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Evaluation of Indonesia's police public service platforms through sentiment and thematic analysis

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ABSTRACT

The Indonesian national police (Polri) offer public services through mobile apps: *Digital korlantas polri (DigiKorlantas)* and samsat digital nasional (SIGNAL). Sentiment analysis gauges public perceptions, serving as a basis for e-government evaluation using user ratings and comments from app stores. Keyword relevance is assessed via feature extraction and Naïve Bayes classification. Thematic analysis is implemented using N-grams methods to identify the factors affecting the effectiveness based on user experiences. The accuracy of the model reaches 81.09% where it indicates a high performance. DigiKorlantas acquires slightly more negative reviews in comparation with positive reviews which are 51% and 49% respectively. In contrast, positive sentiment is dominant on SIGNAL which reach 58%, compared with negative sentiment that in 42%. N-grams reveal similar review patterns for both apps. Some of the solutions are *Korlantas Polri* should enhance the verification functionality with several techniques such as retinex algorithms or optical character recognition pipeline and increase the capacity of supporting server then releasing an updated version of application to address errors or bugs. This analysis can be alternative evaluation by the Polri to measure the success of the application and find out the continuous improvement of the process and the system.

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1. INTRODUCTION

Law No. 25 of 2009 [1], serves as Indonesia's primary legal framework for public services, emphasizing the provision of goods, services, and administrative assistance to citizens and residents. Article 23 highlights the need for a national information system to ensure accessible information. This aligns with President Regulation No. 95 of 2018 [2], which underscores the establishment of e-services to enhance government performance and accountability. The application's purpose is to expedite public service processes, aiming to foster good governance and a corruption-free administration. The concept of good governance, advocated by the United Nations since the late 1980s, guides decision-making and program implementation. It aims to prevent corruption, address minority voices, and meet societal needs [3].

One of the main duties of *Kepolisian Negara Republik Indonesia* or The Indonesian National Police well known as Polri, is to administer all necessary action to ensure the safety and order traffic on the street, including authorized to issue driving license for the citizen [4]. Polri has an execution unit which focus and accountable to maintain the safety and order traffic on the street, namely *Korlantas Polri*. One of the main duty

is to perform administration and identification of driver and vehicle in Indonesia [5]. They have launched two applications to facilitate public access to their services. The first app, *Digital Korlantas Polri* (DigiKorlantas), primarily focuses on issuing and extending driving licenses. The entire administrative process, including document submission and theoretical exams, can be completed within the app. However, practical exams still require a visit to the police office [6]. On the other hand, the second app, *Samsat Digital Nasional* (SIGNAL), streamlines the secure payment of vehicle taxes for citizens. This app utilizes Polri's vehicle database, links with the Ministry of Home Affairs' citizenship database, and integrates with provincial governments' vehicle tax information systems [7].

According to the provisions in Law No. 25 of 2009 [1], organizations are required to conduct assessments for the purpose of continuous enhancement of their services. In the context of the developed application, regular monitoring and evaluation are crucial, ensuring that updates are consistently implemented. However, the regulation does not clearly state the evaluation methodology. The evaluation process should involve end users to determine whether the public service applications effectively fulfill requirements and align with user anticipations [8]. Verma suggested that enhancing e-government public service management could be achieved through techniques such as sentiment analysis, opinion mining, and text analytics [9].

Sentiment analysis is described as computational study which explore the opinion, sentiment, impression, perception and feeling towards entities such as products and services. Sentiment analysis is used to understand and explain the feeling of the public about particular entity to generate actionable knowledge [10]. Individuals commonly share their viewpoints using diverse forms of evaluative expressions on social networks and application platforms [11]–[13]. Chagas [14] mentioned that sentiment analysis plays an essential role in allowing business to enhance their strategy and derive insight of the feedback from their customer about their products. Sentiment analysis is a versatile tool that operates at different levels - word, sentence, paragraph, and document. It employs various techniques like machine learning, semantic approach, and hybrid approach within the data mining process to analyze sentiments [15].

