment.

2.3. Online User Reviews

Reviews are users' personal views, and each person's experience of a product or service (Mudambi & Schuff, 2010). User reviews contain valuable information, such as bug reports, feature requests, and user experiences (Noei & Lyons, 2020). It is also important to consider the number of reviews and general patterns in reviews before deciding on downloading or using an app. Online reviews or reviews are comments, opinions, or evaluations left by users or customers about a particular product, service, or experience on an online platform. Its benefits have been widely acknowledged by much previous literature (Jin, Ji, & Gu, 2016; Mudambi & Schuff, 2010). These reviews can be found on various platforms such as application stores (such as *Google Play Store*, and *App Store*), e-commerce websites, discussion forums, social media, and various other websites (Dospinescu, Dospinescu, & Bostan, 2022; Laitinen & Sivunen, 2021). Online reviews can cover various aspects, including user experience, product or service quality, advantages, disadvantages, and general responses to a product or service (Qi, Zhang, Jeon, & Zhou, 2016; Yang, Liu, Liang, & Tang, 2019). These reviews may assist potential users or other customers in making purchasing or usage decisions. Online reviews can be text, star ratings, images, or a combination of these. They can be positive, negative, or neutral (Le & Liaw, 2017) and they may also reflect each individual's personal preferences and experiences. Online reviews are subjective and may vary between individuals. Even if there are negative reviews, this does not necessarily mean that the product or service is bad, but may reflect a specific negative experience.

Online product or service reviews have become an integral component of product information on e-commerce platforms and are often used as a strategic instrument to gain an advantage (Gutt, Neumann, Zimmermann, Kundisch, & Chen, 2019). Online review behavior is generally carried out because it is relatively fast, which shows that customer review behavior on websites is strongly influenced by extrinsic and intrinsic motivation (L. Li, Yao, Li, & Qian, 2023).

Pew Research Center reports that online reviews have a positive effect on consumer trust (88% think they are a lot or a little helpful), product safety (80%), and company accountability (78%) (Erica Turner, 2020). Consumers primarily rely on online reviews in less experienced product categories. More than eight in ten Americans (82%) say they consult online ratings and reviews when purchasing something for the first time.

With so many reviews, you can see different points of view and experiences from users who have diverse backgrounds, preferences, and needs (David D'Acunto, Annamaria Tuan, 2020). This can help in getting a more complete picture of the product or service. You can then identify general patterns or trends regarding the advantages, disadvantages, or specific aspects of a product or service. This can provide insight into the most appreciated features or problems that need to be fixed (Ajah & Nweke, 2019). These large reviews can also help see the positive and negative sides of a product or service (Le & Liaw, 2017). Understanding the benefits and drawbacks will help in making more informed decisions (Andrew McAfee, 2012; Dahl et al., 2019; Fanelli et al., 2023; Jeble et al., 2018). By collecting information from various reviews, you can make better decisions when choosing products or services that suit your needs and preferences (Jeble et al., 2018). The use of big data can and does avoid problems that might be experienced, this can help reduce the risk of disappointment or waste (Lamata, 2020). Some reviews may come from users who have in-depth knowledge of a particular topic that can be leveraged to learn new things or gain expert views (Hansen & Quinon, 2023).

User reviews are big data that can be mined to generate innovation ideas (M. Zhang, Fan, Zhang, Wang, & Fan, 2021), predict customer-company interaction evaluations (Ferreira, Robertson, Chohan, Pitt, & Foster, 2023), efficiency and effectiveness of marketing systems (Watson & Wu, 2021).

2.4. Popularity Trends

Popularity trend is a term that refers to changes in the popularity or fame of something, such as products, fashion trends, keywords searched on the internet, or even certain topics in the news and social media. These trends often fluctuate over time and can reflect changes in people's interests or preferences. Google Trends is a tool that allows users to see how far a keyword or topic has been searched for in the Google search engine over time. This can give you an idea of what people are searching for most globally or within a particular region. Google Trends is an alternative solution to surveys that often take time, and often get the latest statistics only months or even a year later. Google Trends provides a core offering of a particular brand's popularity and is known to have a positive correlation with consumer search behavior (Jun, Yoo, & Choi, 2018; Keitoku, Nishimura, Hagiya, Koyama, & Otsuka, 2021). Consumers instinctively participate in information search activities, which today often involve web searches (Chumnumpan & Shi, 2019). Purchasing products in online activities is often the result of customer searches via search engines (Chumnumpan & Shi, 2019).

2.5. Natural Language Processing and Sentiment Analysis

Natural Language Processing (NLP) is a form of Artificial Intelligence (AI) that helps computers interpret and understand human language (Chris Manning, 1999). NLP is widely studied in text mining, the process of studying large collections of written sources to obtain new information (B. Liu, 2010) and to identify and extract opinions from a text (Chris Manning, 1999).

Sentiment analysis or opinion mining is the computational study of opinions, sentiments, and emotions expressed in the text (Cambria, Schuller, Xia, & Havasi, 2013; B. Liu, 2010). Sentiment analysis is carried out using the NLP process. User review analysis is a research method that has become increasingly popular and influential in recent years (Schindler & Domahidi, 2021). It can be assumed that analysis of user comments can provide statistically representative results (Reimer, Häring, Loosen, Maalej, & Merten, 2021). Negative comments referred to desires for improved health services, requests for salary increases, and frustration with difficult supervisory relationships (Young & Gavade, 2018). Product reviews provide valuable insight into the challenges customers face and help businesses identify areas for improvement (Ajah & Nweke, 2019). Sentiment analysis approaches to collect and

analyze large text data sets to gain insight into real-life issues are now at a new level of breadth, depth, and scale (Xiang, Schwartz, Gerdes, & Uysal, 2015). By analyzing topics and sentiment in reviews, data scientists can identify key product features that customers like or dislike. Positive reviews to find out what users like about the app. Negative reviews can provide insight into issues that may need to be addressed.

