Analysis of Public Satisfaction Levels towards Hospital Services using the K-Nearest Neighbors Method (Case Study: XYZ Regional Public Hospital)

Novia Ramadani Sibutar-Butar[1*], Muhammad Halmi Dar[2], Mila Nirmala Sari Hasibuan[3]

[1,2,3] Faculty of Science and Technology, Universitas Labuhanbatu, Sumatera Utara Indonesia.
[*]Corresponding Author:
Email: noviaramadani463@gmail.com

Abstract.

The level of public satisfaction with health services is an important indicator that reflects the quality of services provided by a hospital. XYZ Hospital, as one of the main health service providers, strives to continuously improve the quality of its services by understanding and evaluating the level of patient satisfaction. However, challenges arise when it comes to accurately identifying and predicting patient satisfaction, given the diverse characteristics of patients and the complexity of the services provided. Therefore, this study aims to analyze the level of public satisfaction with XYZ Hospital services using the K-Nearest Neighbors method. This study employs a quantitative approach by utilizing patient satisfaction data obtained through a survey. We then analyze the data using the K-Nearest Neighbors method, known for its effectiveness in classifying based on data proximity. We carry out the model performance evaluation process through an evaluation matrix that includes accuracy, precision, recall, and F1-score. The results of the study show that the K-Nearest Neighbors model is able to classify patient satisfaction with an accuracy value of 94%, precision of 97.67%, recall of 95.45%, and F1-Score of 96.55%. These results indicate that the K-Nearest Neighbors model is not only accurate in predicting patient satisfaction but also consistent in classifying patients who are satisfied and dissatisfied. The study's conclusion is that the K-nearest neighbors method is very effective in analyzing and predicting the level of patient satisfaction at XYZ Hospital. This study makes a significant contribution by utilizing the K-Nearest Neighbors model as a potent predictive tool for assessing patient satisfaction, a tool hospitals can employ to enhance service quality. We hope that further development will enable the larger-scale implementation of this model, thereby enhancing the quality of health services across various hospitals.

Keywords: *Classification, Hospital, K-Nearest Neighbors, Performance Evaluation, Public Satisfaction.*

1. INTRODUCTION

The level of public satisfaction is an important indicator for assessing the effectiveness of public services and the quality of products provided by the government and private sector. The quality of public services must improve the quality of life, protect the safety and welfare of the people, and ensure that all people can enjoy public services [1]. Public services must also refer to customer satisfaction to ensure high quality standards [2]. Public satisfaction is the perception and assessment of their experience using a particular service or product. Research on public satisfaction usually involves surveys and data analysis to identify factors that influence the level of satisfaction, such as service quality, reliability, responsiveness, and perceived value [3]. We can use the study's results to develop improvement and enhancement strategies that better meet the community's needs and expectations. Assessment of the level of public satisfaction also helps in understanding areas that need more attention and improvement [4], [5], [6]. For example, in healthcare, patient satisfaction levels can provide valuable insights into the quality of care, interactions with medical personnel, and available facilities. In the private sector, companies can use feedback from customers to improve their products or services, thereby strengthening customer loyalty and competitiveness in the market. Overall, a deep understanding of the level of public satisfaction plays a crucial role in creating more responsive services and better meeting public needs [7].

The level of public satisfaction with the Regional General Hospital (RSUD) is an important indicator in assessing the quality of health services provided by the hospital. RSUD plays an important role in

providing medical services to the local community, so the assessment of patients and their families is very crucial. Public satisfaction covers various aspects, such as the quality of medical care, availability of facilities, reliability and competence of medical personnel, and friendliness and responsiveness of hospital staff. Through surveys and feedback, RSUD can identify areas that need improvement and development to improve the quality of service and meet public expectations. Hospital management can also use the assessment of public satisfaction at RSUD as a basis for decision-making. Information obtained from patient feedback can help management design more targeted improvement strategies, such as improving facilities, training medical personnel, and improving the service system. By focusing on improving the level of public satisfaction, RSUD can strengthen patient trust and loyalty and make a positive contribution to overall public health. Periodic evaluation and corrective actions based on public feedback are key to achieving optimal and sustainable health services.