To determine the appropriate method for this study, a comparison was made among several existing research efforts. One study [16] extensively examined sentiment analysis and categorized commonly used classification techniques. It concluded that the supervised machine learning approach, particularly Naïve Bayes, is optimal due to its ease of use and high accuracy, though it is sensitive to data scarcity. In a separate study [17], the sentiment of the public towards a COVID-19 handling application was analyzed using the Naive-Bayes and support vector machine methods. The research aimed to categorize sentiments from (*Pusat Informasi dan Koordinasi COVID-19 Jawa Barat* or Center for COVID-19 Information and Coordination in West Java) reviews to inform effective communication and policy decisions. After data preprocessing, sentiment analysis was performed using Naive-Bayes and support vector machine classifiers (SVM), with Naive-Bayes achieving a higher accuracy rate of 75.67% compared to SVM 71.62%. Another study [18] focused on assessing the recommended repetition of k-fold cross-validation for obtaining reliable accuracy estimates. This study utilized 2, 5, and 10 folds and compared Naïve Bayes and support vector machine classifiers. The results indicated that when the conditions are met, 10-fold cross-validation should be performed only once for each fold, suggesting that multiple repetitions are suitable for small values of k.

Numerous studies in sentiment analysis have gathered data from Google Play Store reviews and employed the Naïve Bayes method. For instance, a study [11] examined sentiment analysis of Indonesia's peer-to-peer (P2P) fintech platforms to understand user feedback during the COVID-19 pandemic. Reviews from Google Play Store were processed using data mining, term frequency - inverse document frequency (TF-IDF) feature extraction, and the Naïve Bayes classification method. Results indicated that P2P platform A received 77% positive sentiment, while other platforms received comparatively lower positive sentiment. Positive reviews were prevalent in topics related to finance, account verification, app reviews, and referrals. According to [19], [20] TF-IDF is employed to evaluate the relationships between words within a set of documents, aiming to extract key terms and gauge similarities among the documents. TF denotes the frequency of a particular word in the documents, with its value reflecting the word's significance.

Summarizing the previous researches related to classifier method for sentiment analysis [11], [16]–[22], Naïve Bayes demonstrated the highest prediction accuracy among other methods. The models also have more simple algorithms. Keyword relevance can be assessed using feature extraction, such as TF-IDF, before applying the Naïve Bayes classification technique to optimize the accuracy. Then, the model accuracy can be verified through the utilization of 10-fold cross-validation. To get more insight, content analysis like thematic analysis is needed to find the highlight both the positive and negative sentiment [23]. Thematic analysis will help to deep dive the benefits and challenges on those sentiment results.

Based on these characteristics, sentiment analysis can be used to evaluate the effectiveness of Polri applications for continuous improvement [24]. This method is well-suited as it considers public opinions and experiences, supporting good governance. Notably, there's been no prior discussion on evaluating these applications using sentiment analysis from the public's standpoint. Therefore, this method research will focus on discussing the enhancement of both Polri applications through sentiment analysis and optimization of data

pre-processing. The public's perception of the Polri public services application on App Store and Play Store is partially evident through ratings, yet these ratings may not accurately represent the true sentiment due to potential spam and limitations [25]. Hence, below research questions are constructed on this research.
RQ1. How is the public sentiment of two public service applications performance released by Polri?
RQ2. How to improve public satisfaction towards public service applications based on application effectiveness factors by thematic analysis?

This research aims to identify two public service applications released by Polri based on user reviews on App Store and Google Play Store, to analyze the public sentiment on e-government platforms issued by Polri and to provide recommendations of future enhancement on the public service applications. It can serve as a model for evaluating government-issued public service applications, involving a broader user perspective as the state of the art of this research. Furthermore, this approach could potentially be extended to diverse public service applications, offering governmental authorities' guidance in effecting ongoing enhancements aligned with Indonesia's current regulation framework.

2. METHOD

Several tools were utilized in this research. The data was collected and sampled using library on Python programming through Google Colab. The data cleansing and labeling was done manually on Google Sheet. Meanwhile, the preprocessing and modeling was executed by Rapidminer, including evaluation model process. The model execution was running repeatedly until found the acceptable accuration. Last process, thematic analysis using N-grams was analyzed through library on Python programming. This research is conducted through several stages as discussed below. Figure 1 demonstrates the complete research methodology processes.

