BAB III

ARTIKEL KARYA ILMIAH

Application of Extreme Programming Methods in the Design and Building of the Nusantara Capital Sentiment Analysis System

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Abstract: Information about the capital city of the archipelago (IKN) in the digital era serves as a platform for individuals to express views on development, policies, and socio-economic impacts. Such information often contains personal emotional expressions, categorized as negative, neutral, or positive sentiments. This study aims to design a sentiment analysis system to evaluate public opinions regarding IKN. The system utilizes Google NLP services, which offer sentiment measurement features for analyzed text, and web scraping techniques to automate data collection from online sources. The development process employs the Laravel framework and follows the Extreme Programming approach, which ensures work efficiency. Sentiment analysis is conducted using the Support Vector Machine (SVM) method, achieving an accuracy rate of 95%. The system is designed to be web-based, ensuring accessibility across devices, including smartphones and computers. The results demonstrate that this sentiment analysis system can help individuals, organizations, and governments gain deeper insights into public perspectives on IKN. Furthermore, it serves as a valuable tool for strategic decision-making and policy evaluation related to IKN development. Future research may explore expanding the data sources and integrating more advanced analytical techniques to improve system performance.

Keywords: Sentiment Analysis ; Extreme Programming ; Information Systems ; Capital of the Archipelago ; Support Vector Machine (SVM)

INTRODUCTION

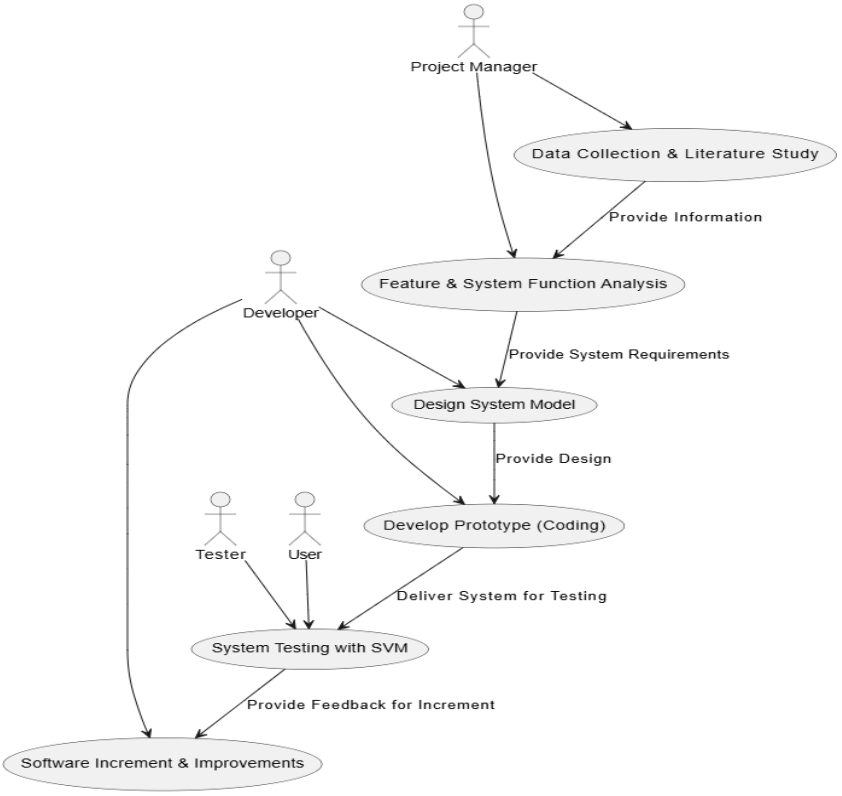
In the digital era, social media has experienced rapid development, one of which is the Twitter platform. This platform offers a space for its users to interact privately and publicly. Various issues ranging from politics, economics, social, culture, to law are often discussed on this platform. Through the hashtag feature, users can monitor topics that are popular in real-time, and discussions on Twitter often trigger the emergence of major news in online media. In Indonesia, Twitter has a significant influence on public opinion on various topics. One issue that is often discussed on Twitter is related to the relocation of the Indonesian capital city (IKN). This issue has become a public discussion in various government periods, and was again widely discussed during the era of President Jokowi until the era of President Prabowo. The discourse on moving IKN raises pros and cons among the community, each of whom has a different perspective. This phenomenon reflects collective attention to this issue. To understand public opinion in depth, sentiment analysis is carried out, which aims to group opinions into positive or negative categories and identify the dominant factors in the discussion