The problem of satisfaction levels at XYZ Regional Hospital often includes various factors that can affect patient perceptions and experiences of the health services provided. Some common problems that are frequently encountered include long waiting times, a lack of effective communication between medical personnel and patients, and limited medical facilities and equipment. The unfriendly or unresponsive attitude of hospital staff can also cause patient dissatisfaction. All of these factors can have a negative impact on the overall patient experience, ultimately reducing public satisfaction with XYZ Regional Hospital. In addition, administrative and management problems often contribute to low levels of satisfaction at XYZ Regional Hospital. Complicated administrative procedures, lack of transparency in handling complaints, and inconsistent service standards can cause frustration and dissatisfaction among patients. To overcome these problems, it is important for XYZ Regional Hospital management to proactively identify and address areas that need improvement. XYZ Regional Hospital can enhance public satisfaction with its services by conducting regular patient satisfaction surveys, providing staff training, and improving the complaint management system.

Machine learning algorithms have become increasingly common in consumer behavior studies [8]. Researchers have utilized machine learning techniques to analyze large amounts of consumer data, including survey responses, online reviews, and other sources, to gain deeper insights into customer preferences [9]. Researchers can analyze customer satisfaction data [10] by classifying it into standard anthropometric indices using the K-Nearest Neighbors (KNN) method [11]. The KNN method is also very suitable for classifying visitor satisfaction data [12]. The KNN method, which is rather simple but very accurate, classifies information based on how close or far it is to each other [13]. KNN calculates the proximity between new cases (test data) and old cases (training data) based on matching the weights of various features [14]. The calculation considers the closest distance to the training data to be the same [15]. The KNN algorithm uses a k-dimensional Euclidean formula that surrounds the test data to compare it with the training data, whose category is known [16]. The KNN algorithm has been used to measure the level of public satisfaction at the Belakang Pondok Bengkulu Village Office in five categories: Very Satisfied, Satisfied, Quite Satisfied, Less Satisfied, and Dissatisfied [17]. Based on the results of research conducted by [18], it shows that the KNN method has a fairly good accuracy value, as seen from the accuracy value. The KNN method's accuracy results are ideal for use as a classification method [19].

Therefore, the author wants to conduct a study on the level of public satisfaction at XYZ Regional Hospital to find out how many people are satisfied or dissatisfied with the services provided. This study will consist of surveys and interviews with patients and their families who have received services at XYZ Regional Hospital. We will analyze the collected data to identify both positive and negative factors that influence the level of satisfaction. The author hopes that the results of this study can provide a clear picture of public perceptions of the quality of health services at XYZ Regional Hospital. We expect this study to provide valuable insights to XYZ Regional Hospital management, enabling them to enhance the quality of their services by understanding the number of satisfied or dissatisfied individuals. We can also use the study's results to design more effective and targeted improvement strategies. Thus, XYZ Regional Hospital can be more responsive to the needs and expectations of the community, increase patient trust and loyalty, and provide more optimal and sustainable health services.

II. METHODS

This study employs the KNN method to determine the level of public satisfaction with XYZ Regional Hospital's services through the Knowledge Discovery in Database (KDD) stage. Figure 1 illustrates the study's flow.

