USE OF BIG DATA IN EDUCATION MANAGEMENT: BUILDING DATA-POWERED DECISION MAKING

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Abstrac

This study aims to analyze the impact of using big data in education management in an effort to improve the quality of education as a whole both in terms of the implementation, benefits and challenges of using big data in education management. The method used in this research is library research method. Data were obtained from various sources such as scientific journals, books, seminar papers and other relevant publications related to research topics both offline and online.

The data obtained were analyzed using an interactive qualitative model. This data analysis technique consists of data collection, data reduction, data presentation and drawing conclusions. The results of this research are first, the implementation of big data in education management through data collection. Big data storage and processing. Data analysis for decision making and use of data analysis tools. Second, the benefits of using big data in education management include increasing the efficiency of education administration. Provide in-depth insight and information about students.

Support curriculum development that focuses on student needs. Provides objective measurement of teacher and school performance. And improve predictions and interventions against educational risks. And third, challenges in implementing big data include challenges in collecting and analyzing complex data. Privacy protection and data security. Infrastructure system development. And an increase in user capabilities and skills. This research contribution can provide a deeper understanding of how the use of big data in education management can have a positive impact on improving the overall quality of education and can also provide a more detailed comparison between data-driven decision-making methods and traditional methods in the educational context.

Keywords: Big Data, Education Management, Building Data, Decision Making.

A. Pendahuluan

The use of Big Data in education management has become an increasingly important and interesting topic in recent years [2], developments in information and communication technology have had a significant impact on various aspects of education, from the learning process to school administration.[3] In recent years, the amount of data generated in educational contexts has increased drastically. These data include information about students, teachers, curriculum, exam results, student enrollment and much more. New technologies such as digital-based

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[3]Muchamad Suradji, "Pengembangan Teknologi Informasi Dan Komunikasi Di Bidang Kesiswaan, Kepegawaian Dan Keuangan Di Sma Muhammadiyah 1 Gresik," *Ta'lim: Jurnal Studi Pendidikan Islam* 1, no. 2 (July 30, 2018): 347–71, https://doi.org/10.52166/talim.v1i2.957.

school management systems,[4] online learning platforms[5] and digital evaluation tools have enabled broader and more detailed data collection than before.[6]

This change has provided a great opportunity to increase the effectiveness of education management.[7] By using Big Data, educational institutions can collect, store and analyze large amounts of data quickly and efficiently. This data can provide valuable insights into student performance, teaching effectiveness and other factors that affect educational outcomes. A digital-based school management system allows for broader and more detailed collection of administrative data.[8] These data include student personal information such as identity, educational history and attendance. In addition, data regarding class schedules, teacher contact information and disciplinary records can also be accessed and managed more easily through the digital school management system.

Online learning platforms also provide rich data sources.[9] Through this platform, teachers can provide assignments, tests, or exercises that are uploaded electronically.[10] Data generated from student interaction with this platform can include learning progress, level of understanding, and study habits. These data provide insight into individual student performance and can assist in identifying areas for improvement or adapting learning materials. Digital evaluation tools also play an important role in data collection in education. Examinations conducted digitally generate data on student test results, individual performance and class rankings.[11] These data can provide information about students' level of understanding of the material, allow for analysis of student-to-student comparisons and provide more detailed feedback on learning progress.

This ability to collect extensive and detailed data provides opportunities for stakeholders in education to make better and more informed decisions.[12] These data can be used to identify individual student learning needs, plan relevant and responsive curricula, monitor teacher performance and evaluate the overall effectiveness of educational programs.[13] However, this increasing amount of data also presents challenges to the effective management, storage and analysis of data. Expertise is required in processing this large and complex data into useful

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[4]Azrina Purba et al., "Pelatihan Penggunaan Sistem Administrasi Sekolah Berbasis Digital Bagi Guru-Guru Sma Swasta Persiapan Stabat," *Jurnal Pengabdian Kepada Masyarakat* 3, no. 2 (2022).

