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26S-B2-Informatik 2 DES 060

26S-B1-Informatik 2 (Moodle PP)

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Infotmatics Management, Engineering, and Information System Journal, Vol. 3, No. 2, December 2025, 146-153
E ISSN : 3025-5384, DOI : https://doi.org/10.56447/imeisj

Grouping Students Based On Academic Values Using The K-Means Method At A Vocational High School In Bandung

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Abstract

A vocational high school in Bandung is dedicated to cultivating competitive and employable graduates. Nonetheless, the institution faces challenges in conducting comprehensive assessments of pupils' academic data to identify their strengths and weaknesses. Currently, data analysis relies on basic descriptive methodologies, which often fail to yield adequate insights for informed strategic decision-making. Furthermore, there is a lack of interactive visualization tools to enhance the presentation of student grouping data.

This study aims to address these concerns by utilizing the K-Means algorithm to categorize pupils based on their academic performance. This classification yields three clusters that delineate students' attributes in high, medium, and low score categories. The evaluation results indicate that the model comprising three clusters has the highest Silhouette Score of 0.3364. This research generates an interactive website as a visualisation tool to display the outcomes of student grouping correctly.

The implementation of this method is anticipated to enhance the school's management of academic data and deliver tailored learning recommendations that more effectively address the needs of students within each cluster. Therefore, the educational quality of this vocational high school in Bandung can be markedly enhanced.

Keywords : *K-Means, Clustering, Academic Data, Visualization*

INTRODUCTION

Education is essential for cultivating individual potential and shaping a nation's advancement. Vocational high schools aim to equip students with the necessary skills for their respective industries (Liu, 2022).

A vocational high school in Bandung offers nine programs and is dedicated to producing competitive graduates at both national and international levels. This school lacks an analytical methodology to categorise students by their academic traits, resulting in analyses being performed solely through basic descriptive approaches.

This constraint hinders the school's ability to acquire comprehensive insights into student characteristic trends. Consequently, an analytical system grounded in data mining, specifically employing clustering techniques, is crucial for enhancing the efficiency and precision of academic data management.

The utilisation of clustering techniques can aid the school in categorising students according to academic similarities, facilitating a more customised learning experience. This method

can enhance data management efficiency and facilitate improved academic decision-making.

Data Mining

Data mining is the technique of identifying patterns in large datasets that facilitate decision-making (Santosa et al., 2021). This strategy facilitates the discernment of trends and correlations within the data using algorithmic analysis. The identified patterns can yield significant insights and facilitate a more precise decision-making process.

Clustering

Clustering is a data mining technique used to categorize data into clusters that exhibit commonalities based on specific attributes (Vankayalapati et al., 2021). This technique aims to identify patterns in the data without necessitating pre-established class designations.

K-Means

K-Means is a non-hierarchical clustering technique that categorises data according to distinctive similarities (Chang et al., 2020). This technique partitions the data into many clusters by minimising intra-cluster variance and maximising inter-cluster differences (Moubayed et al., 2020). This approach is straightforward and efficient in numerous data analysis contexts.

Website

A website comprises a series of interlinked pages that include diverse content, such as documents and photos, hosted on a web server. (Rani et al., 2021; Wati et al., 2021)

Python (Flask)

Python is a programming language engineered for enhanced code readability, primarily through extensive use of indentation (Cahapin et al., 2023). Flask, a Python-based microframework, facilitates the creation of organized and flexible online applications, maintaining a lightweight nature while being adaptable to specific requirements.

Object Oriented Analysis Design

The Object-Oriented Analysis and Design (OOAD) Software Development Model employs the OOAD idea as a system development methodology that prioritizes objects above data or data analysis methods. (Sari, I. P., Al-Khowarizmi, A. K., & Batubara, 2021)

Unified Modeling Language (UML)

The Unified Modelling Language (UML) serves as the standard for visualising, planning, and documenting software systems, applicable to many applications, including corporate and real-time systems (Hamka & Ramdhoni, 2022).

The author aims to develop an interactive website as a visualisation tool to display the outcomes of student clustering effectively. This strategy is anticipated to enable the school to efficiently manage academic data and deliver more customized learning recommendations tailored to the needs of students within each cluster. Consequently, the educational quality of a vocational high school in Bandung might be markedly enhanced.