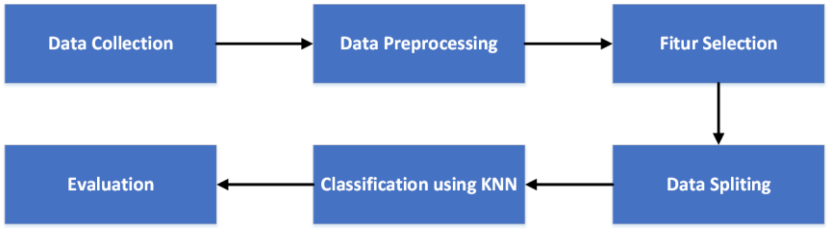

Fig. 1. Research methodology

Figure 1 shows the research flow for analyzing the level of public satisfaction with hospital services using the KNN method. This process begins with the collection of public satisfaction survey data covering various aspects of hospital services, including quality medical services, waiting time, facilities, cleanliness, security, and categories. The data preprocessing stage involves data cleaning, data transformation, and data normalization. This process aims to address problems such as missing data, duplicate data, and inconsistent data scales. Preprocessing the data is crucial to enhance its quality for the KNN model. We also carry out feature selection to identify the most significant variables that influence public satisfaction. We then divide the processed data into two categories: training and testing. Training data is training information used to assist a data classification process. The training data enables accurate classification of the sample data. The KNN method will classify the testing data, which are research sample data. We apply the KNN algorithm to classify data into satisfied or dissatisfied categories based on similarities with other data in the dataset. We then evaluate the results of this classification to gauge its performance. We conduct this evaluation using various metrics such as accuracy, precision, recall, and F1-score. The evaluation results will show how well the KNN model classifies data on the level of public satisfaction.

III. RESULT AND DISCUSSION

We conducted this study by applying the KNN method to analyze the level of public satisfaction with the services of XYZ Regional Public Hospital. We chose the KNN method for its ability to classify data based on similarity or proximity to other data in the dataset. We obtained public satisfaction data from a survey and will process and analyze it using KNN to identify patterns and relationships between various satisfaction factors, including quality of medical services, waiting time, facility, cleanliness, security, and category. Table 1 shows a sample of the research dataset.

Table 1. Sample of Dataset

Respondent	Quality of Medical Services	Waiting Time	Facility	Cleanliness	Security	Category
R1	Good	Fast	Complete	Clean	Secure	Satisfied
R2	Good	Fast	Complete	Clean	Secure	Satisfied
R3	Good	Fast	Complete	Clean	Secure	Satisfied
R4	Good	Fast	Complete	Clean	Secure	Satisfied
R5	Not Good	Slow	Incomplete	Not Clean	Insecure	Not Satisfied
R6	Not Good	Slow	Incomplete	Not Clean	Insecure	Not Satisfied
R7	Baik	Fast	Complete	Clean	Secure	Satisfied
R8	Baik	Fast	Complete	Clean	Secure	Satisfied
R9	Baik	Fast	Complete	Clean	Secure	Satisfied
R10	Baik	Fast	Complete	Clean	Secure	Satisfied

Table 1 contains a sample dataset on public satisfaction with services at XYZ Regional Hospital. The total number of datasets consists of 250 respondents. The table consists of seven columns, each of which has an important role in the analysis. The Respondent column lists a unique code for each respondent (R1 to

R10). The Quality of Medical Services column shows the quality of medical services received by the respondent. It consists of two categories: "good" and "not good" The Waiting Time column indicates the speed of service received by the respondent. The categories are "fast" and "slow". The Facility column describes the completeness of the facilities available to the respondents. The categories used are "complete" and "incomplete" The Cleanliness column indicates the facility's level of cleanliness. There are two categories: "Clean" and "Not Clean" The Security column reflects the respondents' perceptions of hospital security. There are two categories: "secure" and "insecure". The Category column classifies respondents' level of satisfaction with hospital services. There are two categories: "satisfied" and "not satisfied".

