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The Role of Big Data in Improving Educational Management Decisions in Madrasah

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Abstract— *This study aims to explore the role of Big Data in improving educational management decisions in Madrasah. Using a qualitative approach with case studies, the research subjects include educational managers, teaching staff, and students. Data collection techniques consist of observation, interviews, and documentation, while data analysis includes reduction, presentation, and drawing conclusions. The results of the study indicate that the application of Big Data significantly improves educational management decisions through four main indicators: student performance analysis, learning personalization, operational efficiency, and trend prediction. Big data analysis allows management to optimize resource allocation, adjust teaching methods to student needs, and make more accurate data-based decisions. The application of Big Data also helps in identifying educational trends and reducing waste, which ultimately improves the quality of education and operational efficiency. These findings underline the importance of data technology integration in designing more effective and result-oriented educational policies and strategies.*

Keywords— *Big Data, Educational Management Decisions, Madrasah*

1 Introduction

Educational management decisions are not only based on empirical data alone, but involve complex analysis that enables more accurate and relevant decision-making thanks to the integration of Big Data [1]. With this, Big Data Integration enables the collection, processing, and analysis of large amounts of data at high speed, thus providing deeper and more comprehensive insights [2]. Based on research conducted by McKinsey & Company, the use of Big Data in the education sector has shown an increase in the efficiency of management decisions by up to 20%. For example, several leading universities in the United States have succeeded in reducing student drop-out rates by 15% through predictive analysis supported by Big Data [3][4]. By leveraging advanced data analytics, educational institutions are better able to address new challenges, provide more effective interventions, and improve the overall quality of education.

In big data research in improving education management decisions. Some previous studies related to this research theme [5], The application of big data analysis can help in optimizing budget allocation, managing teaching schedules, and monitoring facility usage more effectively. Furthermore, Big data is used to identify students' strengths and weaknesses and adjust teaching methods to improve learning outcomes [6]. Meanwhile, Big Data-based trend analysis helps education management in predicting changes in educational needs, adapting the curriculum to the latest developments, and anticipating future challenges [7].

The novelty of this research lies in the application of Big Data in educational management decision making. Most previous studies have focused more on the use of data in academic and curriculum contexts, while this study emphasizes how Big Data analysis can effectively improve strategic decisions in educational management. This study introduces an approach that focuses on utilizing big data to optimize resource allocation, learning personalization, and operational efficiency [8][9]. Through the application of Big Data, this study provides new insights into how data technology can inform and improve managerial decisions in

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educational institutions. These findings have the potential to be a practical guide for educational institutions in designing more effective, sustainable, and measurable data-based policies and strategies.

This study aims to analyze how the application of Big Data can improve educational management decisions by identifying key factors that influence the effectiveness of educational management, understanding the impact of big data on learning personalization and operational efficiency, and evaluating the results of data-based decisions on the overall quality of education [10]. This study argues that improving educational management decisions requires a more integrated and analytical data-driven approach, especially in managing resources, designing tailored learning strategies, and predicting educational trends [11]. Traditional approaches that rely on intuition and experience are often inadequate to deal with the complexity of the needs and dynamics of modern education [12][13]. By leveraging Big Data, educational institutions can make more accurate, informative, and result-oriented decisions, which ultimately contribute to improving the quality and effectiveness of education.

2 Method

This study uses a qualitative approach, case study type. This approach was chosen because the purpose of this study is to analyze howimproving educational management decisions through big data at MI Unggulan An Nawawi Purworejo. This approach allows researchers to explore the subjective perspectives and experiences of the various parties involved. The research site is MI An Nawawi's Leading High School, with the aim of understanding in depth aboutimproving educational management decisions through big data. The reason for choosing this location is because this madrasah has characteristics that are suitable for testing the application of big data technology in educational management. As one of the leading madrasahs in its area, MI An Nawawi has a fairly well-established educational management system, but it can still be improved by implementing new technologies. This location was also chosen because of the madrasah's commitment to educational innovation, making it an ideal place to study how big data can be used to make more accurate and effective decisions. In addition, support from the madrasah management and the availability of relevant data are important factors that support the smooth running of this research.

Participants were selected using purposive techniques, namely the determination of those selected with certain considerations and objectives. The reason for using this technique is that researchers need data in the form of information that can only be obtained from informants who certainly have more knowledge about the data that researchers want to obtain, so as to produce data that is in accordance with expectations and relevant to the predetermined title. This study involved 9 participants consisting of Principal of Madrasah, Vice Principal of Curriculum, Vice Principal of Student Affairs, IT Staff, and Teachers. Among the informants have different job backgrounds, education, and gender, so it is expected to provide accurate information about the research theme.