METHOD

This study utilises a quantitative research approach to examine the academic performance data of students at a vocational high school in Bandung. It emphasises the application of the K-Means clustering technique to classify pupils according to their academic performance. Data will be gathered from students' academic records, encompassing test results, assignments, and attendance. The preprocessing phase will entail data cleansing to eliminate discrepancies and normalisation to guarantee uniform contribution from each characteristic. The K-Means technique will be employed to generate three clusters denoting high, medium, and low academic achievement. The ideal number of clusters will be found by the Silhouette Score, prioritising the attainment of the highest score for efficient classification.

An interactive website will be created to serve as a visualisation tool for student grouping data. This website will present clustering results via intuitive charts and graphs, enabling instructors to analyse data and derive insights into student performance effortlessly. A preliminary pilot test will be conducted with a selected cohort of educators to gather input, which will subsequently inform the comprehensive deployment of the technology. The implementation's impact will be evaluated through qualitative input from educators and the tracking of changes in student performance over time, with the ultimate goal of enhancing data management and decision-making within the school.

RESULT AND DISCUSSION

Analysis of Current System Work Procedures

The operational protocols of the system presently implemented at a vocational high school in Bandung are as follows:

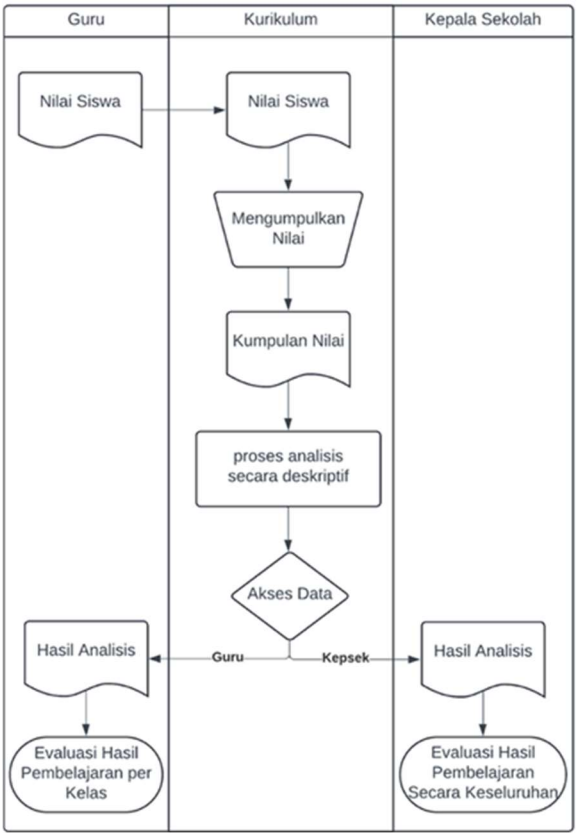


Figure 1. Analysis of Current System Work Procedures

The existing protocol for assessing learning outcomes at the school commences with educators entering student grades into the curriculum system. The curriculum aggregates all student grades and conducts a descriptive analysis of the collected data. Following the study, data access is allocated to instructors and the principal based on their requirements. Teachers utilise the analytical results to assess learning outcomes for each class, whereas the principal conducts a comprehensive evaluation of learning outcomes based on the available data.

System Design

System design aims to identify the technical elements that form the foundation of the design solution. At this juncture, the design is meticulously delineated to tackle specific technical concerns pertinent to implementation tasks, including Use Case Diagrams, Activity Diagrams, Sequence Diagrams, Class Diagrams, and interface design.