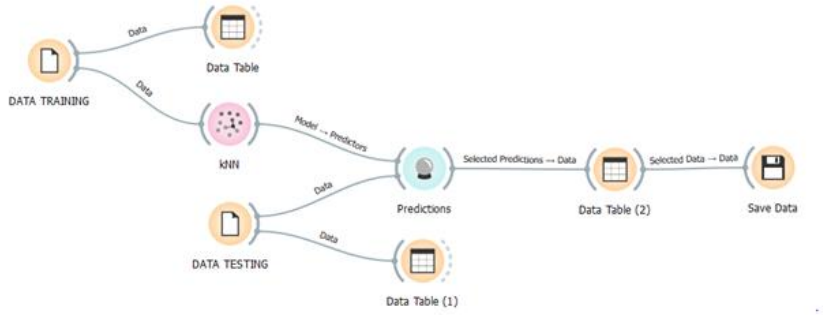

Fig. 2. Data Mining Process

Figure 2 shows the process of mining data on public satisfaction with XYZ hospital services using the KNN method. This diagram consists of several connected steps, each representing a stage in the data mining process using the KNN method. In this stage, we collect training data to construct the KNN model. The training data includes historical information on public satisfaction with hospital services. The goal is to train the KNN model to recognize patterns and characteristics from existing data. We arrange the data collected in the previous stage in tabular form to streamline the next process. This data includes various features such as quality of medical services, waiting time, facilities, cleanliness, and security. This stage also entails gathering test data to evaluate the KNN model's performance. The model has never encountered test data previously. This procedure demonstrates that the KNN model constructs itself using training data, which encompasses diverse elements influencing public satisfaction. This model's success is highly dependent on the quality and representation of the training data used. Testing the model with separate test data is crucial to prevent overfitting and enable the KNN model to generate accurate predictions on previously unseen data. The prediction results are presented in tabular form, making it easier to evaluate model performance. Prediction result analysis can provide important insights into the factors that most influence community satisfaction. Storing prediction result data allows researchers to conduct further analysis and compile reports based on the research findings. The data mining process shown in this figure illustrates the systematic stages of analyzing community satisfaction with hospital services using the K-Nearest Neighbors method. From data collection, model training, testing, and storing prediction results, each step plays an important role in producing accurate and meaningful analysis. Good implementation of each stage will provide useful results to improve the quality of hospital services based on a deeper understanding of community satisfaction.

		Predicted		
		Satisfied	Not Satisfied	∑
Actual	Satisfied	210	10	220
	Not Satisfied	5	25	30
	∑	215	35	250

Fig. 3. Confusion Matrix

Figure 3 shows the confusion matrix of the KNN method. This confusion matrix consists of four main components: True Positive (TP), actually satisfied, and predicted to be satisfied; the value is 210. False Negative (FN), which is actually satisfied but predicted to be dissatisfied, has a value of 10. False Positive (FP), which is actually dissatisfied but predicted to be satisfied, has a value of 5. The True Negative (TN), which is actually dissatisfied and predicted to be dissatisfied, has a value of 25. Overall, the matrix divides into two main categories: satisfied and not satisfied, both in terms of actual and predicted satisfaction. Based on the confusion matrix results, the KNN model successfully predicts 210 respondents as satisfied with the hospital service. The model predicts 10 respondents as dissatisfied, despite their actual satisfaction. This shows an error where the model fails to recognize satisfaction. There are 5 respondents who are actually dissatisfied, but the model predicts them to be satisfied. This is an error where the model provides an overly optimistic prediction. The model correctly predicts 25 respondents who are actually dissatisfied. The total number of respondents who were actually satisfied was 220 (210 + 10). The total number of respondents who were actually dissatisfied was 30 (5 + 25). The total number of data points was 250 (215 + 35). The 10 false negatives indicate that there is a small risk that patients who are actually satisfied may be considered dissatisfied. This could be a concern for the hospital because there may be aspects of satisfaction that the model does not consider. The 5 false positives, although small in number, could lead the hospital to believe that the service is better than it actually is, which could lead to unanticipated dissatisfaction in the future.