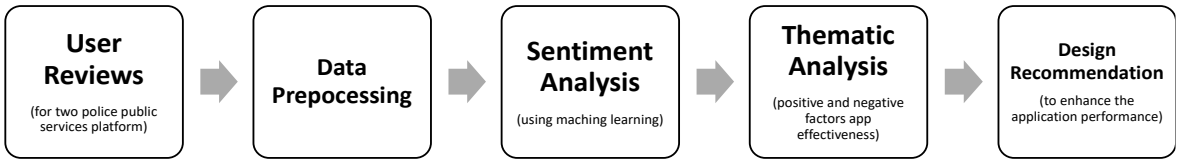

Figure 1. Research methodology

2.1. User reviews

User reviews of the Signal and DigiKorlantas applications on the Play Store and App Store are the primary data used in this research. Before conducting an analysis, user review data needs to go through a series of processes. The process begins with data collection and continues through data cleaning. This stage consists of several steps, namely,

– Crawling data

This phase was used to data extraction and refers to collecting data. It was executed by using Google Play Reviews Scraper and App Store Scrapper on Phyton through Google Colab to extract all reviews with comments. The main object of this research consists of two public services applications: SIGNAL and DigiKorlantas. The data is obtained through assessment reviews on both platforms: Google Play Store and App Store. Referring to each application page on both platforms, Table 1 is the matrix of user reviews taken on November 23rd, 2022, 11:30 AM.

Table 1. Total of user reviews

Application/Platform	Google Play Store	App Store	Total Reviews
SIGNAL	5.671	850	6.521
Digital Korlantas Polri	9.082	1.257	10.355

– Preparing dataset

Dataset was prepared by translate English reviews into Bahasa and sampling some reviews. Random sampling with length of sample 391 (using error 5%) for both applications based on Slovin's Formula. The distribution of the amount of data for each application and platform will be proportioned according to the population. Table 2 describes the matrix of sample.

Table 2. Sample of review

Application/Platform	Google Play store	App Store	Total Samples
SIGNAL	139	24	163
Digital Korlantas Polri	204	24	228

– Data labelling

Data was labelled based on the rating submitted by users to determine its polarity. The reviews with rating 1 and 2 was labelled as negative sentiment and positive sentiment for rating 4 and 5. The reviews with rating '3' don't have any clear polarity between positive and negative sides. Therefore, it didn't use on modelling process.

2.2. Data preprocessing

Data preprocessing is a stage to convert raw data into a form that is easier to be processed by the system. In another study [26], it was deduced that text data preprocessing is an effective technique for cleansing and transforming unstructured data into organized and meaningful formats used four steps of data preprocessing to process the data as described below and Table 3 show the example of process.

– Case folding: process to fetch only string and convert string intolowercase.
– Tokenization: process to divide string into pieces (numbers, symbols, words, phrases).
– Stemming: process to remove prefix and suffix.
– Stopword removing: process to remove unimportant words.

Table 3. An example of preprocessed review

Description	Input	Output
Case Folding	"This application is very useful, but the application is lagging and hangs a lot, so I'm hesitant to use this application, in the end, manual queuing at the Samsat 😭 "	"this application is very useful, but the application is lagging and hangs a lot, so i hesitant to use this application, in the end, manual queuing at the samsat"
Tokenization	"this application is very useful, but the application is lagging and hangs a lot, so I hesitant to use this application, in the end, manual queuing at the samsat "	['this', ' application', 'is', 'very', 'useful', 'but', 'the', 'application', 'is', 'lagging', 'and', 'hangs', 'a', 'lot', 'so', 'i', 'hesitant', 'to', 'use', 'this', 'application', 'in', 'the', 'end', 'manual', 'queuing', 'at', 'the', 'samsat']
Stemming	['this', ' application', 'is', 'very', 'useful', 'but', 'the', 'application', 'is', 'lagging', 'and', 'hangs', 'a', 'lot', 'so', 'i', 'hesitant', 'to', 'use', 'this', 'application', 'in', 'the', 'end', 'manual', 'queuing', 'at', 'the', 'samsat']	['this', ' application', 'is', 'very', 'useful', 'but', 'the', 'application', 'is', 'lag', 'and', 'hang', 'a', 'lot', 'so', 'i', 'hesitant', 'to', 'use', 'this', 'application', 'in', 'the', 'end', 'manual', 'queue, 'at', 'the', 'samsat']
Stopword Removing	['this', ' application', 'is', 'very', 'use', 'but', 'the', 'application', 'is', 'lag', 'and', 'hang', 'a', 'lot', 'so', 'i', 'hesitant', 'to', 'use', 'this', 'application', 'in', 'the', 'end', 'manual', 'queue, 'at', 'the', 'samsat']	[' application', 'very', 'useful', 'application', 'lag', 'hang', 'hesitant', 'use', 'application', 'end', 'manual', 'queue, 'samsat']

Table 3 show the example of data processing result. After stopword removing, TF-IDF was implemented for getting better accuracy. The number of words that have gone through this preprocessing process were 6526 words from 391 opinons. Then, the process has produced 1158 different number of words.