Sentiment analysis is an automatic process for exploring, processing and understanding unstructured text data in order to identify the sentiment contained in opinions(Chen & Yik, 2022), both positive and negative emotions(Ahuja et al., 2019; Nandwani & Verma, 2021; Wankhade et al., 2022) This technique is often used to evaluate public opinion on various topics, including politics, economics, and social issues(Drus & Khalid, 2019),(Ying et al., 2020). Twitter, with its enormous usage data, has become an important source for researchers to analyze people's opinions and feelings through this technique. Sentiment analysis is part of the field of Natural Language Processing (NLP), which allows the systematic extraction of opinions from text(Kastrati et al., 2021)(Rajput, 2019). One approach to sentiment analysis is to utilize the Google Natural Language Processing (Google NLP) service which is integrated with web scraping techniques to retrieve data from various platforms, including the Indonesian capital system or social media(Ekawaty et al., 2024). With this technology, the data collection process becomes faster and more efficient, making it easier for individuals and organizations to understand public opinion related to certain issues. To support sentiment analysis, web scraping technology is used which allows data to be retrieved from HTML or XHTML based websites automatically. In system development, the Extreme Programming (XP) methodology was chosen because of its flexibility in supporting software development that is responsive to user needs(Asri et al., 2018)(Kayanda, n.d.). XP allows users to be directly involved during the development process, so that the resulting system can meet their needs optimally. This system is designed using the Laravel framework with Model-View-Controller (MVC) architecture and is integrated with a MySQL database to store the analyzed data(Rahmouni et al., 2023). The development of a web-based sentiment analysis system with the integration of Google NLP and web scraping techniques provides an effective solution for identifying public opinion on an issue(Birjali et al., 2021). This system not only helps in understanding public opinion, but also provides a basis for organizations or individuals to evaluate and improve future performance. Sentiment analysis has great benefits in evaluating comments on Social Media, which can then be processed into more meaningful information, such as in the form of simple statistics regarding the percentage of positive and negative sentiment towards the new capital in Indonesia, using the web-based Support Vector Machine method.

METHOD

The development of a sentiment analysis system for Indonesian capital cities was carried out by applying the Extreme Programming (XP) method(Munir et al., 2021)(Handri et al., 2024). This approach aims to ensure the system development process runs in an organized, efficient and fast manner. The XP method, developed by Kent Beck, Ron Jeffries, and Ward Cunningham, is a method for software development that is simple and oriented towards agile principles(Ju Adnan Hemani Joshua Zeitsoff Yannis Dimitriadis Armando Fox Joshua Hug, 2020)(Shrivastava et al., 2021). This method is designed to form small to medium development teams, so it does not require a team with a large number of members. XP offers a new disciplined approach to software development by applying basic principles, such as communication, simplicity, feedback, courage and respect. The XP method is used in this research because it is suitable for software development with requirements that are not fully defined at the start and tend to change rapidly(Edison et al., 2022). This characteristic is in line with the development of a sentiment analysis system for Indonesian capital cities, which has a short development time and allows for adjustments to system requirements according to current conditions. After the XP method is run, there is a system analysis using the SVM method to analyze the system test results(Harimoorthy & Thangavelu, 2020),(Wen et al., 2018).

Gambar 4 Scema XP Practices



The XP method process includes several stages

Planning

The planning stage begins with data collection and literature studies related to existing sentiment analysis systems(Diamantini et al., 2019)(Chamekh et al., 2022). This step aims to get a clear picture of the main features, system functions, and expected output. In the context of developing a sentiment analysis system for Indonesian capital cities, this stage includes identifying the sentiment analysis process, data collection methods, and analyzing user needs to determine system features.

Design

At this stage, a model is created based on the needs analysis obtained from the planning stage. Modeling includes data structures and relationships between data designed using Logical Record Structure (LRS). In addition, UML (Unified Modeling Language) diagrams, such as Use-Case Diagrams and Activity Diagrams, are used to visualize the systems and processes that will be developed.

Coding

The coding stage is the implementation of the design results in the form of program code. The software prototype was developed using the Python programming language combined with Json, HTML, CSS, and JavaScript in the Laravel framework. System data is stored using MySQL as a database management system (DBMS).

Testing

System testing is carried out to ensure that system features and functionality work according to user needs. The testing method used is SVM, which focuses on testing system input and output without looking at the implementation details of the program code.

Software Increment

This stage is a continuous development process for the system that has been created. The addition of new features or services is carried out in stages to improve system functionality after implementation.