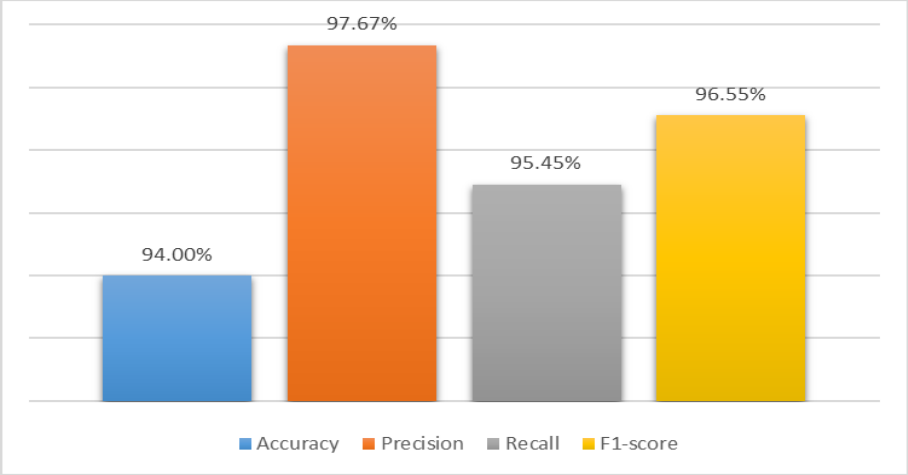

Fig. 4. Performance Evaluation Matrix of KNN

The KNN method uses Figure 4 as its performance evaluation matrix to analyze the level of public satisfaction with XYZ Hospital's services. This performance evaluation matrix displays four important metrics: accuracy, precision, recall, and F1-score. Accuracy shows that the KNN model can correctly predict 94% of all cases (both satisfied and dissatisfied). This means that out of 100 predictions, about 94 of them are correct. Despite the impressive result, we should exercise caution when interpreting high accuracy, particularly if the data exhibits imbalances such as a higher number of satisfied patients than dissatisfied ones. In this context, 94% accuracy suggests that the model is quite reliable in overall classification, but we should check other metrics to ensure that the model is not too biased towards a more dominant class. This very high precision (97.67%) indicates that almost all positive predictions generated by the model are correct. This means that out of all patients predicted to be satisfied, 97.67% are indeed satisfied. This is significant because the error in identifying satisfied patients as dissatisfied (false positives) is very low. This high precision indicates that the KNN model is very effective in reducing false positive prediction errors, which is its main advantage in this study. The recall of 95.45% indicates that the model is able to identify 95.45% of all true satisfied cases. In other words, the model incorrectly detected only 4.55% of satisfied patients, resulting in a false negative. This suggests that the model excels in identifying nearly all satisfied patients, thereby enabling hospitals to accurately identify the majority of satisfied patients. The F1-Score is the harmonic mean of precision and recall, which in this case reaches 96.55%. This shows that there is a satisfactory balance between precision and recall. This high F1-Score indicates that the KNN model is not

only accurate in positive predictions but also quite good at recognizing all satisfied cases. This F1-Score approaching 100% indicates that the model has consistent performance in terms of correct predictions and true case detection, without being too biased towards one metric.

The KNN model showed excellent performance with high accuracy, precision, recall, and F1-Score. This indicates that the model is very effective in classifying the level of public satisfaction with hospital services. The high F1-Score confirms that the model has successfully found a balance between precision (avoiding false positives) and recall (avoiding false negatives). In the context of hospital services, accurately identifying both satisfied and dissatisfied patients is crucial for enhancing the quality of care. With high precision and recall, the hospital can use this model to predict patient satisfaction with a high degree of confidence. This allows the hospital to identify areas for improvement based on the model's predictions, thereby improving the overall patient experience. Despite the positive results, we still recommend conducting additional analysis, such as testing on a larger or more balanced dataset or perhaps using other models to validate these results. Experimenting with other models can help confirm the KNN model's performance and ensure that it is truly the best for this case. Overall, the Performance Evaluation Matrix shows that the KNN method is a very effective tool in analyzing patient satisfaction at XYZ Hospital. This model shows high reliability in terms of accuracy, precision, recall, and F1-Score, making it very suitable for application in this context. However, there is always room for further development to ensure that this model remains effective as data or organizational needs change.

IV. CONCLUSION

This study shows that the K-Nearest Neighbors (KNN) method has excellent performance in analyzing the level of public satisfaction with the services of XYZ Hospital. The performance evaluation matrix has an accuracy value of 94%, a precision value of 97.67%, a recall value of 95.45%, and a F1-score of 96.55%. These results show that the KNN model can predict patient satisfaction with a very high level of accuracy, both in identifying satisfied and dissatisfied patients. The KNN model successfully classifies patient satisfaction with excellent accuracy, indicating that this model is reliable in overall prediction. High precision and recall, as well as an almost perfect F1-Score, indicate that this model is not only accurate in positive predictions but also consistent in recognizing the most satisfied cases. With a high F1-Score, this model shows a strong balance between precision and recall, which is crucial in real-world applications such as healthcare. This study shows the enormous potential of the KNN method in analyzing patient satisfaction at XYZ Hospital. However, with further development, including broader data handling and advanced modeling techniques, the results can be refined and applied more widely. This will not only increase the accuracy of the model's predictions, but it will also have real benefits in improving the quality of health services provided to the community.