2.3. Sentiment analysis

The Naïve Bayes model was built using Rapidminer tools for those words. *K*-fold cross validation is implemented on the testing set to acquire reliable accuracy estimates. As suggested by [18], 10-fold cross validation should be the first option to be applied for the large-sample conditions. Another paper [27] used *k*-fold and found result that with 10-fold validation method give accuracy 83% higher than average that only 73%. According on human baseline agreement, human analysis tend to agree around 80-85% of the time [28]. Then to reach that baseline agreement, 10-fold cross validation is performed on this study to get better accuracy. The model, derived from processed sample data, is then applied to the entire preprocessed dataset. The model's usability is verified through performance measurement. The model produces relevant data including true positives, true negatives, false positives, false negatives, and accuracy for a novel dataset [29]. The classification algorithm's performance is assessed using a confusion matrix, where 'True' or 'False' signifies accurate predictions, and 'Positive' or 'Negative' denotes the data class [30].

2.4. Thematic analysis

Thematic analysis using N-grams is performed to identify the various factors affecting the effectiveness of the applications in the positive and negative sides based on user's review [23]. N-grams was executed by natural language toolkit (NLTK) package on Python. This research used N-grams consist of two and three words for each application sentiment type to identify the problem. Unigrams is not performed as it could be interpreted to various extend and could not identify the factors affecting public's sentiment. All analyses are applied to text in Bahasa, while the visualizations presented have been translated into English.

2.5. Design recommendation

Improvement recommendations for both applications will be formulated based on the analysis results from N-grams. N-grams will map out the positive and negative factors influencing the effectiveness of application usage. Therefore, recommendations will be structured around these factors to support ongoing improvements for both applications, which can be carried out by the Korlantas Polri team.

3. RESULTS AND DISCUSSION

3.1. Sentiment classification

The model exhibits relatively strong performance, evident in its accuracy rate of 81.09%. Table 4 is the detailed of confusion matrix on sample data. Precision indicates the classifier's competence in a specific class; higher precision signifies improved prediction. From the results, precision stands at 82.49%, indicating 82.49% accuracy in identifying positive sentiment. Recall, on the other hand, depicts the classifier's ability to categorize data into specific classes based on actual positive instances, with the table revealing a recall value of 83.26% signifying correct identification of 83.26% actual positive reviews. When compared to previous studies, Naive Bayes' accuracy demonstrated variable outcomes: [27] reported 76%, [26] achieved 65.09%, and [31] obtained 72.06% accuracy, whereas our research's accuracy ia 81.09%, falling within the human baseline agreement range of 80%-85% [28].

Table 4. Confusion matrix of classification model

	True Positive	True Negative	Class Precision
Pred. Positive	179	38	82.49%
Pred. Negative	36	138	79.31%
Class recall	83.26%	78.41%	

Figure 2 displays the projected public sentiment results for both applications. The predictive analysis reveals noticeable variations in sentiment characteristics between the two applications. SIGNAL registers a higher positive sentiment at 58% from user comments, whereas DigiKorlantas's positive sentiment stands at 49%. Based on these figures, it can be inferred that SIGNAL provides a more satisfying user experience compared to DigiKorlantas. Futhermore, Figure 3 illustrates the app's performance across different platforms, examining potential distinctions in user satisfaction between Android and iOS smartphone users. This indicates that a greater number of iOS mobile users have negative sentiments towards both applications compared to Android mobile users. This suggests that Korlantas Polri, as the owner of the applications, should place a stronger focus on iOS-based app improvements.