[5]Dewi Surani, Jaka Wijaya Kusuma, and Nugrahini Kusumawati, "Platform Online Dalam Perkuliahan Pada Masa Pandemi Covid-19," *Jurnal Pendidikan: Teori, Penelitian, dan Pengembangan* 5, no. 9 (September 1, 2020): 1338, https://doi.org/10.17977/jptpp.v5i9.14057.

[6]Aries Setia Nugraha, "Analisis Kemampuan Mahasiswa Dalam Mengembangkan Alat Evaluasi Berbasis Digital," *Literasi: Jurnal Ilmiah Pendidikan Bahasa, Sastra Indonesia Dan Daerah* Vol. 13, No. 1, (January 2023).

[7]Sudarsri Lestari, "Peran Teknologi dalam Pendidikan di Era Globalisasi," *Edureligia; Jurnal Pendidikan Agama Islam* 2, no. 2 (August 10, 2018): 94–100, https://doi.org/10.33650/edureligia.v2i2.459.

[8]Moh Muslim, "Visi Kepemimpinan Digital Kepala Sekolah Dasar Di Era Teknologi Digital," *Elementeris : Jurnal Ilmiah Pendidikan Dasar Islam* 3, no. 1 (April 7, 2021): 1, https://doi.org/10.33474/elementeris.v3i1.8796.

[9]Dera Sulastri and Luthfi Hamdani Maula, "Pemanfaatan Platform Digital Dalam Pembelajaran *Online* Selama Masa Pandemi Covid-19 Di Sekolah Dasar," *Jurnal Pendidikan Dasar* 11(02), (2020): 219-229.

[10]Muhammad Sholeh, "Pengembangan *Elearning* Menggunakan Moodle Di SMK Muhammadiyah 2 Muntilan," *Jurnal Gaung Informatika,* 10(1). (2017).

[11]Evi Sapinatul Bahriah, Lathifa Utami Dewi, and Dedi Irwandi, "Pengaruh Media Penilaian Formatif Online Quizizz Terhadap Hasil Belajar Siswa Materi Sistem Periodik Unsur," *JRPK: Jurnal Riset Pendidikan Kimia* 11, no. 1 (July 1, 2021): 19–26, https://doi.org/10.21009/JRPK.111.04.

[12]Herry Fitriyadi, "Integrasi Teknologi Informasi Komunikasi Dalam Pendidikan: Potensi Manfaat, Masyarakat Berbasis Pengetahuan, Pendidikan Nilai, Strategi Implementasi Dan Pengembangan Profesional," *Jurnal Pendidikan Teknologi dan Kejuruan,* Volume 21, Nomor 3, (Mei 2013).

[13]Atik Puspita Rini et al., "Pendekatan Terintegrasi dalam Pengembangan Kurikulum Abad 21," *Jurnal Ilmiah Pendidikan Holistik (JIPH)* 2, no. 2 (April 30, 2023): 171–82, https://doi.org/10.55927/jiph.v2i2.3942.

information and can be used in decision making.[14] Technological developments such as digital-based school management systems,[15] online learning platforms[16] and digital evaluation tools have opened up great potential in data collection in education.[17] These data provide valuable information for understanding and enhancing student learning experiences, improving the quality of education, and supporting more effective decision-making in education management. The use of Big Data in education management also poses challenges that need to be overcome.[18] One of the main challenges is how to manage, process and analyze large and complex data. adequate infrastructure and data analysis skills are required to generate useful and reliable information.

Data privacy and security issues are also an important concern in the use of Big Data in education.[19] Personal data of students and teachers must be properly protected so that it is not misused or accessed by unauthorized parties.[20] Although there are challenges in using Big Data, its potential in education management is enormous. By analyzing data carefully, decisions can be made based on solid and objective evidence. This can assist policy makers, school principals and educators in designing more effective learning strategies, monitoring student performance, evaluating educational programs, and identifying problems and opportunities that may arise. In an ever-evolving educational context, the use of Big Data in education management is becoming increasingly important. By harnessing the potential of existing data, educational institutions can make smarter decisions, improve the quality of education, and provide a better learning experience for students.