The stages above aim to ensure system development runs iteratively and adaptively according to user needs. This is expected to produce a sentiment analysis system that is effective and in line with research objectives.

System Analysis

Training Process

The training process is carried out to teach the machine to be able to predict the given data. There are two results from this training, namely TF-IDF Data Training Results and TF-IDF Data Testing Results. Features are obtained by extracting data through processes such as preprocessing and stemming on previously processed data. During training, the data is labeled manually, with -1 for negative data and 1 for positive data, then converted into a certain format, namely the libSVM format. This format consists of a label, followed by the model index and its weight.

Testing Process

The testing process is carried out to predict new data based on labels and models that have been obtained in the system. At this stage, data is taken directly from the data that has been input. After the data is obtained, preprocessing is carried out to remove unnecessary elements. Next, testing is carried out to find the basic forms of words in the data. After the data is cleaned, the processed data will be matched with the features obtained from previous training and given weights according to the relevant feature index. If no features are found, then the sentiment has been processed. The results, in the form of percentage Accuracy Score, F1 Score, Precision Score and Recall Score sentiment along with a list of data taken from the data upload, Cleansing, tokenization, stopwords, stemmed, normalization, labeling, training, testing and testing stages, will be sent to the device and displayed in the form of a pie chart that can be seen on the dashboard.

RESULTS AND DISCUSSION

XP method for sentiment analysis system for Indonesian capital cities. Where the development stage is divided into five stages. An explanation of each stage in more detail, as well as the results of applying XP in the system development process, is as follows.

Planning

Planning as an initial stage is carried out with an identification process followed by needs analysis from the sentiment analysis system. An explanation of each stage in planning is as follows.

Identification

The identification process is carried out by studying literature related to existing sentiment analysis systems there is, apart from that, the existence of a sentiment analysis system also occurs because of the large amount of information in the capital city of the archipelago which contains personal opinions containing positive, neutral and negative values, thus giving rise to an opportunity for the development of a sentiment analysis system with a new method, based on the integration of Google NLP with methodology. XP development as demands of short development time.

2) Needs Analysis

Requirements analysis relates to the system's features, as a result of the elaboration process user activity in the system. Table 1 describes the requirements analysis of the system.

Table 1. Needs Analysis

No.	Feature	Admin	Members
1	Register	x	o
2	Login	o	o
3	Log out	o	o
4	View & change profiles	o	x
5	View dashboard	o	o
6	Upload scrapping results	o	x
7	View member data	o	x
8	Sentiment analysis of the capital of the archipelago	o	o
9	History of sentiment analysis	o	o

Design

System design is divided into two types. namely system modeling and database modeling. An explanation of the two types of system design is as follows.

1. Use-Case Diagram

Use-Case Diagrams describe every activity that can be carried out by each actor (user) involved in the system, which is created based on the results of the planning stage. Figure *5 is a Use-Case Diagram of the sentiment analysis system.*

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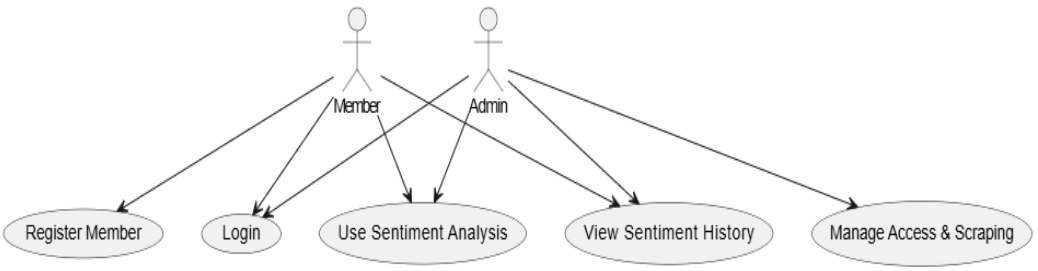
Gambar 5 Use Case Diagram



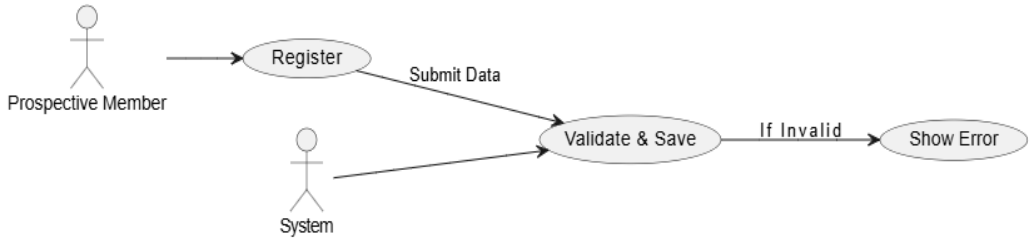
The diagram above illustrates the activities that can be carried out by each actors (users) involved in the system, where the admin holds control over the system with management activities regarding the access rights and privileges of each user, management of the scrapping process

(method for retrieving data from the system), as well as features for viewing member data. Members and admins can log in to the system, with a registration process first for members, then members and admins can use the sentiment analysis feature of the Indonesian capital system and the feature to view the history of sentiment analysis results.