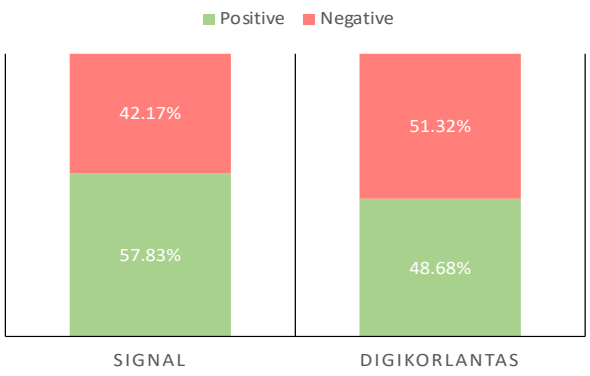

Figure 2. Percentage of SIGNAL and DigiKorlantas sentiment

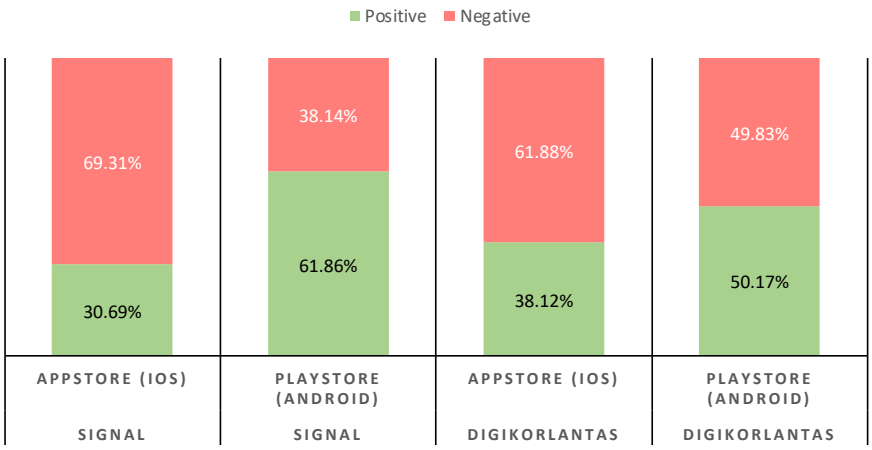

Figure 3. Percentage of SIGNAL and DigiKorlantas sentiment based on type of smartphone user

3.2. Factors affecting application effectiveness

Thematic analysis was conducted on positive and negative reviews to identify components that affecting the effectivity of application. N-grams analysis were performed on all application reviews both from App Store and Play Store, because the thematic analysis of comments indicated that each positive and negative factor for both applications from both types of smartphone users was consistent. Although the proportions of sentiment differ, the positive and negative factors remained identical.

3.2.1. Digital Korlantas application

Figure 4 illustrates the distribution of positive theme's appearances on all user reviews of DigiKorlantas application presented in a treemap format. It is shown that 'renewal', 'license' which mean 'driver's license renewal' appears the most which nearly reaches 1,000 times. While 'thank you' is on second place which appears 549 times and 'easy', 'fast' which mean 'easy and fast' is on third position which shows 189 times. In general, these terms are correlated with the goal of the app to ease the public to extend their driving license seamlessly.

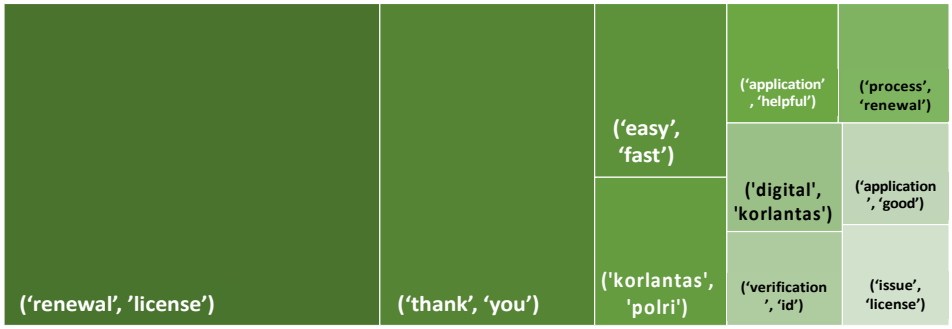

Figure 4. Treemap of bigrams analysis for positive factors of DigiKorlantas application

As shown on Figure 5, trigrams analysis is reflected similar patterns as bigrams analysis for the positive theme of DigiKorlantas. The review of 'renewal', 'license', 'online' which mean 'online driver's license renewal' is submitted the most on the positive side. 'Thank you, korlantas' reflects public's gratitude to the institution, for providing useful application to process the extension of driving license without any requirement to present at the police station. This also aligns with the findings of other trigrams like 'helpful, thank you' and 'assisting in the driver's license renewal', indicating that this application has been quite helpful due to its streamlined process.

Negative factor of DigiKorlantas application is shown in Figure 6 in bigrams on treemap format. Interestingly, it has the similar result that 'renewal', 'license' or 'driver's license renewal' appears the most as in the positive theme. 'verification', 'id' or 'Identity card verification' is commonly reviewed by the user which indicates some issues faces by the users during verification step of the identification card. 'Otp code' and

'verification', 'face' or 'face recognition' imply that users might don't receive the OTP code and failed on face recognition.