The purpose of this study is to analyze the impact of using Big Data in education management with the aim of improving the quality of education as a whole both in terms of implementation, benefits and challenges of using big data in education management. With this aim, this research is expected to provide a more in-depth understanding of how the use of Big Data in education management can have a positive impact on improving the overall quality of education and also this research can provide a more detailed comparison between data-based decision-making methods and traditional methods in educational context.

B. Metode Penelitian

The method used in this research is library research method. Literature-based research is a form of research that uses literature as an object of study.[21] Literature studies are obtained from various sources such as scientific journals, books, seminar papers, and other related publications related to research topics both offline and online. In the early stages of the research, the researcher determines keywords relevant to the research topic, such as "use of big data", "education management", "decision making", and "data-supported decisions". Then, the researcher conducted a search for related literature sources using online databases such as Google Scholar, ResearchGate, Publish or Perish, WOS, Beliefe search engine and JSTOR. After obtaining relevant literature sources, the researcher made a selection using certain inclusion and exclusion criteria. Literature sources that are considered relevant and of good

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[14]Paul Eduard Sudjiman and Lorina Siregar Sudjiman, "Analisis Sistem Informasi Manajemen Berbasis Komputer Dalam Proses Pengambilan Keputusan," *TeIKa* 8, no. 2 (June 16, 2020): 55–66, https://doi.org/10.36342/teika.v8i2.2327.

[15]Hermawansyah, "Manajemen Lembaga Pendidikan Sekolah Berbasis Digitalisasi Di Era Covid -19," *Fitrah Jurnal Studi Pendidikan* 12, no. 1 (2021).

[16]Lukmanul Hakim, "Pemilihan Platform Media Pembelajaran Online Pada Masa New Normal," *Justek: Jurnal Sains dan Teknologi* 3, no. 2 (November 30, 2020): 27, https://doi.org/10.31764/justek.v3i2.3516.

[17]Nugraha, "Analisis Kemampuan Mahasiswa Dalam Mengembangkan Alat Evaluasi Berbasis Digital."

[18]Efgivia, "Pemanfaatan Big Data Dalam Penelitian Teknologi Pendidikan."

[19]Fendy Prasetyo Nugroho, Robi Wariyanto Abdullah, and Sri Wulandari, "Keamanan Big Data Di Era Digital Di Indonesia," *Informa: Jurnal Penelitian Dan Pengabdian Masyarakat* 5, no. 1 (2019): 28-34.

[20]Muhammad Fatkhul Hajri, "Pendidikan Islam di Era Digital: Tantangan dan Peluang pada Abad 21," *Al-Mikraj Jurnal Studi Islam dan Humaniora* 4, no. 1 (2023): 33–41.

[21]Kadir Sawarjuwono, T. A. P, "Intellectual Capital: Perlakuan, Pengukuran Dan Pelaporan (Sebuah Library Research)," *Jurnal Akuntansi Dan Keuangan,* 5(1) (2004): 35–57.

quality are then analyzed and synthesized by the researcher. The data obtained from the literature study were then analyzed descriptively by grouping the main themes and sub-themes related to the use of big data in education management: building data-supported decision making. The data obtained was analyzed using a qualitative interactive model[22]This data analysis model consists of data collection, data reduction, data presentation and drawing conclusions.

C. Hasil Dan Pembahasan

1. Basic Concepts of Education Management and Big Data
   a. Definition of Education Management.

      Education management is a process of managing and regulating the education system that aims to achieve predetermined educational goals. According to Suharsimi Arikunto [23], education management is a process that includes planning, organizing, implementing, and supervising educational activities in order to achieve the goals that have been set. In education management, there are several aspects that must be considered, such as aspects of the curriculum, teaching staff, facilities and infrastructure, and financial aspects.