2. Member Registration Activity Diagram

The registration feature can be used by users to register as members of the sentiment analysis system, so that users can use the sentiment analysis feature of the Indonesian capital system and the history of the system. The activity diagram for member registration can be seen in Figure 6.

Gambar 6 Member Registration Activity Diagram

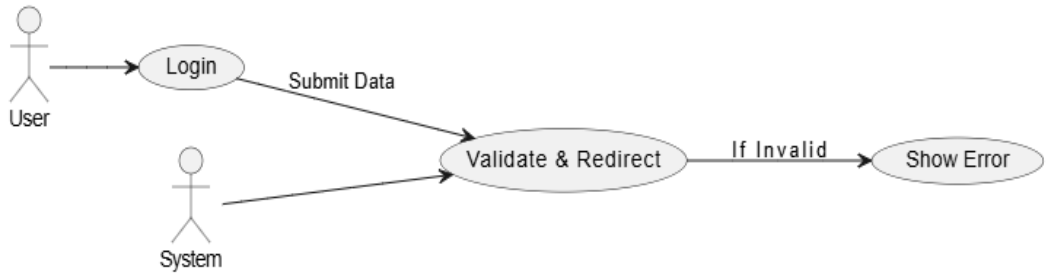


Prospective members who want to register open the registration menu, then the system displays the registration page, prospective members must fill in the data completely (according to what the system requires) then click submit, then the system will validate the data, if it is complete and appropriate the system will save the data , but if it is not appropriate, the system will display an error in the data provided.

Activity Diagram Login

Login is a feature used by members and admins to enter the sentiment analysis system. Figure 7 depicts the login activity diagram of the sentiment analysis system.

Gambar 7 Activity Diagram Login

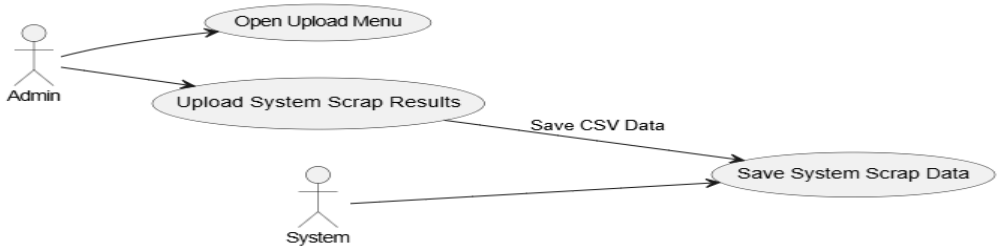


Admins and members who want to log in open the login menu then the system displays the login page, then the user must input the email and password then click submit, then the system validates and checks the account data, if the data is found the user will be directed to the dashboard page , however if the data is not found the system will display an error.

Activity Diagram Upload System Scrap Results

The system scrap management feature is a feature that is used as a setting for uploading system scrapping results. A scrapping system is needed to retrieve news data and information in the form of the content of the news, which will then be carried out by sentiment analysis. This feature can only be accessed by admins, for initial definition purposes starting from tags which are part of the content of news in a system. The activity diagram of the system scrap management feature is in Figure 8.