3. Methods

In conducting this research, there are several stages carried out starting from business processes, preparation for data collection to producing a classification model. The stages used are the development of the Cross Industry Standard Process for Data Mining (CRISP-DM) standard stages (Galit Shmueli, Nitin R. Patel, 2010). Mariscal et al. (2010) stated CRISP-DM as the de facto standard for developing data mining and knowledge discovery projects and has been widely used in data mining development (Binsar & Mauritsius, 2020b, 2020a). The CRISP-DM process model provides an overview of the life cycle of a data mining project. CRISP-DM has 6 stages, namely business understanding, data understanding, data preparation, modeling, evaluation, and development. Based on these stages, this research breaks down the problem into separate tasks to mimic real-world scenarios. It begins by presenting an abstract model of sentiment analysis, which formulates the problem and provides a general framework for unifying research directions (business understanding). This research further identifies phases which include data collection, data preparation, and classification. The stages of this research are shown in Figure 1. Review data was collected (data collection) online using Jupyter Python. Then carry out the data preparation stage (preprocessing) including data cleaning, feature extraction, and normalization. This is then continued with the sentiment assessment phase and topic model classification. Sentiment classification and topic modeling determine whether a review or opinion sentence contains positive or negative statements. Sentiment classification can clearly be formulated as a supervised learning problem with two class labels (positive and negative). The training and testing data used in existing research are mostly product reviews (B. Liu, 2010).

The tool used in this research is Python programming (Albon, 2018), which has many libraries that can be used for data processing and machine learning. Python itself has proven its reliability and has been widely used by previous researchers (Babalola, 2021; Binsar & Mauritsius, 2020b, 2020a; Shi, Jia, Sun, Tian, & Chen, 2020; J. Zhang, Wang, Zheng, & Wang, 2019).

3.1. Data Collection

The data used in this research is quantitative, and because the data is available online, we collected it directly from the source. Research utilizing online surveys (digital non-surveys) is more frequently used and more accepted by researchers than before 2005, and can better track actual behavior (Evans & Mathur, 2018). Interviews are not always necessary to get a complete picture of customer needs and preferences, moreover, traditional surveys are unlikely to produce in-depth strategic analysis if large customer samples are required (Kenny, 2019). Online review data for the Mobile JKN application was taken online from the Google Play Store website which was accessed on August 17 2023 using the Google-play-scraper library which was accessed via Jupyter Python. Data was taken from June 2016 to August 17 2023 with a total of 145,407 reviews. The data that is successfully withdrawn is then saved to an Excel file. From this data, it can be seen that the application can be accessed online by the public exactly 2 years after BPJS started operating. At first not many people used this application, in line with regulations and community needs, recently more and more people are using it. This is shown by the large number of reviews each year as shown in Figure 1.

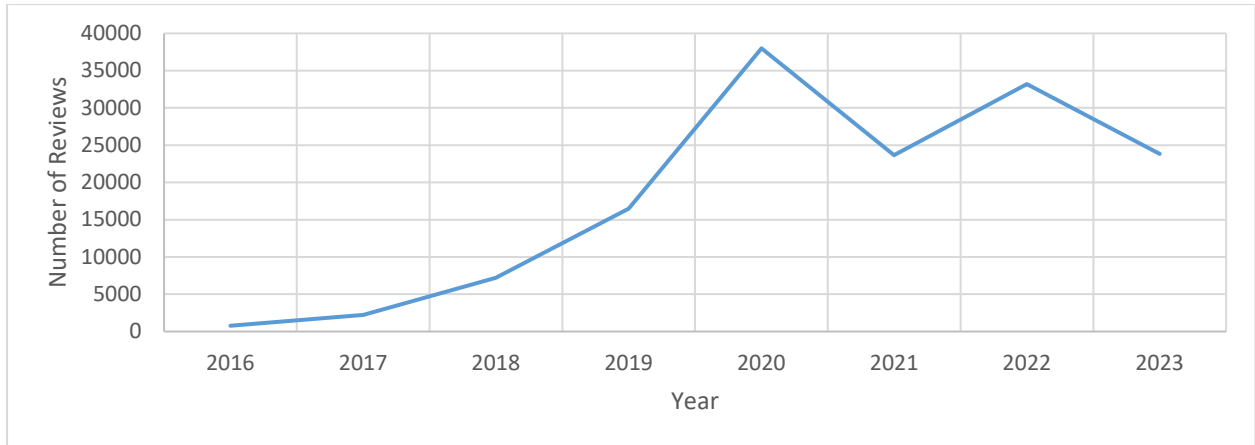


Fig 1: Number of online reviews per year

The number of users who downloaded applications from Google web pages was shown to be more than 10 million times, a quite large figure. When compared with Indonesia's population of 270.20 million people in 2020 (Badan Pusat Statistik, 2021), this figure is 4%.