      After 2015, education management experienced significant developments. This is due to changes in the education system which are increasingly complex and dynamic. According to Mulyasa[24], the development of education management after 2015 was marked by a change in the education management paradigm which prioritized aspects of quality and accountability. In addition, there have also been changes in the use of information technology in education management. Education management is a scientific discipline and practice concerned with planning, organizing, managing and supervising various aspects of the education system. Education management includes management activities that involve decision making, resource allocation, strategic planning, policy development, monitoring, evaluation, and improving the quality of education.[25]

      Education management involves a number of interrelated elements, including management of human resources (such as teacher s, administrative staff, and students), financial management (budget, funding, and asset management), curriculum management (preparation of learning programs, selection of materials, and development of methods teaching), management of physical facilities (such as school buildings, laboratories, libraries), management of information and technology (implementation of technology in learning and administrative processes), as well as management of relationships with stakeholders, including parents, community, and related agencies[26].

      The main goal of education management is to create a conducive environment for effective and quality learning [27]. This involves making good decisions, proper allocation of resources, monitoring and evaluating performance, and continuous improvement to achieve set educational goals. Education management also involves the application of

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[22]Miles M. B. A., Huberman M., Saldaña J., "Qualitative Data Analysis: A Methods Sourcebook.," Third Edition (California: SAGE Publications, Inc., 2014).

[23]Arikunto Suharsimi, "Manajemen Pendidikan" (Jakarta: Bumi Aksara, 2017).

[24]E Mulyasa, "Manajemen Pendidikan: Konsep, Strategi Dan Implementasi." (Bandung: Remaja Rosdakarya, 2017).

[25]Ully Muzakir, "Manajemen Peningkatan Mutu Pendidikan Tinggi," *Visipena Journal* 4, no. 2 (December 31, 2013): 130–45, https://doi.org/10.46244/visipena.v4i2.218.

[26]Apriyanti,et al., "Ilmu Manajemen Pendidikan: Teori Dan Praktek Mengelola Lembaga Pendidikan Era Industri 4.0 & Soceity 5.0." (Jakarta: PT. Sonpedia Publishing Indonesia., 2023).

[27]Afif Zamroni, "Penerapan Sistem Informasi Manajemen Pendidikan dalam Proses Pembelajaran di Sekolah Menengah Pertama," *Munaddhomah: Jurnal Manajemen Pendidikan Islam* 1, no. 1 (2020).

general management principles, such as strategic planning, efficient organization, effective leadership, coordination, data-driven decision-making, and developing policies that are responsive to changes in education. So, education management is a systematic approach that aims to optimize the use of resources, increase the effectiveness of the learning process, and achieve the set educational goals.

b. The Important Role of Education Management in Improving the Quality of Education

Education management plays a very important role in improving the quality of education. This role covers various aspects of management involving planning, organizing, monitoring, and evaluating within the education system. Following are some of the important roles of education management in improving the quality of education:

1) Strategic Planning [28]: Education management assists in the formulation and implementation of strategic planning in the educational context. With good planning, clear educational goals can be set, appropriate policies can be formulated, and resources can be allocated effectively. Strategic planning also allows the identification of challenges, opportunities and the development of strategic steps to improve the quality of education.
2) Resource Management [29]: Education management involves managing resources, including financial management, facility management, and human resource management. By managing resources efficiently and effectively, funds can be allocated wisely, facilities can be managed properly and teachers and administrative staff can be optimally empowered. Good resource management will have a positive impact on the availability and quality of resources that support learning.
3) Policy Development [30]: Education management plays a role in developing policies that support improving the quality of education. Good policies include regulations, guidelines and procedures that support efforts to improve the quality of learning and school management. The right policies can create an enabling environment for students and teachers, encourage educational innovation and promote equity and fairness in the education system.
4) Monitoring and Evaluation [31]: Education management involves continuous monitoring and evaluation of educational performance. With good monitoring, weaknesses and strengths in the education system can be identified. Evaluation is carried out to evaluate the achievement of educational goals, measure the quality of the learning process, and identify areas that need improvement. With systematic monitoring and evaluation, corrective steps can be taken to improve the quality of education.
5) Effective Leadership [32]: Education management involves effective leadership at all levels, both at the school level and at the educational administration level. Good leadership can inspire, motivate and guide teachers, students and other staff towards achieving educational goals. Effective leadership also builds a positive, collaborative and innovative work culture.