Gambar 8 Activity Diagram Upload System Scrap Results

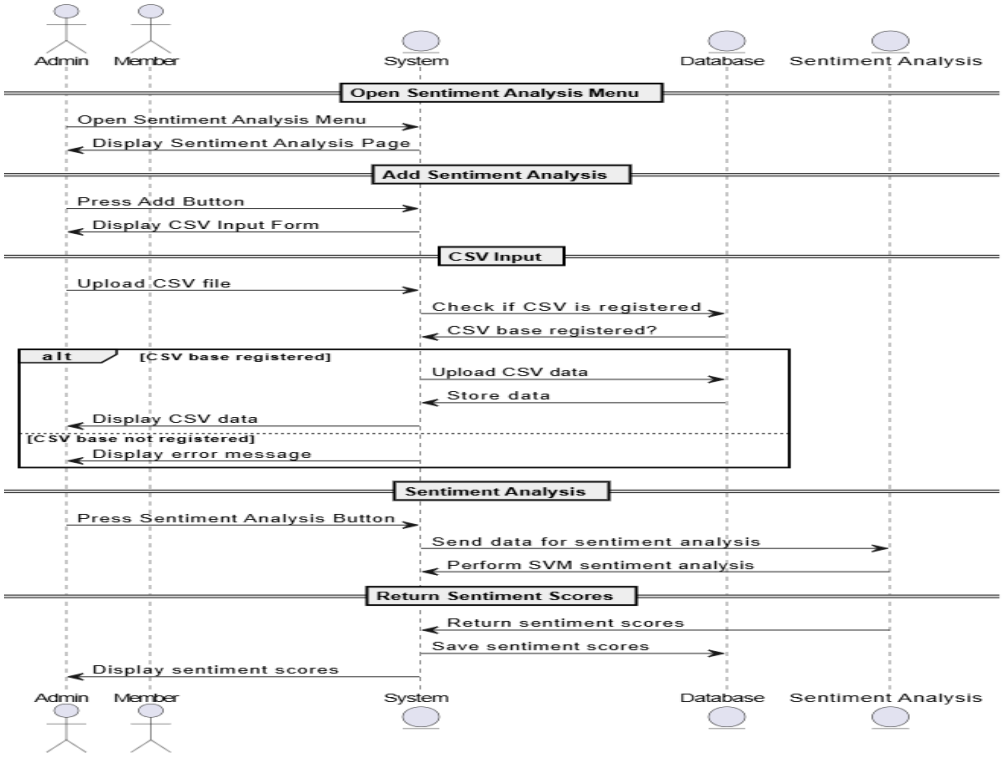


The admin who uploads the results of the system scrapping process must open the upload system scrap results menu and the system will display a page for the system scrap results, to add a system scrap results file by pressing the add button, then the system displays the add system scrap results form then the admin enters the data system scrap results (in the form of a CSV file) and click save, then the system will save the new system scrap data.

Sentiment Analysis Activity Diagram

Sentiment analysis of the Indonesian capital system is the main feature of the system to be developed. The sentiment analysis feature of the Indonesian capital system can only be used by admins and members (users who already have an account). The activity diagram of the sentiment analysis system for Indonesian capital cities can be seen in Figure 9.

Gambar 9 Sentiment Analysis Activity Diagram



Admins or members who carry out sentiment analysis for the Indonesian capital system must open the sentiment analysis menu for the Indonesian capital system and the system will display a page for sentiment analysis for the Indonesian capital system, adding sentiment analysis is done by pressing the add button, then the system will display a form to system data input, where the system data that needs to be input is CSV from the system, then the system will validate that the base of the system CSV has been stored in the system data database, if the CSV base has been registered, then the process of uploading data from the system can be done by pressing the Upload button, However, if the CSV base has not been registered, the system will display an error message and the uploading process cannot continue. After the upload process is complete and the system contents have been stored in the database and have been displayed to the user, the process continues to sentiment analysis, the system will carry out sentiment analysis after the sentiment analysis process button is clicked. During the sentiment analysis process, the system uses the SVM method, by sending the contents of the data to the system via a web service, then the system will carry out a sentiment analysis process for each sentence in the Indonesian capital system. After the sentiment analysis process is complete, the system will send a return value. to the sentiment analysis system, in the form of a sentiment score from each sentence of the system content as well as an overall sentiment score, then the sentiment analysis system will save the sentiment score, to then be displayed to the user, so that the user can see the results of the sentiment analysis of the Indonesian capital system that has been input.

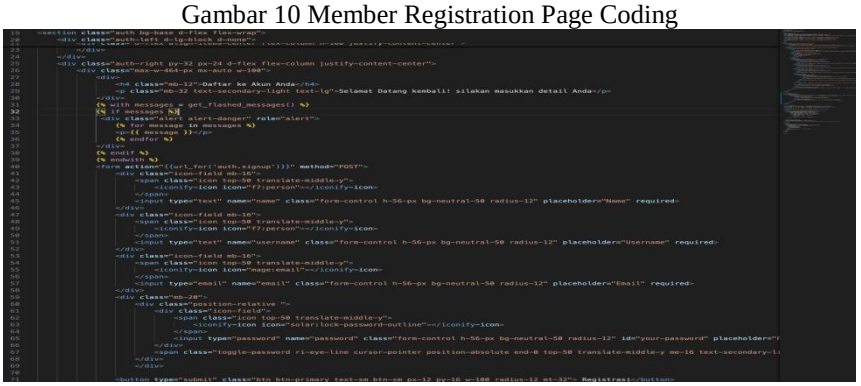
Coding

Coding is the implementation stage of system design. The implementation of the system is made in the form of a website, allowing the system to be accessed from various platforms, be it mobile, desktop or tablet based. The coding process is carried out based on the Laravel framework which uses the Python programming language base, of course with a combination of HTML and CSS for display purposes. Several pages as the main features of the system are as follows.