During the same period, data on search interest via Google by Indonesian people was obtained from Google Trends, collected by comparing the two keywords "*Mobile JKN*" and "*BPJS Kesehatan Online*". Online search interest data is shown in Figure 2. Trend numbers represent search interest relative to the highest point on the graph for a specific region and time. A value of 100 is peak popularity, and a value of 50 means the keyword is half as popular. In this image, it can be seen that the search trend using the keyword "*JKN Mobile*" continues to increase and reach its peak in the last year, whereas search results based on the keyword "*BPJS Kesehatan Online*" have experienced a significant decline.

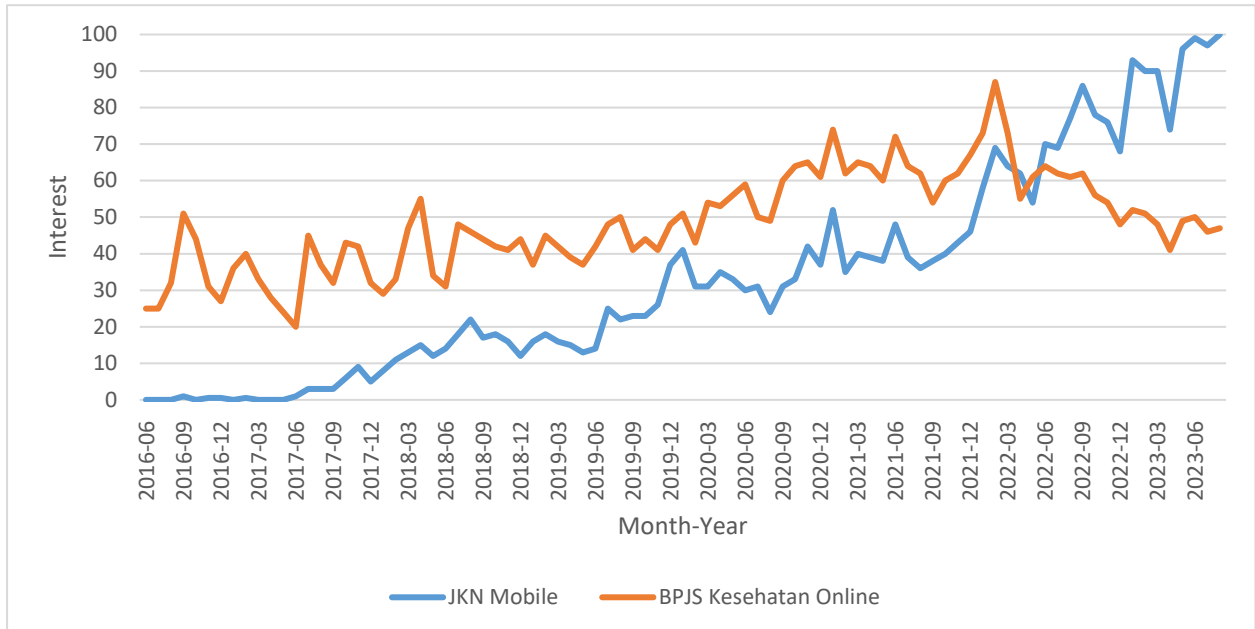


Fig 2: Google Search Interest Trends Over Time

3.2. Data Understanding

Online review data is obtained with 12 information fields consisting of *fl*, *reviewId*, *userName*, *userImage*, *content*, *score*, *thumbsUpCount*, *reviewCreatedVersion*, *at*, *replyContent*, *repliedAt*, and *appVersion*. Field *fl* stores the data sequence, *reviewId* contains the review's unique identification in character sequence format, *userName* is the user's name or nickname, *userImage* is the user's image icon, *content* is the content of the review, the *score* is the rating number by the user ranging from 1

(unacceptable) to 5 (excellent), *thumbsUpCount* is the number of users who responded to the review whether it was useful or not, it can measure how many people liked or liked a piece of content, *reviewCreatedVersion* is the version of the application when the review was given, *at* is the date and time the review was written, *replyContent* is the response given to a review, *repliedAt* is the date and time of the response, and *appVersion* is the version when the response was received. Because this research focuses on reviews that will be processed using the NLP approach, the researcher only used the content field.

3.3. Data Preparation

Before the data is processed in modeling, the data is first cleaned into a better form than its original form so that it can be used in machine learning algorithms. This process aims to remove noise, homogenize word forms, and reduce word volume. This research data only uses review data from 2022 to 2023, namely 57,037 reviews. The stages carried out on the data consist of:

- *Filtering*, considering that for topic modeling needs, only takes reviews that have a minimum length of 30 characters, this is done because reviews that are too short cannot provide maximum meaning, especially for modeling topics.
- *Labeling*, giving each review data a neutral, positive, or negative label value.
- *Cleaning*, cleaning the review of words that are not needed to reduce noise in the classification process. Words that need to be removed include HTML tags, keywords, emotion icons, hashtags (#), usernames, URLs, and emails.
- *Case folding*, homogenizes letters and eliminates punctuation. In this case, it only accepts Latin letters between a to z.
- *Parsing*, breaking down reviews into words by analyzing groups of words by separating words and determining the syntactic structure of each word.
- *Tokenization*, separating sentences into meaningful parts and identifying individual entities within sentences.
- *Stemming*, finding the root of a word by removing affixes in a word. The aim of applying stemming in this research is to improve performance and reduce system resource usage by reducing the number of unique words that must be accommodated by the system.