With this important role, education management contributes significantly to improving the overall quality of education. Through strategic planning, sound resource

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[28]Sri Budiman and Suparjo Suparjo, "Manajemen Strategik Pendidikan Islam," *JISIP (Jurnal Ilmu Sosial dan Pendidikan)* 5, no. 3 (July 16, 2021), https://doi.org/10.36312/jisip.v5i3.2197.

[29]Anggal, et al, "Manajemen Pendidikan: Penggunaan Sumber Daya Secara Efektif Untuk Meningkatkan Mutu Pendidikan." (Jakarta: CV. Gunawana Lestari., 2020).

[30]Heri Susanti, "Manajemen Pendidikan, Tenaga Kependidikan, Standar Pendidik, dan Mutu Pendidikan," *Asatiza: Jurnal Pendidikan* 2, no. 1 (January 18, 2021): 33–48, https://doi.org/10.46963/asatiza.v2i1.254.

[31]Amrullah Aziz, "Peningkatan Mutu Pendidikan," *urnal Studi Islam,* 10, no. 2 (2015).

[32]Rasdi Ekosiswoyo, "Kepemimpinan Kepala Sekolah Yang Efektif Kunci Pencapaian Kualitas Pendidikan," *Jurnal Ilmu Pendidikan,* 14(2). (2016).

management, appropriate policy development, ongoing monitoring and evaluation, and effective leadership, education management helps create a quality, competitive educational environment that provides fair opportunities for all students.

c. Introduction to Big Data in an Educational Context

The introduction of Big Data in the educational context has brought about significant changes in data collection, analysis and utilization [33]. Big Data refers to the large, complex and continuous volume, speed and diversity of data generated from various sources such as digital-based school management systems, online learning platforms, digital evaluation tools and others.

In an educational context, the use of Big Data involves collecting and analyzing data that includes information about students, teachers, curriculum, exam results, student participation, and more. These data cover various aspects that are relevant to the learning process and management of education as a whole. One of the advantages of using Big Data is its ability to process large and complex amounts of data using sophisticated algorithms and analytical techniques [34]. This allows the identification of patterns, trends and relationships that may not be apparent with traditional methods. With sophisticated data processing, Big Data can provide in-depth insights into student performance, learning preferences, factors that influence learning success, as well as the effectiveness of teaching methods and curricula.

In the context of education management, the use of Big Data can provide many benefits. First, Big Data enables better and more informed decision making [35]. With comprehensive data analysis, decision making can be based on solid facts and evidence, not just intuition or experience. This allows education managers to identify areas for improvement, design more effective strategies, and measure the impact of education policies and programs. Second, Big Data can be used to enhance student learning experiences [36]. By analyzing data on learning preferences, student interests, and individual needs, learning approaches tailored to student needs can be developed. This helps create a more adaptive and personalized learning environment, increases student motivation, and maximizes their learning potential. Third, the use of Big Data in education management can also increase management efficiency and effectiveness [37]. The data collected can provide insight into resource usage, such as budget allocation, timing, and facility management. With this information, decisions about resource use can be made better, optimizing resource use and increasing operational efficiency.