The result of trigrams analysis is displayed on Figure 7, where 'verification', 'id', 'fail' or 'Identity card verification failed' appears 732 times as the most common theme on the negative topic. 'e', 'id', 'fail' or 'identity card electronic failed' is also on the third position. It strengthens our analysis on the bigrams analysis that users face a lot of errors during the verification step of national identification card. Besides that, users had some issues on face recognition which indicates by 'verification', 'face', 'fail' or 'face verification failed' and times out issues from server side. Some improvements are needed related to that verification features to improve public's satisfactions.

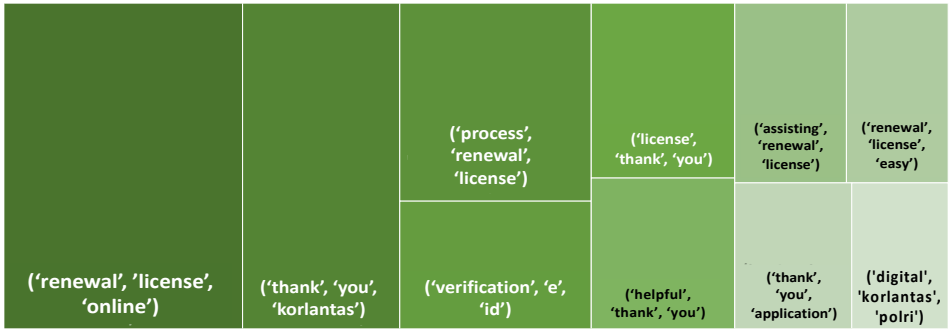

Figure 5. Treemap of trigrams analysis for positive factors of DigiKorlantas application

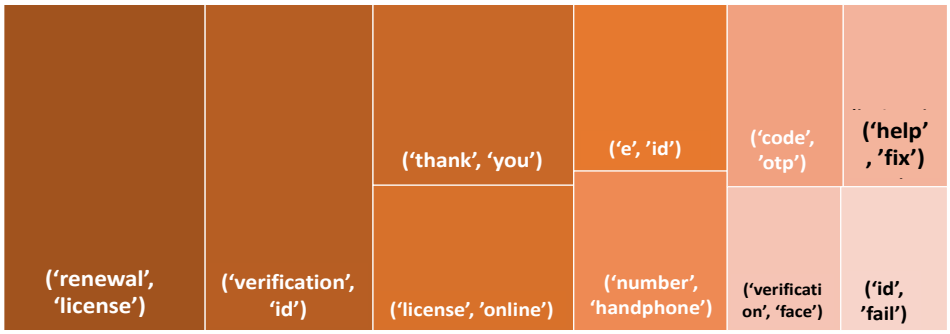

Figure 6. Treemap of bigrams analysis for negative factors of DigiKorlantas application

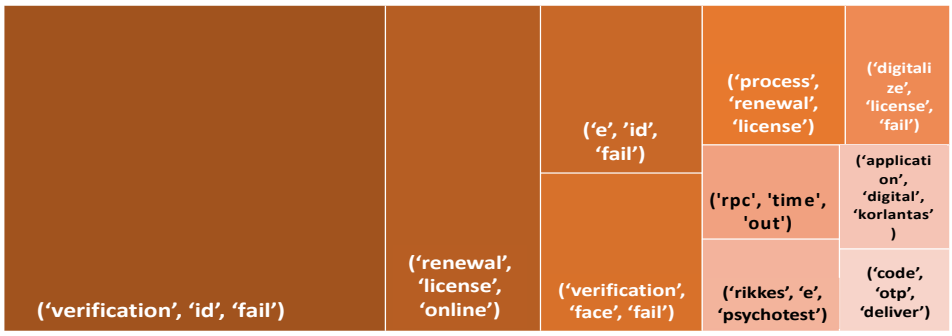

Figure 7. Treemap of trigrams analysis for negative factors of DigiKorlantas application

3.2.2. SIGNAL application

A thematic analysis employing bigrams is conducted to explore the positive themes within the SIGNAL app, as depicted in the treemap presented in Figure 8. 'pay tax' shows up the most which reaches 533 times in total reviews. 'thank you', 'easy and fast', 'helpful application', 'good application', and 'fast process'

are commonly displayed on the user's review for the positive theme. It can be concluded that users feel grateful of the feature developed on the app and they realize the benefit of using SIGNAL application to pay the vehicle taxes. The public also perceive that the application is useful through its ability to process the delivery of legal documents directly to home, indicated by the bigrams 'deliver, home' which mean 'delivered to the home' in the 10th position.