Member Registration Page

The registration page can be used by users to register as members of the sentiment analysis system, so they can use the main features of the system. The display of the member registration page is shown in Figure 10.

Gambar 10 Member Registration Page Coding



The member registration page can also be said to be a form for guests who want to register an account with the Indonesian capital's sentiment analysis system. The data that needs to be filled in to register as a member is name, email, password and password confirmation. The registration form also has several validations, namely validation of empty data for inputting name, email, password and password confirmation, validation of registered email. in the system (already used by another user), as well as validating the number of characters for the password
namely a minimum of 8 characters.

Login Page

The login page can be used by users to enter the sentiment analysis system, for users who already have an account. The display of the login page can be seen in Figure 11.

Gambar 11 Login Page Coding

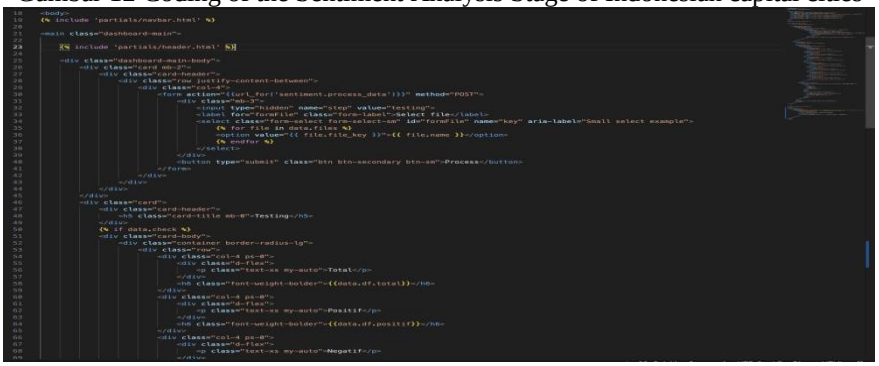
The data that needs to be filled in by users who already have an account to enter the sentiment analysis system, in this case admin and member, is email and password. The system will check and validate the email and password that have been filled in by the user. If the email and password match the account data stored in the database, the system will direct the user to the dashboard page, but if they do not match, the system will display an error message, which indicates that the account data was not found.

Sentiment Analysis Stage Page for Indonesian capital cities

The sentiment analysis stage page for the Indonesian capital can be said to be the main feature of the system, which functions to carry out the sentiment analysis process for the system's content data. The system analysis process as the initial stage in sentiment analysis for the capital of the archipelago requires data input from the system, then the system checks the management data that

has been created by the admin, if the database from the system provided matches the data registered in the data management data, then The process can continue, but if it has not been registered, the upload process cannot be carried out. After the system upload process is complete, the process can proceed to the sentiment analysis stage. The display of the sentiment analysis page can be seen in Figure 12.

Gambar 12 Coding of the Sentiment Analysis Stage of Indonesian capital cities



The follow-up process after system scrapping is complete and the content of the news has been seen is the sentiment analysis process. The sentiment analysis process for system content involves SVM, where the system sends the data in stages via a web service, then the data will be subjected to sentiment analysis by SVM, after the sentiment analysis process, the system will send the results of the sentiment analysis, in the form of an overall sentiment score and a score sentiment of each sentence contained in the system. The sentiment score sent by the system and received by the Indonesian capital's sentiment analysis system will then be stored in the system database.

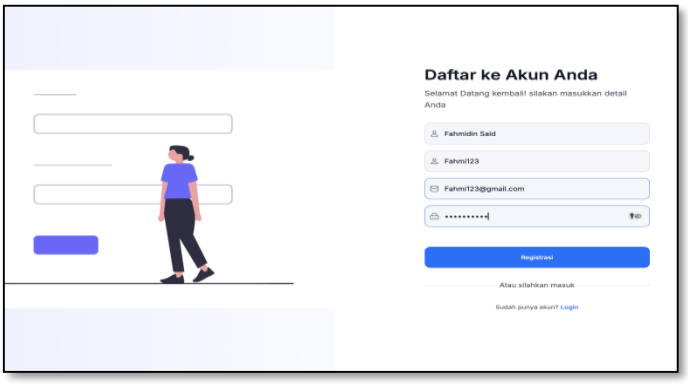
Testing

Testing or testing of the system is carried out by the user automatically from the system, where the user directly tests the system features from the input process to the system output. Tests that have been carried out by users can be explained as follows.