The interview technique used in this study is a semi-structured interview technique, which means it has an interview guideline, and although there are interviews outside the guideline. At the beginning of each interview, the researcher introduced himself and provided an overview of the interview topic. To increase accuracy and thorough documentation, an agreement was made with the participants to record the interviews. These recording sessions, along with the accompanying transcripts, serve as valuable sources for careful analysis and interpretation in this study. The researcher prepared several questions relevant to the research theme as a semi-structured interview.

Based on the interview transcripts, the researcher identified themes that were in line with the research objectives. This process involved identifying themes in the interview data by reviewing the interview transcripts thoroughly several times until the researcher obtained a clear picture of theimproving educational management decisions through big data at MI Unggulan An Nawawi. After the interview, the researcher assured the participants that the interview recordings would be kept confidential. The research interview protocol was essential in helping to guide the in-depth semi-structured interviews with the participants.

The semi-structured design offers a balance between flexibility and an established framework, allowing researchers to delve into a particular subject while remaining open to unexpected outcomes. The protocol served as a methodological framework, ensuring uniformity in data collection procedures during the interviews and allowing for the investigation of key themes regardingimproving educational management decisions through big data at MI Unggulan.

Miles and Huberman's qualitative data analysis techniques from the researchinvolves four steps, starting with the formulation of clear research objectives [14]. This research aims to analyzeimproving educational management decisions through big data at MI Unggulan An Nawawi.The initial stage of data analysis includes collecting research data obtained through the process of observation and interviews and documentation as research notes. The second step in data reduction is to summarize, select key elements, and focus on important data that is in line with the research theme. This careful data reduction process aims to present a clear and concise picture of radicalism in rural areas. Furthermore, the third step involves presenting data through narrative text. The final step in the data analysis process includes drawing research conclusions based on data reduction. These conclusions are made carefully to synthesize the data collected. Data validity is ensured through the process of data triangulation and review, which ensures consistency with research findings. To ensure the accuracy of the data collected, source triangulation is carried out by cross-referencing information from previous theories and studies related to the rolebig datainimprove education management decisions.

3 Findings And Discussion

This study discusses the role of Big Data in educational management decision-making, focusing on performance analysis, learning personalization, operational efficiency, and trend prediction. The results of the study show that Big Data enables in-depth student performance analysis, supports learning personalization, improves operational efficiency, and helps predict educational trends. The discussion highlights the positive impact of Big Data on the accuracy of management decisions and challenges related to data privacy. The results of this study are presented in the following five sections.

Performance Analysis

Performance analysis is part of the findings in improving educational management decisions through big data. HF as the principal said that Big Data has great potential in improving the quality of student performance analysis. With data collected from various sources, such as exam results, assignments, attendance, and student activities, we can conduct deeper and more detailed analysis. For example, we can identify each student's learning patterns, see trends in their achievements, and detect problems before they develop into bigger problems. Thus, management can make more informed decisions regarding educational interventions, such as adjusting teaching methods or providing additional support for students in need.

From the statement above, it can be understood that Big Data plays a significant role in improving student performance analysis by collecting data from various sources, such as exam results, assignments, and attendance. Through in-depth analysis, learning patterns and student achievement trends can be identified, allowing early detection of problems before they develop. This allows management to make more informed decisions, such as adjusting teaching methods or providing additional support to students in need, so that educational interventions become more effective and targeted.

Regarding the benefits of using big data, as Fika said, the ability to make more precise decisions based on real data. With Big Data analysis, we can understand where the weaknesses and strengths of students are, so that we can provide more personalized and targeted assistance. In addition, management can respond more quickly to student needs and optimize available resources to support the teaching and learning process. Ultimately, the main goal is to improve student learning outcomes and ensure that every student gets the best education.