Trigram analysis is presented in Figure 9, where 'pay', 'tax', 'vehicle' or 'vehicle tax payment' appears as the most frequently displayed comment, totaling 163 occurrences. SIGNAL app users appreciate the Korlantas Porli's efforts in releasing an e-government application to streamline the tax payment process, as evidenced by the numerous positive themes that emerged: 'helpful, thank you', 'thank you application', and 'facilitate payment tax' which can be described as 'simplify tax payment'.

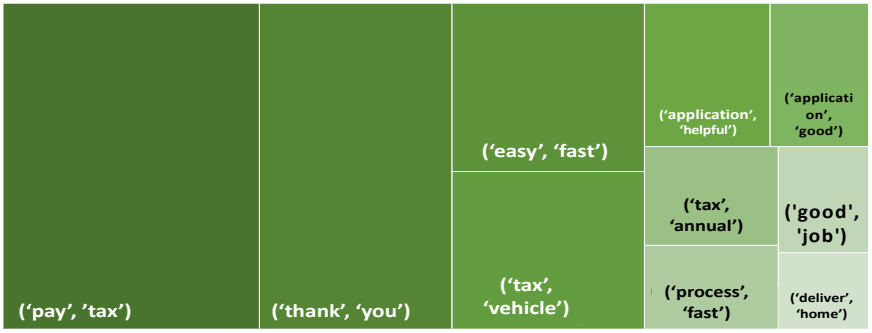

Figure 8. Treemap of bigrams analysis for positive factors of SIGNAL application

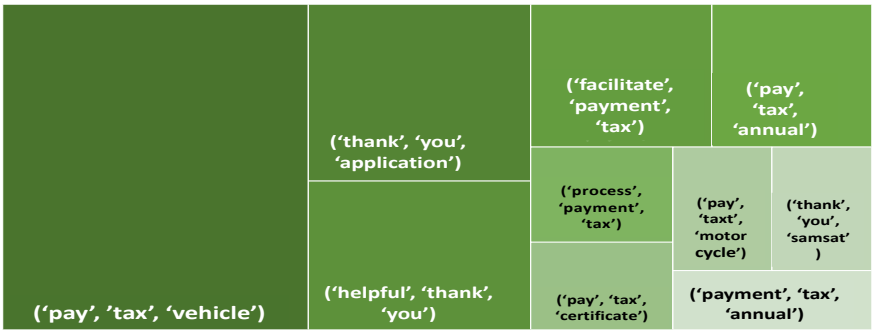

Figure 9. Treemap of trigrams analysis for positive factors of SIGNAL application

Apart of positive reviews, SIGNAL application has significant negative feedback from the users which illustrates by Figures 10 and 11. Bigrams analysis on Figure 10 shows that users have some issues on 'photo', 'id' or 'identity photo', 'face verification' and 'verification failed'. It means that multiple verification failures faced by the users during identity identification and face recognition phases. Furthermore, negative theme of SIGNAL application through trigrams analysis as shown on Figure 11. It has similar patterns as bigrams analysis that users found errors during face and id card verifications as well as during capturing process. This conclusion is based on the most appears theme which are: 'verification of ID photo', 'face verification failed', 'photo verification failed', 'failed ID photo', and 'ID verification failed'. These findings can initiate another process of providing design recommendation to resolve some issues identified by users based on these negative themes.

3.2.3. Recommendation

The causative factor that influencing users to give positive or negative reviews were uncovered in this research. Those reviews are basis of recommendation for the evaluation both for the business process and the applications. N-grams play a crucial role in facilitating this analysis, ensuring the visibility of recommendations for both processes and applications. The procedural aspects pertain to Korlantas Polri's responsibility for these public services, while the application-related aspects involve the developer team accountable for system enhancements.