1) Testing the Member Registration Feature

Testing carried out on the member registration feature is testing each input contained in the member registration form, namely name, email, password and password confirmation. The test results of the member registration feature are shown in Figure 13.

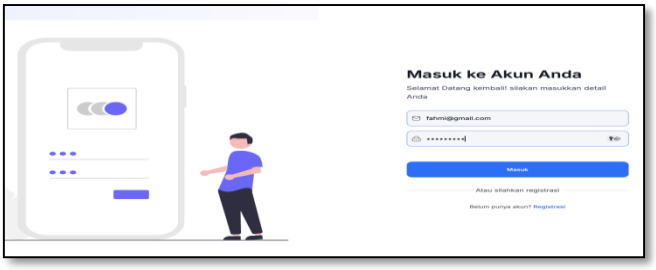
Gambar 13 Member Registration Page



Login Feature Testing

Testing of the login feature is carried out on the email and password validation function and ensures that the function of the login feature is running correctly. Figure 14. explains the test results of the login feature.

Gambar 14 Login Page

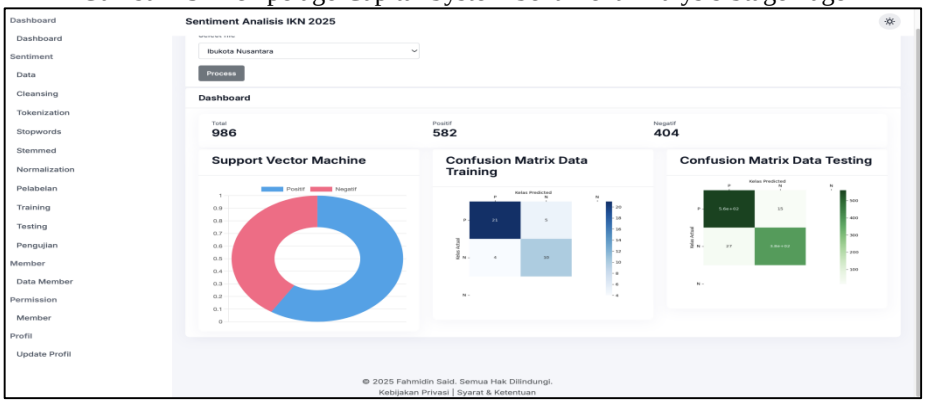


Testing the Sentiment Analysis Stage Features of the archipelago capital system

Feature testing of the sentiment analysis stage of the Indonesian capital system is carried out on the system content function,

including uploading data, cleaning, tokenization, stopwords, stemmed, normalization, labeling, training, testing and testing the Indonesian capital system with data stored in the database, as well as testing the sentiment analysis feature of the system content obtained from the data collection process. Figure 15 explains the test results of the sentiment analysis feature of the Indonesian capital system.

Gambar 15 Archipelago Capital System Sentiment Analysis Stage Page



Software Increment (Software Improvement)

Software increment is an advanced stage of the system implementation process, which after testing features and system implementation, is then continued with system evaluation. Based on this evaluation, it is necessary to develop the system by adding several features that are able to improve the system and support the performance of system users. There are several features that will be further developed, namely email verification after the member registration process has been successfully carried out, management features for admin accounts, a forgotten password feature, as well as a feature for creating reports on the results of sentiment analysis for the Indonesian capital system.

Systems Analysis

Training Process

In the training process, the system is trained to predict sentiment from the given data. The data used is first cleaned and processed to convert words into their basic form (stemming). After that, features from the data are extracted using the TF-IDF method, which is useful for assessing how important each word is in a document. The data was then labeled manually, with a value of -1 for negative sentiment and 1 for positive sentiment. After that, the data is converted into libSVM format, which makes it easier for the model to process and learn existing patterns. In testing the model with 788 training data and 198 testing data, the model obtained an accuracy of 81.82%, which was calculated using the formula Accuracy = (TP + TN) / (TP + TN + FP + FN). The model precision was recorded at 81.75%, calculated using the formula Precision = TP / (TP + FP), which means 81.75% of positive predictions were correct. The model recall was 81.82%, calculated using the formula Recall = TP / (TP + FN), which shows the model was able to recognize 81.82% of positive cases. Finally, the model's F1 score was 81.77%, calculated using

the formula F1 Score = 2 * (Precision * Recall) / (Precision + Recall), which shows a good balance between precision and recall in predicting test data. Figure 16. explains the test results from the training results of the sentiment analysis system for the Indonesian capital system.