Despite the positive results of this study, there are several areas for further development to enhance the findings and application of the KNN model in patient satisfaction analysis. If there is an imbalance in the amount of data between satisfied and dissatisfied patients, measures such as oversampling, undersampling, or using methods such as SMOTE can be applied to ensure the model is more fair and accurate in predicting both classes. We should carry out additional exploratory analysis on the data distribution to eliminate any unintentional bias that might impact the model's performance. In addition to KNN, considering other models such as Random Forest, Gradient Boosting, or Support Vector Machine can provide additional insights and potential improvements in model performance, especially when dealing with more complex data. You can use ensemble techniques to combine multiple models and enhance the accuracy and robustness of predictions. Adding or developing additional features such as patient demographic data, type of complaint, or medical history can improve the model's ability to predict patient satisfaction more accurately. We can simplify the model without losing important information by using dimensionality reduction techniques like PCA. We use cross-validation techniques to test the model's generalizability on different or larger datasets, ensuring consistency in the results. We are testing the model on data from other hospitals to validate its performance across contexts and ensure its relevance extends beyond a single hospital. The development of a model for real-time patient satisfaction monitoring can assist hospitals in making prompt decisions to

enhance their services. Segmenting patient data based on specific characteristics (e.g., age, gender, disease type) can help in better understanding the specific needs of different patient groups.

REFERENCES

[1] Hardiansyah, ***Kualitas Pelayanan Publik (Konsep, Dimensi, Indikator dan Implementasinya)***. Yogyakarta: Gava Media, 2018.

[2] M. F. T. Mutaqin, D. Darmawan, N. Handayani, and I. Masturoh, "Kualitas Pelayanan Publik Sektor Pendidikan: Analisis Survey Kepuasan Masyarakat di Kabupaten Pandeglang," in ***Prosiding Seminar Nasional Pendidikan Non Formal***, 2023, pp. 616–625.

[3] P. P. Sary, Maria, and R. Armaini, "Faktor-Faktor yang Mempengaruhi Akuntabilitas Publik Badan Layanan Umum Daerah," ***J. Darma Agung***, vol. 31, no. 6, pp. 198–209, 2023, doi: 10.46930/ojsuda.v31i6.3616.

[4] M. W. Kurniawan, S. Alifiyah, E. Setyowati, A. I. Jinan, A. W. Rahmadhani, and E. Nurhayati, "Tingkat Kepuasan Pengguna Terhadap Pelayanan Publik di Perpustakaan UPN Veteran Jawa Timur," ***JIPP J. Ilmu Pendidik. dan Pembelajaran***, vol. 06, no. 3, pp. 100–111, 2024.

[5] I. Lastriyani, Lidiawati, R. S. Sauri, and I. Wasliman, "Kualitas Pelayanan Pendidikan di TK Aisyiyah Kota Sukabumi: Strategi Pendekatan Metode Service Quality," ***Munaddhomah J. Manaj. Pendidik. Islam***, vol. 4, no. 4, pp. 1047–1055, 2023, doi: 10.31538/munaddhomah.v4i4.876.

[6] M. P. Permatasari *et al.*, "Persepsi Kepuasan Layanan Transportasi Kereta Api PT. Kereta Api Indonesia (PT. KAI): Survey pada Mahasiswa yang Berkuliah di Surabaya," ***Valuasi J. Ilm. Ilmu Manaj. dan Kewirausahaan***, vol. 4, no. 2, pp. 561–575, 2024, doi: 10.46306/vls.v4i2.

[7] N. Aprilia and D. I. Nur, "Kinerja Program Kalimasada Melalui Layanan Administrasi Kependudukan Di Kelurahan Gunung Anyar Tambak," ***KARYA J. Pengabdi. Kpd. Masy.***, vol. 3, no. 3, pp. 218–229, 2023.