However, the introduction of Big Data in the educational context also has challenges that need to be overcome. These challenges include issues of privacy and data security, the ability to manage and analyze large and complex data, and the need for skilled human resources in the use of technology and data analysis. So the

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[33]Delipiter Lase, "Pendidikan di Era Revolusi Industri 4.0," *Sundermann: Jurnal Ilmiah Teologi, Pendidikan, Sains, Humaniora dan Kebudayaan* 12, no. 2 (November 7, 2019): 28–43, https://doi.org/10.36588/sundermann.v1i1.18.

[34]Novanto Yudistira, "Peran Big Data dan Deep Learning untuk Menyelesaikan Permasalahan Secara Komprehensif," *EXPERT: Jurnal Manajemen Sistem Informasi dan Teknologi* 11, no. 2 (December 10, 2021): 78, https://doi.org/10.36448/expert.v11i2.2063.

[35]Doni Heryana, Linda Setiawati, and Budi Suhendar, "Sistem Informasi Dan Potensi Manfaat Big Data Untuk Pendidikan," *Gunahumas* 2, no. 2 (January 25, 2020): 350–57, https://doi.org/10.17509/ghm.v2i2.23023.

[36]Ketut Agustini, "Inovasi Teknologi dalam Pendidikan melalui Big Data Analytic dan Personalized Learning," *Senapati)* 8 (2017).

[37]Yuspiani Yuspiani, Wahyuddin Wahyuddin, and Muhammad Shabir U, "Transformasi Arsip Di Era Big Data," *Idaarah: Jurnal Manajemen Pendidikan* 5, no. 1 (June 14, 2021): 73, https://doi.org/10.24252/idaarah.v5i1.20372.

introduction of Big Data in the educational context brings great potential to improve decision making, student learning experience and management efficiency. By wisely utilizing Big Data, educational institutions can optimize the quality of education and respond proactively to changes and demands in the world of education.

1) Potential and Advantages of Using Big Data in Education Management

The use of Big Data in education management offers significant potential and advantages. Following are some of the main potentials and advantages that can be obtained through the use of Big Data in education management:

a) Data-Based Decision Making [38]: Big Data provides access to large and diverse amounts of data, which enables more informed decision-making. By analyzing relevant data, decision making can be based on solid facts and evidence, not just intuition or experience. This helps improve the accuracy and effectiveness of decisions taken, whether in strategic planning, policy development, resource allocation, or evaluating educational programs.

b) Deep Understanding of Students [39]: Big Data allows the identification of patterns, trends and relationships that may not be visible with traditional methods. By analyzing data on academic achievement, learning behavior, learning preferences, and other factors that influence student success, educators and education administrators can gain an in-depth understanding of their students. This allows for the adoption of more personalized and adaptive learning approaches, as well as the development of appropriate intervention strategies to enhance student achievement.

c) Improving Learning Quality [40]: Big Data can be used to analyze the effectiveness of curriculum, teaching methods, and educational interventions. By looking at data on exam results, enrollment rates, student engagement and student feedback, educational institutions can identify areas for improvement and develop more effective strategies to improve the quality of learning. Utilization of Big Data in curriculum development and learning design can improve the relevance, accuracy and attractiveness of learning.

d) Efficient Management of Resources [41]: Big Data can assist educational institutions in managing resources efficiently. Data on resource usage, such as budgets, facilities, and teaching staff, can be analyzed to identify areas for savings and efficiency improvements. By leveraging Big Data, educational institutions can optimize resource allocation and avoid unnecessary waste.

e) Identification of Trends and Developments [42]: Big Data can provide insight into trends and developments in education. By analyzing data on student progress over the years, demographic data, or data on enrollment in specific programs, educational institutions can identify important trends in education and respond quickly. This helps in policy formulation, long-term planning, and adaptation to changing educational environments.

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[38]Akhmad Sirojuddin et al., "Peranan Sistem Informasi Manajemen Dalam Pengambilan Keputusan Di Madrasah Ibtidaiyah Darussalam Pacet Mojokerto," *Zahra: Research And Tought Elmentary School Of Islam Journal* Vol. 3 No. 1 (2022).