Gambar 16 Sentiment Analysis Training Results

Testing Process

Based on the data provided, of the total 986 data tested, there were 581 positive data and 405 negative data. The system shows an Accuracy Score of 95.64%, which means that 95.64% of the predictions made by the model match the original labels of the data. To calculate other metrics, we use the Accuracy formula as follows:

Accuracy = (TP + TN) / Total Data = (TP + TN) / 986 = 0.9564

With these results, we can conclude that TP + TN = 943, where TP is True Positives (positive data that is predicted correctly) and TN is True Negatives (negative data that is predicted correctly). Next, to calculate Precision and Recall, we use the formula:

Precision = TP / (TP + FP) = 0.9564

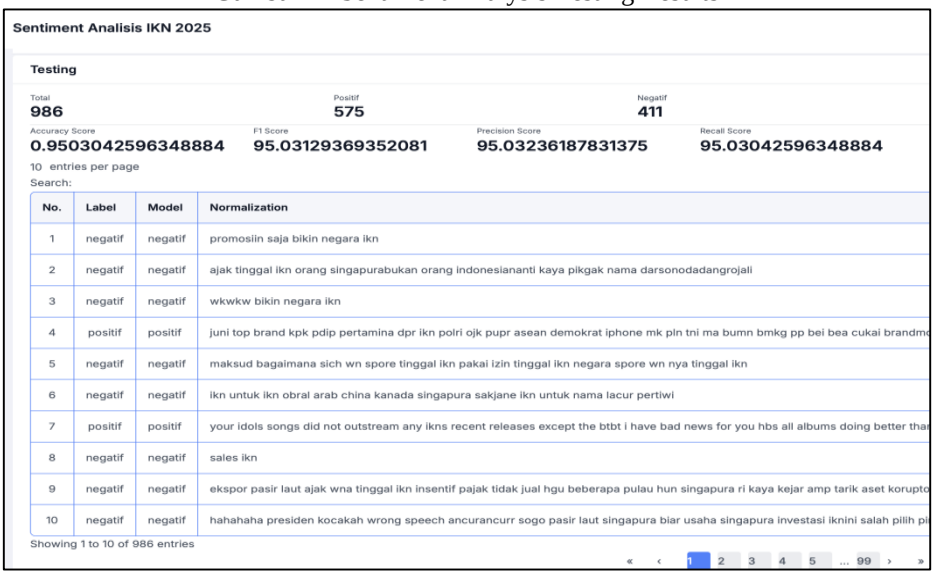
Recall = TP / (TP + FN) = 0.9564

From these two formulas, we can estimate False Positives (FP) and False Negatives (FN) based on the relationship between TP, FP, and FN. The F1 Score which is calculated as the harmonic average between Precision and Recall is as follows:

F1 Score = 2 * (Precision * Recall) / (Precision + Recall) = 95.63%

Overall these results show that the model has excellent performance in classifying data with a very low error rate. The test results of the member registration feature are shown in Figure 17.

Gambar 17 Sentiment Analysis Testing Results



CONCLUSION

State: The development of the Indonesian capital sentiment analysis system begins with the planning, modeling, implementation and testing stages. The application of the Extreme Programming (XP) method in system development greatly influences the success of implementation, because it involves users directly, which greatly supports the achievement of development in a short time. XP divides the application development process into five stages: planning, designing, coding, testing, and software improvement. The design stage in XP includes creating Use-Case Diagrams, Activity Diagrams, and Logical Record Structures, which are then translated in the coding stage into a system, followed by testing at the testing stage, and evaluation at the software improvement stage. This sentiment analysis system is integrated with the CSV method, so that the sentiment analysis process becomes faster and more efficient. Test results show that the system functions well, especially in displaying sentiment scores and emotional classification of given words. Based on adequate results, this system can be a useful alternative for society in conducting sentiment analysis, which can also be used as a reference in decision making and evaluation. However, development and addition of system features are still needed to increase ease of use and effectiveness, as well as to ensure that the system remains relevant to technological developments and meets user needs through regular evaluation.

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