[8] P. Ndikum, "***Machine Learning Algorithms for Financial Asset Price Forecasting***," pp. 1–16, 2020, [Online]. Available: http://arxiv.org/abs/2004.01504

[9] L. Ma and B. Sun, "Machine learning and AI in marketing – Connecting computing power to human insights," ***Int. J. Res. Mark.***, vol. 37, no. 3, pp. 481–504, 2020, doi: https://doi.org/10.1016/j.ijresmar.2020.04.005.

[10] V. M. R., R. Ashok, and L. Nitha, "Electric Vehicles Acceptance and Knowledge Identification in India using Naive Bayes and k-Nearest Neighbor Classifiers," ***Int. J. Innov. Technol. Explor. Eng.***, vol. 9, no. 5, pp. 1630–1633, 2020, doi: 10.35940/ijitee.e3008.039520.

[11] S. Diansyah, "Klasifikasi Tingkat Kepuasan Pengguna dengan Menggunakan Metode K-Nearest Neighbour (KNN)," ***J. Sistim Inf. dan Teknol.***, vol. 4, no. 1, pp. 7–12, 2022, doi: 10.37034/jsisfotek.v4i1.114.

[12] H. A. Pratama, G. J. Yanris, and M. N. S. Hasibuan, "Implementation of Data Mining for Data Classification of Visitor Satisfaction Levels," ***Sink. J. dan Penelit. Tek. Inform.***, vol. 8, no. 3, pp. 1832–1851, 2023, doi: 10.33395/sinkron.v8i3.12674.

[13] R. Rismala, I. Ali, and A. Rizki Rinaldi, "Penerapan Metode K-Nearest Neighbor untuk Prediksi Penjualan Sepeda Motor Terlaris," ***JATI (Jurnal Mhs. Tek. Inform.***, vol. 7, no. 1, pp. 585–590, 2023, doi: 10.36040/jati.v7i1.6419.

[14] S. Rahayu, Y. MZ, J. E. Bororing, and R. Hadiyat, "Implementasi Metode K-Nearest Neighbor (K-NN) untuk Analisis Sentimen Kepuasan Pengguna Aplikasi Teknologi Finansial FLIP," ***Edumatic J. Pendidik. Inform.***, vol. 6, no. 1, pp. 98–106, 2022, doi: 10.29408/edumatic.v6i1.5433.

[15] F. Marisa *et al.*, "Pengukuran Tingkat Kematangan Kopi Arabika Menggunakan Algoritma K-Nearest Neighbour," ***JIMP J. Inform. Merdeka Pasuruan***, vol. 6, no. 3, pp. 1–5, 2021, doi: 10.51213/jimp.v6i3.280.

[16] F. Rozi, F. Sukmana, and M. N. Adani, "Pengelompokan Judul Buku dengan Menggunakan Algoritma K-Nearest Neighbor (K-NN) dan Term Frequency - Inverse Document Frequency (TF-IDF)," ***JIMP J. Inform. Merdeka Pasuruan***, vol. 6, no. 3, pp. 1–5, 2022, doi: 10.51213/jimp.v6i3.346.

[17] L. T. Amelia, H. L. Sari, and R. Zulfiandry, "Penerapan Algoritma K-Nearest Neighbor dalam Mengukur Tingkat Kepuasan Masyarakat pada Pelayanan Umum Kantor Kelurahan Belakang Pondok Bengkulu," ***Djtechno J. Inf. Technol. Res.***, vol. 3, no. 2, pp. 208–216, 2022, doi: 10.46576/djtechno.v3i2.2733.

[18] M. Fansyuri, "Analisa Algoritma Klasifikasi K-Nearest Neighbor dalam Menentukan Nilai Akurasi Terhadap Kepuasan Pelanggan (Study Kasus PT. Trigatra komunikatama)," ***Humanika J. Ilmu Sos. Pendidikan, dan Hum.***, vol. 3, no. 1, pp. 29–33, 2020.

[19] D. J. Triani, M. H. Dar, and G. J. Yanris, "Analysis of Public Purchase Interest in Yamaha Motorcycles Using the K-Nearest Neighbor Method," ***Sink. J. dan Penelit. Tek. Inform.***, vol. 7, no. 3, pp. 1238–1254, 2023, doi: 10.33395/sinkron.v8i3.12433.