Use Case Diagram

Figure 2. Use Case Diagram

Activity Diagram

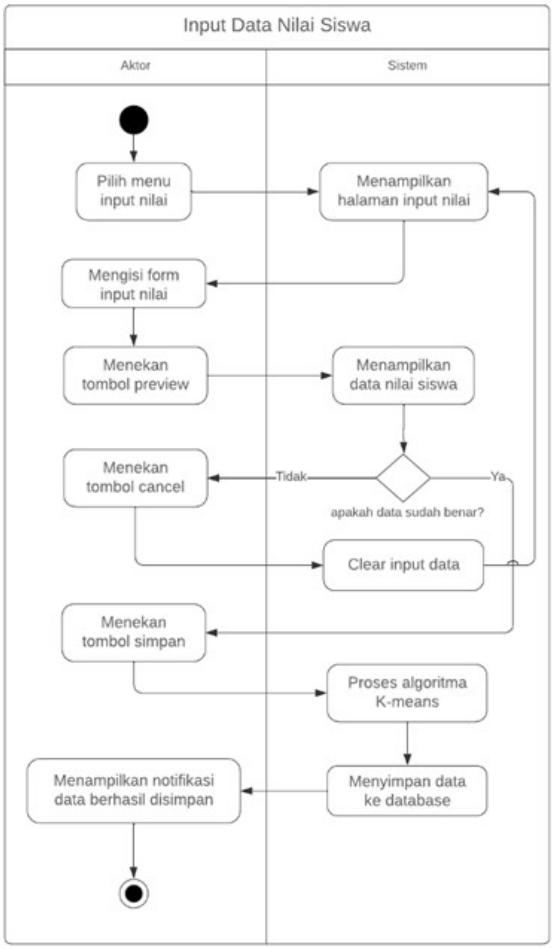


Figure 3. Activity Diagram

Sequence Diagram

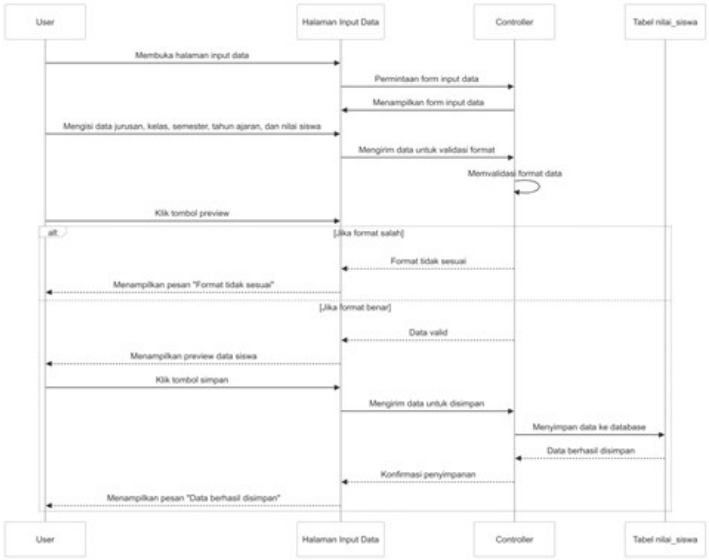


Figure 4. Sequence Diagram

Class Diagram

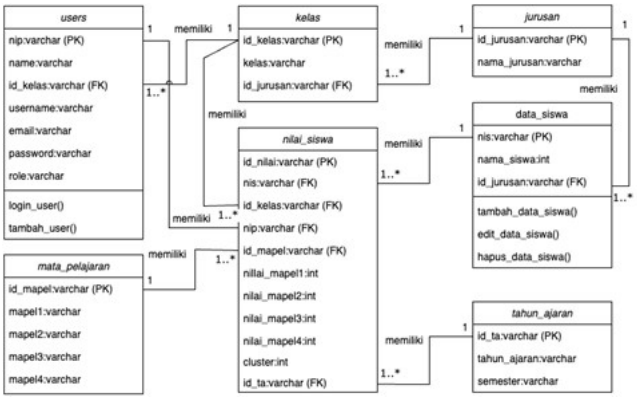


Figure 5. Class Diagram

Interface Design

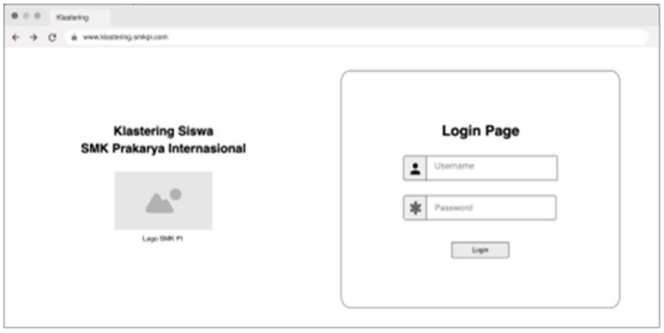
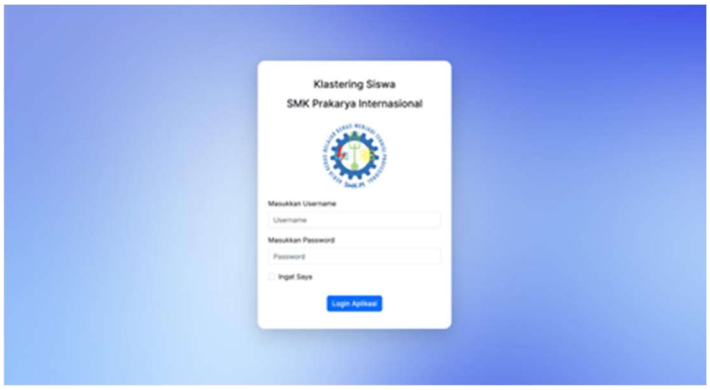
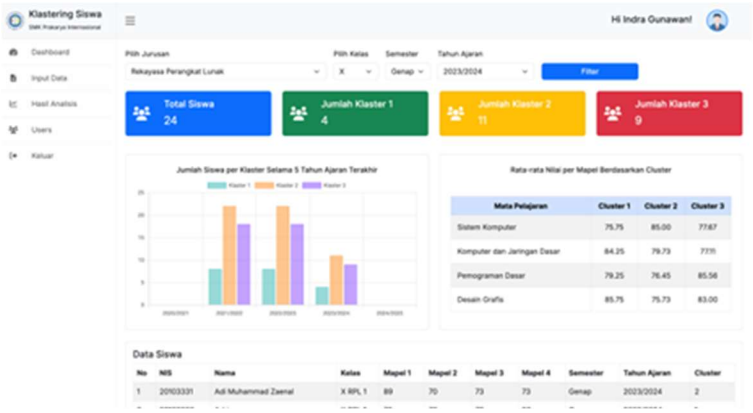


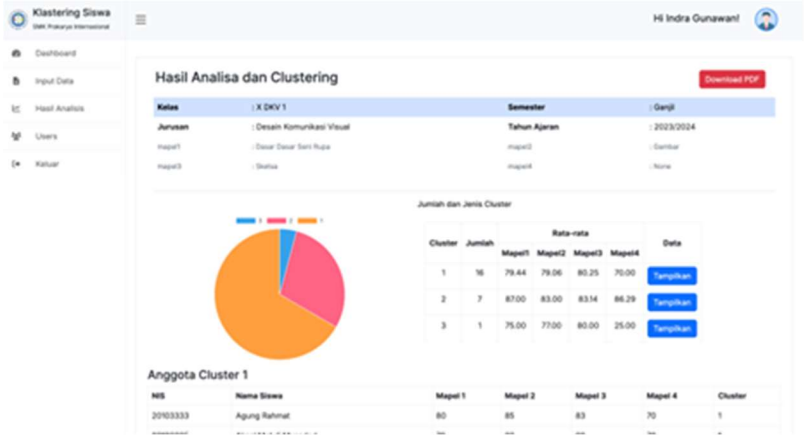
Figure 6. Interface Design

System Implementation

Implementation is the process of ensuring the execution and attainment of a programme or policy.







CONCLUSION

The findings of this study will significantly aid the school in assessing and appraising student learning outcomes more efficiently. The use of the designed system streamlines the collection and analysis of grades, allowing teachers to assess learning for each class with enhanced precision. This increased precision enables educators to pinpoint specific areas of student difficulty and to customise their instructional methods accordingly, ultimately resulting in higher student performance.

Moreover, the technology enables the principal to perform a thorough assessment of overall learning outcomes. By utilizing comprehensive data, the principal may evaluate the school's educational quality and make informed judgments to improve teaching methodologies and resource allocation. This comprehensive strategy not only enhances the ongoing advancement of academic standards but also cultivates a learning environment that emphasises student success and involvement.

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