After carrying out these stages, the final data that is ready to be used as a model in this research is 25,901 reviews.

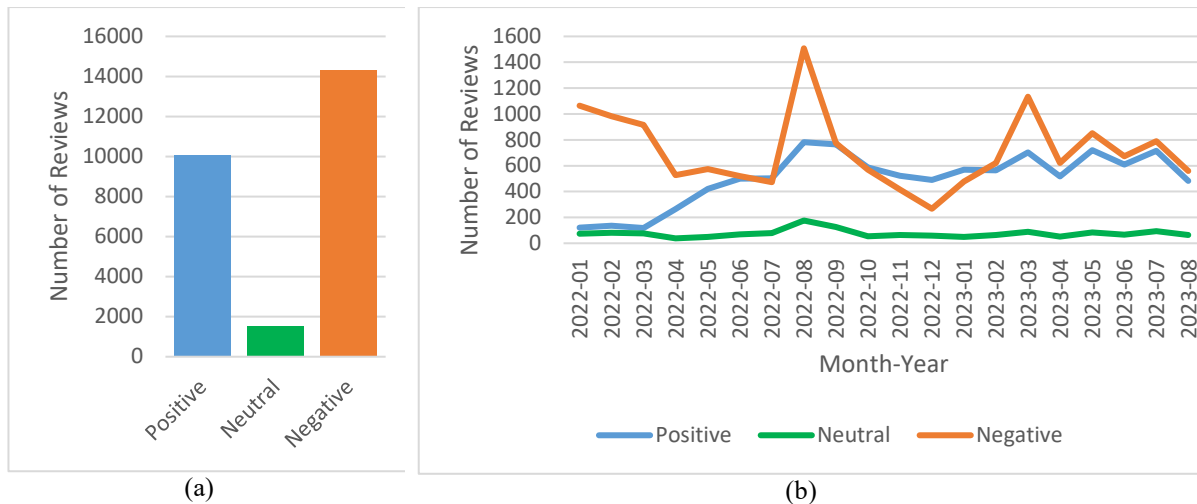
3.4. Modeling

Many NLP methods can be used to classify public reviews and social media content. However, this research uses the *Random Forest Classifier* method to classify review data. This method was chosen because the *Random Forest Classifier* (Binsar & Mauritsius, 2020b) is the best method with the best value for the confusion matrix for all labels used. Sentiment is assessed based on 3 categories, namely positive, negative, and neutral. Positive review sentiment indicates that the review has words that contain more positive meaning. Negative sentiment indicates that the sentence contains more words with negative meaning. Meanwhile, neutral sentiment indicates that the review has the same number of positive words as the number of negative words.

4. Results

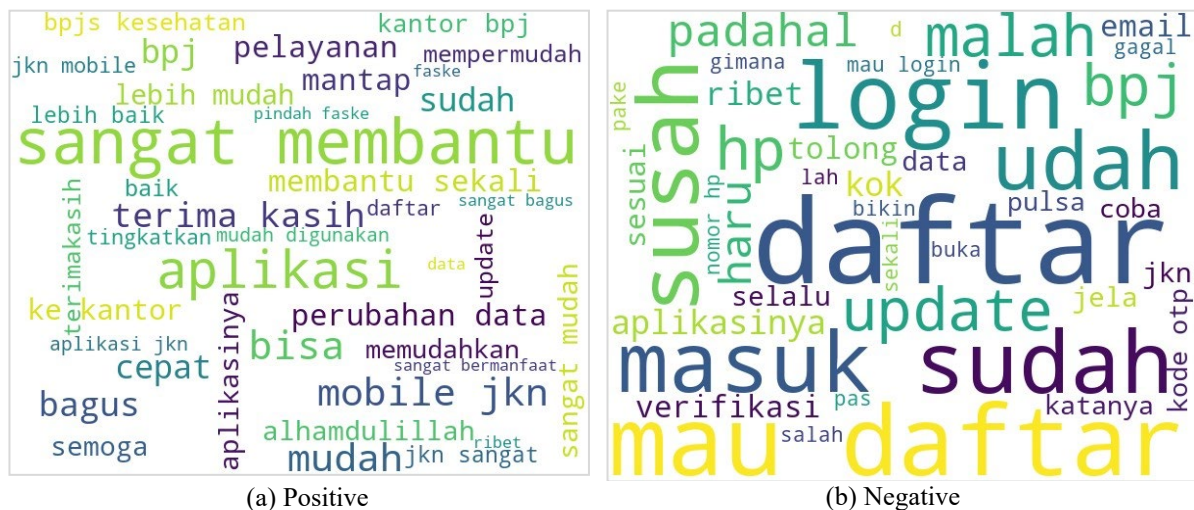
4.1. Sentiment Analysis

By using a training model of 70% of the total review data, and the remaining 30% is used to test the model, sentiment classification is obtained using the *Random Forest Classifier* as shown in Figure 3.



The classification results in Figure (a) show that the total number of negative sentiments is greater than positive sentiments, namely 14,312 reviews. Negative sentiment was 10,081, while neutral sentiment had the smallest number, namely only 1,508 reviews. The number of sentiment classifications is also consistent based on time history, from the beginning of 2022 to 2023 showing the highest number of negative sentiments. However, the number of positive sentiments reached its highest figure in the period October 2022 to February 2023.