[39]Prabaswara, et al, "Aplikasi Integratif Personalized Learning System Berbasis Big Data Untuk Menciptakan Pendidikan Indonesia Yang Fleksibel.," *Lomba Karya Ilmiah,* 2 (1) (2021): 235-252.

[40] Irika Widiasanti et al., "Pemanfaatan Big Data dalam Pembelajaran Jarak Jauh (PJJ) selama Pandemi pada Daerah 3T (Terdepan, Terpencil dan Tertinggal)," *Cetta: Jurnal Ilmu Pendidikan* 6, no. 2 (June 1, 2023): 398–410, https://doi.org/10.37329/cetta.v6i2.2391.

[41] Heryana, Setiawati, and Suhendar, "Sistem Informasi Dan Potensi Manfaat Big Data Untuk Pendidikan."

[42] Rutman Lumbantoruan, "Big Data, Data Akademik Universitas," *Fundamental Management Journal*, 2, no. 1 (2017): 57-66.

f) Innovation and Sustainable Development [43]: Big Data can be a source of inspiration for innovation and sustainable development in education management. By looking at the data collected, educational institutions can identify new opportunities, develop innovative solutions, and improve the quality of education in a sustainable manner.

Utilization of Big Data in education management provides the potential to increase the effectiveness, efficiency and quality of education as a whole. However, it is important to maintain data privacy and security and address the technical, ethical and expertise challenges of managing and analyzing big data. With a wise approach, the use of Big Data can provide significant benefits to educational institutions and advance the overall quality of education.

d. Implementation of Big Data in Education Management

1. Data Collection in an Educational Context

Data collection in the context of education is the process of gathering relevant information about students, teachers, educational programs and other aspects related to the learning process and management of education. Data collection was carried out with the aim of obtaining a better understanding of conditions, needs and achievements in the educational context. The following are some methods and sources of data collection that are commonly used in educational contexts:

a) Academic Data [44]: Academic data includes information about student academic achievement, such as test scores, report cards, and academic transcripts. This data is usually collected by schools or educational institutions through periodic assessments and evaluations.

b) Surveys and Questionnaires [45]: Surveys and questionnaires are used to collect data from students, teachers, parents, or other education stakeholders. Surveys can include questions about perceptions, preferences, needs, or experiences related to education.

c) Observation [46]: Observation is carried out by directly observing learning activities in the classroom or other educational environments. Observations can provide data about student-teacher interactions, teaching styles, student engagement, and other factors relevant to the learning process.

d) Interview [47]: Interview is a data collection method that involves direct interaction between the interviewer and the respondent. In the context of education, interviews can be conducted with students, teachers, principals or parents to obtain more in-depth information about experiences, perceptions or challenges in education.

e) Administrative Data: Administrative data includes information that is routinely documented by educational institutions, such as student attendance data, teacher

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[43] Heryana, Setiawati, and Suhendar, "Sistem Informasi Dan Potensi Manfaat Big Data Untuk Pendidikan."

[44]Puji Astuti, "Penggunaan Metode Black Box Testing (Boundary Value Analysis) Pada Sistem Akademik (SMA/SMK)," *Faktor Exacta* 11, no. 2 (August 8, 2018): 186, https://doi.org/10.30998/faktorexacta.v11i2.2510.

[45]Dede Kurniadi, Aisyah Fitri Islami, and Sekolah Tinggi Teknologi Garut, "Perancangan Aplikasi Survei Kepuasan Mahasiswa Berbasis Kuesioner Online," *Jurnal Algoritma* 15, no. 2 (February 28, 2019): 43–50, https://doi.org/10.33364/algoritma/v.15-2.43.