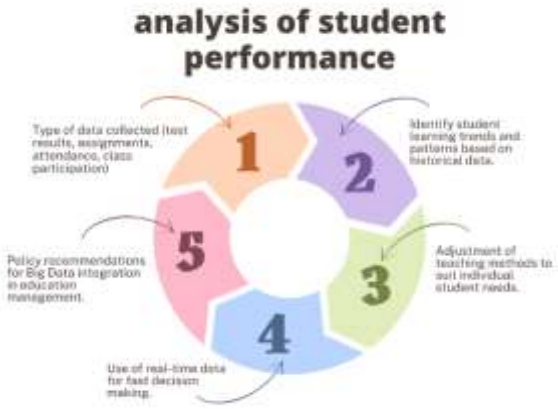

Figure 1. Student Performance Analysis Indicators

From the figure 1 above, it shows that Big Data in student performance analysis allows the collection and utilization of data from various sources such as exam results, assignments, attendance, and class participation. By identifying learning patterns and segmenting students, management can detect problems early and adjust teaching methods to meet individual needs. The speed and accuracy of decision making is improved with real-time data analysis, which then has a positive impact on student learning outcomes [16][17]. However, challenges such as data privacy and security remain a concern, requiring innovative solutions and the development of technological infrastructure and training for optimal integration of Big Data into the education system.

Personalization of Learning

Personalization of learning as a result of the application of Big Data in educational management shows that this approach allows the development of learning strategies that are more tailored to the individual needs of students. By analyzing data such as learning preferences, comprehension speed, and engagement patterns, educational institutions can design curricula and teaching methods that are more relevant and effective for each student. This personalization not only increases student engagement in the learning process but also has a positive impact on their academic outcomes, as learning becomes more tailored to each individual's unique style and needs. These findings underscore the importance of leveraging Big Data in creating more adaptive learning experiences, ultimately improving the overall quality of education.

Table 1. Results of the Learning Personalization Interview

Statement	Coding	Informant Code
"With Big Data, we can identify students' individual learning styles and preferences, so that the curriculum can be tailored to each student."	Personalization	HF
"Data analysis helps us understand the speed at which students learn, which allows us to adjust our teaching methods to be more effective."	Adjustment	MRR
"Personalizing learning through data allows students to be more engaged and their academic outcomes improve because the material is delivered according to their needs."	Involvement	SH
"With the data collected, we can design learning strategies that are more adaptive and relevant to each individual, improving the quality of education."	Adaptation	Sb

The results of the interview in the form of the table above show that the use of Big Data in personalizing learning has a significant impact on the effectiveness of education [18]. Informants revealed that data allows identification of individual students' learning styles and preferences, which supports the adjustment of the curriculum to meet each student's needs, a process known as Personalization [20]. In addition, data analysis also facilitates the adjustment of teaching methods according to the speed of student understanding [21]. With this approach, student engagement in learning increases, which is reflected in their academic results, a phenomenon termed Engagement. Finally, data allows the development of more relevant and effective Adaptation of learning strategies, improving the overall quality of education.

Operational Efficiency

Operational efficiency in the context of Big Data implementation reveals that the use of big data significantly improves resource management and operational processes in educational institutions. With in-depth data analysis, institutions can optimize budget allocation, manage staff more effectively, and maximize facility utilization. Big Data provides real-time insights and analytics that enable the identification of areas for improvement and reduction of waste. This efficiency not only saves costs but also improves operational quality, making it more economical and aligned with educational goals. Regarding optimization, Sb said that by using Big Data, we can monitor and analyze resource usage in real-time, which allows us to optimize budget allocation and reduce waste.

Another perspective, from MRR regarding facility utilization that Big Data provides in-depth insights into facility utilization, so that we can maximize utilization and reduce overall operational costs. The importance of Big Data in providing in-depth insights into facility utilization in educational institutions. With comprehensive data analysis, management can identify patterns of facility utilization and suboptimal areas. This allows them to maximize the utilization of existing facilities, reduce waste, and lower overall operational costs. As a result, MI Unggulan can improve operational efficiency and allocate resources more effectively, supporting more economical and sustainable management.

The following statement from the informant above shows that the implementation of Big Data significantly increases operational efficiency in educational institutions. With in-depth data analysis, management can optimize budget allocation, better manage staff, and maximize facility utilization [23]. Big Data provides real-time insights that enable identification of areas for improvement and waste reduction [24][25]. This results in increased efficiency, cost savings and more effective resource management, which supports educational goals in a more economical and sustainable manner.

Trend Prediction

Trend predictions show a significant shift in education management becoming increasingly data-driven, with the increasing use of predictive analytics to monitor and project student performance, enabling timely and effective interventions. In addition, personalization of learning is gaining prominence, with Big Data being used to customize teaching methods, increasing student engagement and learning effectiveness. This trend also includes optimizing educational resources based on comprehensive data analysis, increasing operational efficiency and transparency in decision-making, and building trust among stakeholders. Overall, the application of Big Data is predicted to continue to grow, driving innovation and transformation in education management.