Positive sentiment often occurs due to the frequent appearance of the words “*sangat membantu*”, “*pelayanan*”, “*perubahan data*”, “*mudah*”, and “*mantap*”, as shown by the word cloud visualization in Figure 4. The large number of occurrences of these words shows that users feel satisfied and very helpful with the application. The larger the font size of each word indicates the more often that word appears.



On the other hand, negative sentiment occurs with the appearance of words such as “*daftar*”, “*mau daftar*”, “*susah*”, “*login*”, and “*malah*”. The appearance of these words generally leads to difficulties in the registration process and it is still difficult to log in. The word size here is generally larger than positive sentiment words, which shows that words with negative sentiment appear more frequently.

Table 1 shows a snapshot of some of the most popular positive reviews among other reviews. The review content is taken directly from users who use Indonesian. Review popularity is taken from

thumbsUpCount count information.

Positive reviews contain messages of support and user satisfaction with utilizing digital applications. Digital applications are very helpful in making administration easier and getting other up-to-date information without having to go directly to the BPJS office. Digital applications are felt to be useful for users who have long distances to BPJS and health service facilities. Each review is also followed by information on the number of users who agree. Only 1 review with the number of other user endorsements is above 100, the others are below 100.

Table 2 shows a summary of some negative reviews, the number of popularities, and the date the review was created.

In general, negative reviews contain messages about frequent error messages, requests to update the application, and information that is inaccurate and does not match expectations. This shows that technical aspects have not been fulfilled properly, and deficiencies in terms of features and data presentation. In this review, no one discusses the shortcomings of the flow and management side of the service. Each negative review has a large number of support from other users, the number of user support reaches more than 200.

Table 1: Positive reviews

No	Content	at	thumbsUpCount
1.	Sekarang aplikasi bpjs sudah sangat puas, tidak lelet seperti dulu, dan tidak bertele2 seperti dulu prosedur dan mekanisme nya, sbg contoh ketika ingin berpindah paskes, atau tambah/hapus anggota. Bisa kapan dan dimana saja. Goodjob!!!	2022-11-09 21:30:28.000	154
2.	buat saat ini aplikasinya berguna, infonya juga jelas & transparan.	2023-03-02 14:05:29.000	53
3.	semoga pengaktifan keanggotaan lagi, perubahan segmen peserta bisa cepat tersedia dan all in one semua yang berkaitan dengan bpjs kesehatan bisa diurus di aplikasi ini	2022-05-26 10:19:45.000	37
4.	Sekarang apk ini sudah lebih mudah untuk update data. Tp faskes masih ada aja yg bilang bahwa sejak perubahan data masih harus nunggu 1 bulan setelah update. Sedangkan di apk sudah ada pemberitahuan tanggal mulai berlaku faskes yg baru (yaitu tgl 1 bulan	2022-08-25 11:42:15.000	31
5.	Terima kasih.. Wa Pandawa direspon sangat cepat.. Dan aplikasi mobile JKn juga sudah mudah diakses kembali..	2022-04-04 03:12:46.000	29

Table 2: Negative reviews

No	Content	at	thumbsUpCount
1.	Mau daftar aja dipersulit. Sudah sesuai mengikuti langkah pendaftaran, malah stuck di laman pengisian no hp/email yang padahal sudah jelas-jelas isi dengan benar malah keluar tulisan salah mulu... Tekan no hp/email apabila lupa ma....	2022-04-05 19:03:40.000	654
2.	Paling sering minta update, sekarang setelah diupdate malah banyak fitur yg terkunci, mana yg terkunci malah fitur yg paling sering dipake pula. Kartu peserta juga ga bisa dibuka. Kalo semuanya dikunci begini trus aplikasi gunanya bu...	2022-08-26 16:02:51.000	618
3.	Faskes tidak bisa di search, dan yang ditampilkan hanya sesuai gps, lha kalau kita dikantor mau ubah faskes yang ditampilkan yg dekat dengan kantor, cari dekat rumah tidak muncul. Mohon diperbaiki lagi. Kalau sudah update, bintangnya akan update. Thanx	2022-12-28 08:40:56.000	511

4.	Hallo Mobile Jkn, saya sudah berkali ² daftar saat input no HP tidak pernah ada kode OTP masuk, sampai saya pakai no HP satu lagi padahal ada pulsa semua tapi ada note : pulsa tidak mencukupi. Tlg ditindak lanjuti sistemnya agar dapat dipergunakan sesuai d	2023-05-27 17:28:16.000	217
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By comparing the reasons in Table 1 and Table 2, it can be seen that negative reviews receive more approval from other users, reaching numbers above 200. This shows the high level of concern of users to get better service and application conditions.

In contrast to positive reviews which generally only contain support information and expressions of satisfaction, no information can be used as feedback for applications or services. However, negative reviews provide a lot of information in the form of suggestions and real conditions that occur. The suggestions given are valuable input for BPJS to improve the digital application and increase its benefits.

4.2. Popularity Trends

First of all, we examined an overview of the search popularity trends for the two keywords "*JKN Mobile*" and "*BPJS Kesehatan Online*" via the Google search engine from 2022 to the present as shown in Figure 5. There was a sharp decline in mid-April 2023 for both keywords. In this period, information spread about the elimination of classes 1, 2, and 3 in BPJS membership and changing to Standard Inpatient Class (KRIS) (CNBC Indonesia, 2023). This change in Government policy was followed by a new tariff adjustment. This policy with an impact on rates seems to reduce the interest of BPJS participants in accessing BPJS services, including searching on online search engines such as Google. This condition returned to normal in May when the government began to reduce BPJS participation rates again, the excess contributions that had been paid by JKN-KIS participants in April, would be compensated for contributions in the following month (Berita Depok, 2023; Kompas, 2023).