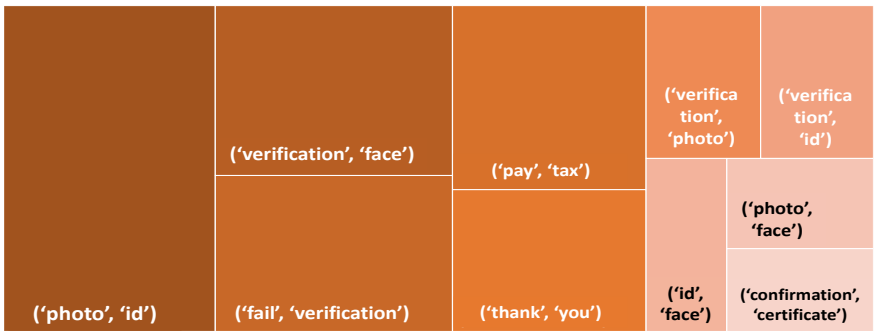

Figure 10. Treemap of bigrams analysis for negative factors of SIGNAL application

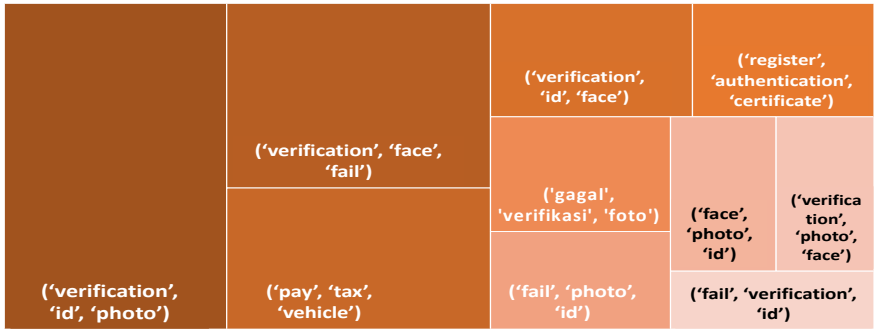

Figure 11. Treemap of trigrams analysis for negative factors of SIGNAL application

Several factors contributing to positive user reviews for both applications include their beneficial features, high application quality, expedited processes, and simplified driver's license renewal for DigiKorlantas, as well as the ease of paying vehicle taxes through the SIGNAL app. Most positive reviews highlight the improved service processes, indicating that Korlantas Polri's initiatives are yielding the intended outcomes. On the negative review, several factors that cause user to provide review for the two apps have some similarities, especially regarding features and system failure. Korlantas Polri must work closely with the developer's team to address this problem. User has trouble to verify identity card, failed face verification, encounter a server time out and request to fix the application. The developer's team can enhance the verify identity feature with several technique such as retinex algorithm [32], [33] and an end-to-end optical character recognition pipeline [34] to improve service quality of their e-government platform. Retinex Algorithms is built for Chinese citizens with 96.50% recognition accuracy of the identity card. While the optical character recognition pipeline is built for Indonesian Identity Card by combine the image processing and deep learning approaches in 93.6% accuracy on 16 digits identity number recognition. To improve face verification feature, convolutional neural network (CNN) framework is popular technique and effective method to use by the developer's team [35].

Furthermore, to assist the advancement of the development team, Korlantas Polri should enhance the capacity of the supporting server and encourage the release of updated application versions to rectify glitches or issues. Moreover, certain users expressed dissatisfaction with the driver's license renewal process at DigiKorlantas, which necessitates the utilization of two additional applications, namely e-Rikkes and ePPsi, for medical and psychological tests. To enhance future efficiency and simplicity, Korlantas Polri should innovate a solution to streamline these disparate applications into a single service process.

The results of the evaluation of the two above-mentioned applications through this research model have proven to engage a broader user perspective, which is the strength of this research. By considering the viewpoint of the public as users, this research has provided a more holistic insight into user satisfaction with both applications provided by the service providers. Furthermore, the approach used in this research has the potential to be extended to various other public service applications, offering guidance to government authorities in improving these applications in accordance with the current regulatory framework in Indonesia and the expectations of the public as service users.

4. CONCLUSION

Naïve Bayes and N-grams was conducted to identify the factors affecting the effectiveness based on user experiences and produce the high-performance model. Some improvements are required to resolve those error on both applications to improve public's satisfaction toward both e-government applications. In summary, DigiKorlantas application acquires slightly more negative reviews in comparation with positive reviews which are 51% and 49% respectively. In contrast, positive sentiment is dominant on SIGNAL application which reach 58%, compared with negative sentiment that in 42%. Based on the thematic analysis result, the main solutions to enhance the application effectiveness are the developer's team should enhance the verification functionality with several technique such as Retinex Algorithms or optical character recognition pipeline and streamline the process business to single service process on DigiKorlantas application. The sentiment and thematic analysis with N-grams can serve as an an alternative evaluation strategy for Polri to gauge the application's success upon launch and strategically plan ongoing enhancements for both the process and system. The research methodology also can be applied more broadly to a variety of public service applications.

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