Table 2. Results of Trend Prediction Interviews

Statement	Coding	Informant Code
"The use of predictive data has helped us identify students who need special attention earlier."	Predictive analytics	HF
"Data analysis allows us to allocate budgets more efficiently, ensuring optimal use of resources."	Resource optimization	LH
"Transparency in school decisions has increased, I can see how data is used for policy."	Transparency	SA
"The application of Big Data in schools will continue to grow, creating new innovations in education."	Innovation	AT

From the table above, it can be concluded that the use of Big Data in education management supports predictive trends in identifying students who need intervention, facilitating personalization of learning, and improving operational efficiency through resource optimization. In addition, Big Data also strengthens transparency and accountability in decision making. This application is predicted to continue to grow, driving innovation and transformation in education, with data as the main key in improving the quality of management and student learning outcomes.

Figure 2. Trend Prediction Indicator

The figure 2, above explains that the use of Big Data in education has a significant impact, especially in facilitating early identification of student needs, and optimizing resource allocation more efficiently [26][27]. In addition, Big Data also increases transparency and accountability, supporting more informed decision making [28][29]. With the continued development of the application of this technology, innovation and transformation in education are expected to be stronger, making data a key element in improving the quality of management and academic outcomes.

Data-Driven Decisions

Data-driven decisions in education management have transformed the way institutions respond to student needs, enabling more timely interventions and personalization of instruction. In addition, data helps in more efficient allocation of resources and increases transparency in decision-making. Overall, this approach not only improves operational efficiency but also drives innovation and trust in education management. As conveyed by Sb that timely intervention, namely data helps us in making quick decisions to provide support to students who need it. Meanwhile, MRR said that with data, teaching methods can be adjusted to better suit the needs of individual students. Various parties in education management see the benefits of data-driven decisions, ranging from more timely interventions to increased efficiency and transparency.

The informant's statement above concludes that data-based decisions in educational management accelerate support for students in need, allow for the adjustment of teaching to individual needs, and increase efficiency in budget allocation [30][31]. In addition, data also provides higher transparency in decision-making, which increases trust among all parties involved [32]. Overall, this approach strengthens education management through more timely interventions and optimal use of resources.

Figure 3. Data-based Decisions through Big Data Education

The figure 3, it shows that the use of data in educational management has a significant impact by enabling fast and precise action on student needs, more effective personalization of teaching, and efficient allocation of resources [33]. In addition, data also increases transparency, which strengthens trust among all parties involved [34]. This approach overall improves the quality of management and educational outcomes [35].

4 Conclusion

This study examines how the application of Big Data can improve educational management decisions by leveraging student performance analysis, learning personalization, operational efficiency, and trend prediction. The results show that the use of Big Data enables more effective and data-driven management in various aspects of education. Through in-depth analysis, management can personalize student learning experiences, optimize resource allocation, and make more accurate and informed decisions. The combination of these various Big Data applications has been shown to improve the quality of education, reduce waste, and support the achievement of educational goals in a more efficient and sustainable manner.

The theoretical implications of these findings extend the application of Big Data in educational management, which was previously better known in the context of business and industry. The application of Big Data for student performance analysis, learning personalization, operational efficiency, and trend prediction has proven effective in improving managerial decisions in educational institutions. These findings suggest that data-driven methods can be widely applied to improve the quality of education and resource management. In addition, the results of the study emphasize the importance of a deep understanding of students' needs and characteristics and optimizing data-driven strategies to achieve efficiency and effectiveness. Thus, this study contributes to the literature on educational management and provides practical guidance for decision makers in educational institutions to utilize Big Data in designing more measurable and result-oriented policies and strategies.

These findings highlight the importance of Big Data in improving educational management decisions. In today’s digital era, where big data can be acquired and analyzed quickly, educational institutions need to adopt data-driven strategies to improve the effectiveness of management and strategic decisions. By leveraging Big Data, educational institutions can optimize resource allocation, personalize learning, and predict trends more

accurately. This study also provides valuable insights into how data technology can be used to improve educational quality and operations, expand the reach of analysis, and support more informed decision-making. These findings suggest that Big Data integration can strengthen educational management by providing tools for in-depth analysis and more efficient management, ultimately contributing to the achievement of better educational outcomes.

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