Then analyze any queries related to "*JKN Mobile*" on Google Trends as shown in Figure 6. Here it can be seen that searches are generally carried out to obtain information about registration, membership status, and application login. The trend in search popularity on average has not been different in the last 2 years and since 2016. Historically, the development cycle of a digital application for public services does not require a very long time. On the other hand, the popularity trend does not show the emergence of new keywords, the emergence of new keywords is expected with the emergence of several new service modules in the application. The only keywords related to the service module are "*how to register*", "*don't log in*", and "*check BPJS*". All of these keywords are very basic in a service module. Thus it can be concluded that since the application was published in 2016 and even in the last two years there has been no development of services in digital adoption, even though in real implementation in the field many new things and services were discovered.

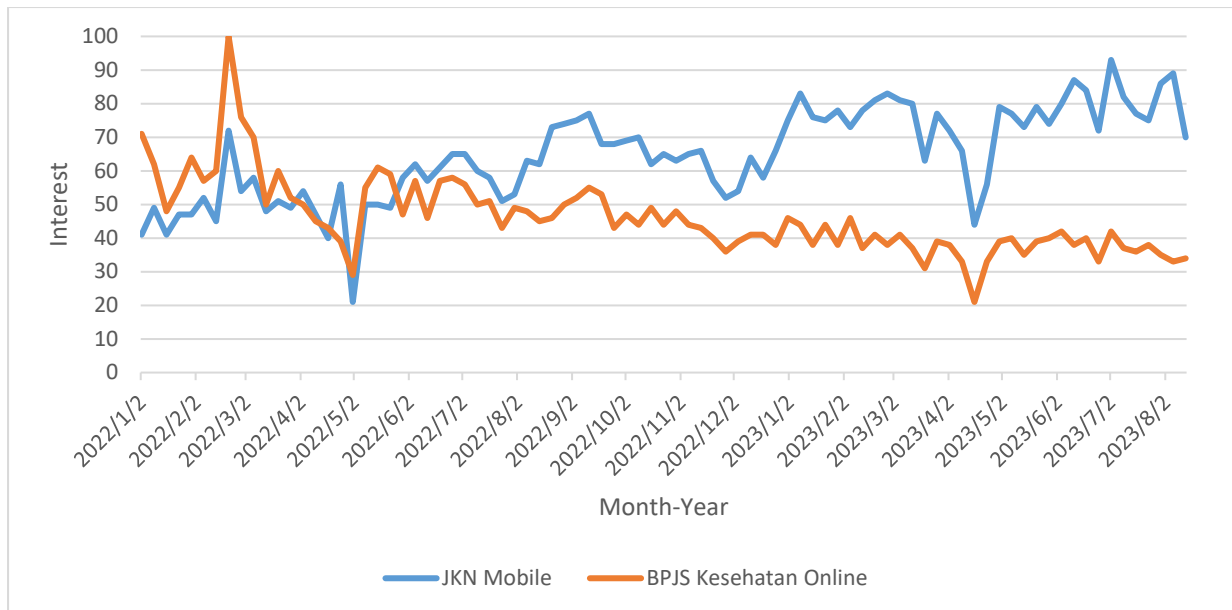


Fig 5: Google Search Interest Trends Since 2022

Since the COVID-19 pandemic hit the world and Indonesia in particular, there have been a lot of regulations related to social distancing protocols and online consultation services such as telemedicine or telehealth, so keywords related to post-COVID-19 services should also appear in this search trend.

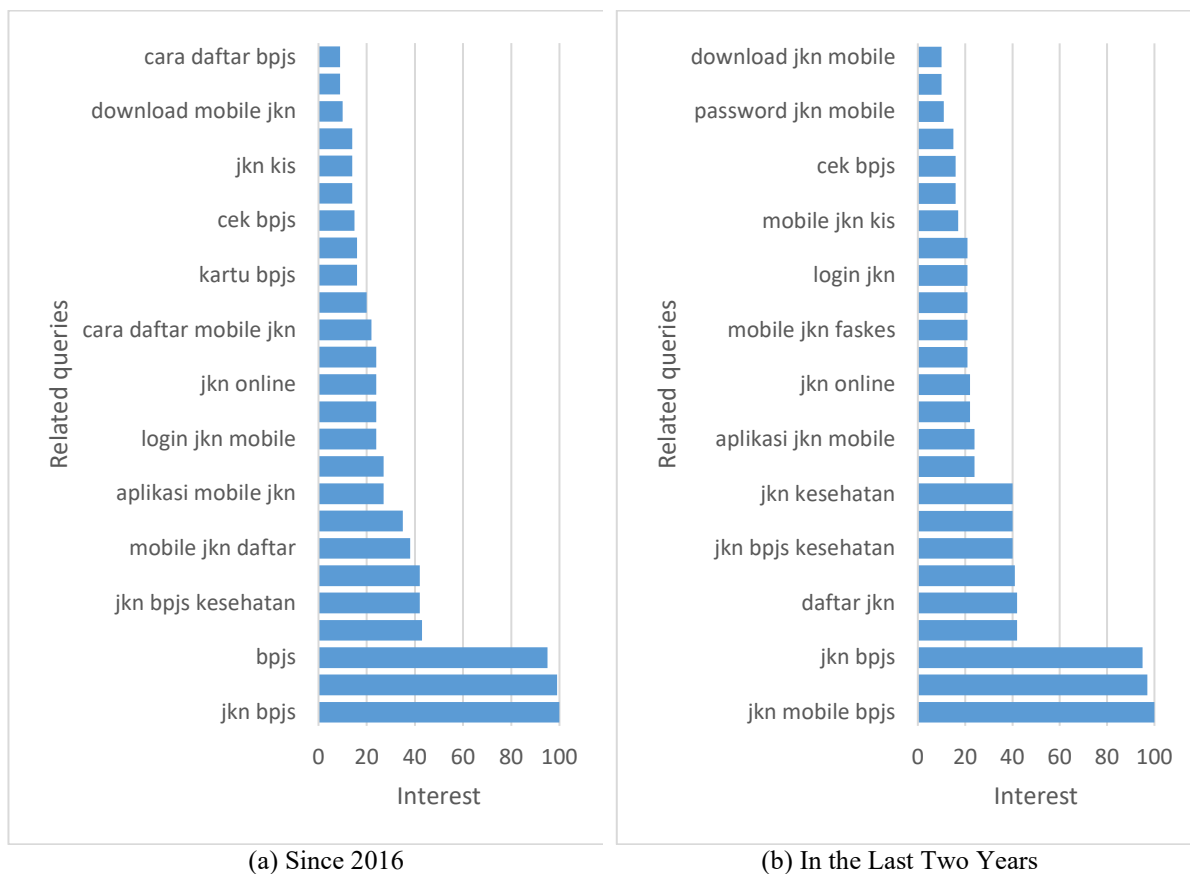


Fig 6: Most related queries of JKN Mobile

Next, an analysis of any queries related to "BPJS Kesehatan Online" in Google Trends is shown in

Figure 7. In general, the search trend is almost the same as the first, where search keywords are generally carried out to obtain information about how to register and check membership status. There is the emergence of a new keyword, namely "*antrian*", and it was only found in the last two years with minimal numbers. This keyword was not found for the search period since 2016, because the number of searches was still too low compared to other keywords. This happened as a result of the government's post-COVID-19 policy to run online queues for participants so that there was no accumulation of patients in hospitals (tempo.co, 2022). In this application, patients are also given information about the doctor's service hours, which allows patients to come at that time without having to come too early (DetikFinance, 2022).

These trends reflect the various ways in which the scope of digital content is delivered to the public through digital platforms. The limited variations in keywords that appear here are greatly influenced by the limited scope of digital services provided through the application. Technological innovation continues to shape the evolution of digital services, while changes in consumer lifestyles and habits also play an important role in driving this trend.

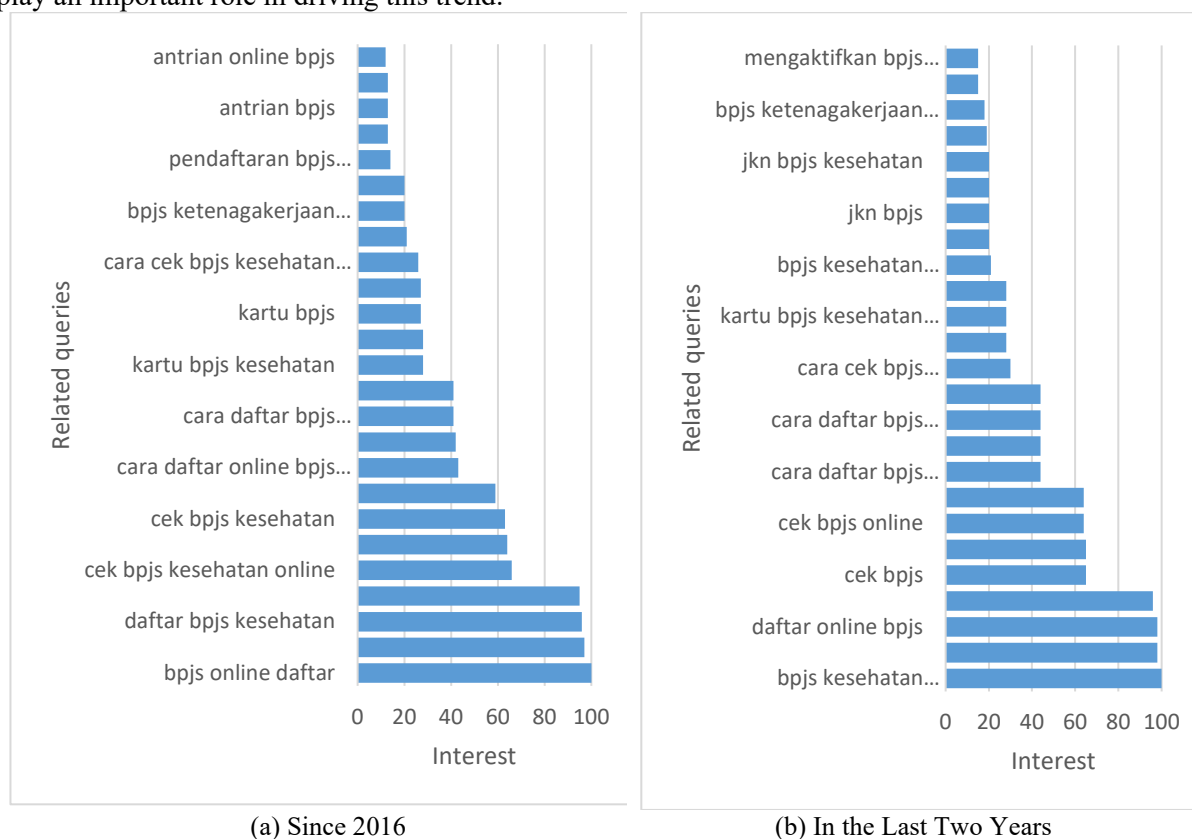


Fig 7: Most related queries of BPJS Kesehatan Online

5. Discussions

Positive reviews generally only contain support information and expressions of satisfaction, no information can be used as feedback for the application or service. Positive reviews have a very positive impact on a business and can help build good relationships with customers. However, businesses must also always strive to maintain and improve the quality of their products or services so that positive reviews continue to flow. Positive reviews help increase consumer confidence in the products or services offered by the service provider. When potential customers see that others have had positive experiences, they are more likely to trust and choose the service. This will certainly help build a better reputation for service providers. A good reputation can attract more customers and keep the service

running well.

On the other hand, positive reviews can provide valuable feedback to a service about what they are doing well, helping service providers to understand the areas in which they have been successful so they can maintain them. This can help service providers to understand what customers like and to maintain the quality of their products or services. Businesses or services with lots of positive reviews tend to have a competitive advantage in their services. This can help win market share, competing better than its competitors.

Meanwhile, negative reviews provide more information in the form of suggestions and real conditions that occurred. The suggestions provided are valuable input for BPJS as a service provider to improve digital applications and increase their benefits. So the collaboration of these two review sentiments helps BPJS in providing and improving digital-based services to the community. Although sometimes considered unprofitable, it can have many benefits, especially for public services. Negative reviews can provide a deeper understanding of customer preferences and expectations and can help a business identify problems or deficiencies in its app product, service, or customer experience. Negative reviews can also give potential customers a different perspective. They help potential customers understand that not every experience will be perfect, and this can provide better context when making a decision. Therefore, it is important to handle negative reviews in a professional way and in a way that improves the business's image. Because it shows that the business treats customers with respect and seriously takes responsibility for any problems that arise. When businesses use negative feedback to continually develop their products or services, it gives them a competitive advantage. Businesses that listen to customers and respond to their feedback tend to be more successful in the long run.

The findings of this study also strengthen the results of Colmekcioglu's findings (Colmekcioglu, Marvi, Foroudi, & Okumus, 2022) using the integration of text mining and co-citation analysis, finding that companies' responses to negative online reviews cannot be analyzed without understanding the role of customers. Therefore, this research yields insights into customers and companies at each stage of negative online reviews, providing a conceptual framework that synthesizes previous literature and highlights the most important research gaps that require attention.

The combination of positive and negative sentiment certainly provides very valuable input for businesses where the existence of the JKN Mobile application is very helpful and provides many conveniences for users. By developments and conditions of use in the field, input and suggestions from users become input for improvements to the application to make it easier to operate.

Ideally, trends in the popularity of public services change over time and are influenced by various factors including technological developments, social changes, and community needs. The findings of this case study show that there has been no change in popularity trends since the digital application was first published. The two keywords used "*JKN Mobile*" and "*BPJS Kesehatan Online*" which contain two important words in digital technology, namely "*mobile*" and "*online*", should make it possible for the latest technology terms to appear in the "*related queries*" section. Among the "*related queries*" are expected to contain terms such as "*artificial intelligence*", "*chatbot*", "*telemedicine*", and "*telehealth*" to support better public service activities. This shows that service modules related to these terms have not been facilitated in digital applications. This is also caused by the lack of transparency in service delivery in terms of data and information on JKN implementation as well as the centralized nature of governance. Transparency and accountability in the Indonesian health system are still weak, although the transition to democratization and decentralization seeks to increase the accountability of public sector services to the community (Mahendradhata et al., 2017).

The findings of this research are in line with and support previous literature where the use of popularity trends can have a major impact on the public service sector, including business, marketing, and strategic decision-making. Understanding these trends can help service providers and individuals follow or even exploit them to achieve desired goals. However, there are limitations in the emergence of variations in keywords which are influenced by the limited scope of digital services provided through

applications from time to time, indicating that more innovation is needed to be able to develop in line with the times and the development of society's needs.

6. Conclusion

This study fulfills its aims to assess digital adoption capability in Indonesian public healthcare services by analyzing online reviews and popularity trends. The findings reveal predominantly negative user reviews expressing technical and informational deficiencies of the JKN mobile app. Review topics centered on basic functions without reflecting new services. Search popularity trends also showed minimal variation over time, signaling stagnant digital development. The study demonstrates the value of mining online big data to monitor and evaluate public service performance. User reviews provide candid public feedback to identify successes, problems, and areas for improvement. Tracking search trends offers insights into changing societal interests and needs. This novel empirical approach contributes actionable knowledge for public service providers to boost quality, transparency, and accountability.

Theoretically, the study expands our understanding of how big data analytics techniques can be applied to assess and inform public service delivery. For practice, it provides a replicable framework for governance agencies to harness online data for assessing and informing digital transformation. Future research should examine other public services, reviews in local languages, and additional analytical methods. Overall, this timely study highlights the potential of online user data to support more responsive, citizen-centric public services that better meet societal needs and expectations.

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