[46]Shintia Kandita Tiara and Eka Yuliana Sari, "Analisis Teknik Penilaian Sikap Sosial Siswa Dalam Penerapan Kurikulum 2013 Di SDN 1 Watulimo," *EduHumaniora | Jurnal Pendidikan Dasar Kampus Cibiru* 11, no. 1 (January 31, 2019): 21, https://doi.org/10.17509/eh.v11i1.11905.

[47]Rofiatun Nisa' and Eli Fatmawati, "Kerjasama Orang Tua dan Guru dalam Meningkatkan Motivasi Belajar Peserta Didik," *Ibtida'* 1, no. 2 (November 18, 2020): 135–50, https://doi.org/10.37850/ibtida.v1i2.147.

employment data, registration data, and other data related to school administration and management.

f) Technology and Information Systems [48]: The use of technology such as digital-based school management systems, online learning platforms, or digital evaluation tools can produce data related to user interactions and activities. These data can provide additional information about learning activities, student performance, and resource usage.

Data collection in the context of education must be carried out with due regard to aspects of privacy, security and ethics. It is important to maintain the confidentiality of students' and other stakeholders' personal data and ensure compliance with applicable data protection policies. In data collection, it is also important to have clear objectives, choose appropriate collection methods, and ensure the validity and reliability of the data collected. Accurate, relevant and up-to-date data will provide a solid basis for decision making and the development of effective education programs.

2. Big Data Storage and Processing

Big Data storage and processing is an important stage in data management that involves large volumes, diversity, and high data rates. In the context of education, storing and processing Big Data is done to manage information on students, teachers, curriculum, and various other aspects of education. Following are some aspects to consider in Big Data storage and processing:

a) Storage Infrastructure [49]: Big Data requires adequate storage infrastructure to accommodate large amounts of data. Educational institutions must have a storage system that can handle large data scales and ensure data availability with high reliability and speed. This can involve using a distributed database, cloud storage system, or Hadoop based storage system.

b) Collection of Structured and Unstructured Data: Big Data in the educational context often involves a combination of structured data (e.g. academic data) and unstructured data (e.g. text, images or videos). Big Data management requires the ability to efficiently integrate and process these two types of data. The use of technologies such as data lakes or data warehouses can assist in the management and integration of structured and unstructured data.

c) Data Processing: Big Data requires sophisticated data processing tools and techniques to analyze and generate valuable insights. Data processing methods that are commonly used in the context of Big Data include parallel processing, distributed processing, or real-time processing. These techniques enable fast and efficient processing of data, thereby producing relevant and accurate analytical results.

d) Data Security and Privacy [50]: In processing Big Data, it is important to maintain data security and privacy. Educational institutions should adopt adequate security measures, including the use of data encryption, strict access controls, and monitoring of data usage activities. Privacy policies and data protection regulations must be followed carefully to protect the personal information of students and other education stakeholders.

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[48]Farhania Putri Yusril, "Pemanfaatan Teknologi Informasi Dalam Bidang Pendidikan (E-Education)," preprint (Open Science Framework, December 19, 2019), https://doi.org/10.31219/osf.io/ycfa2.

[49]Asril Basry, "Penyimpanan Data Berbasis Cloud Sebagai Mitigasi Bencana Kerusakan Data," *Simetris : Jurnal Teknik Mesin, Elektro dan Ilmu Komputer* 6, no. 2 (November 1, 2015): 249, https://doi.org/10.24176/simet.v6i2.460.

[50]Winarsih Winarsih and Irwansyah Irwansyah, "Proteksi Privasi Big Data," *Jurnal Audience* 3, no. 1 (October 19, 2020): 1–33, https://doi.org/10.33633/ja.v3i1.3722.

e) Data Analytics and Machine Learning [51]: Big Data in education offers great opportunities to analyze data and gain valuable insights. Data analysis techniques such as statistical analysis, predictive analysis or visual analysis can be applied to identify relevant patterns, trends and relationships in education data. Additionally, machine learning techniques can be used to build predictive models, classify data, or generate personalized recommendations in an educational context.

It is important to have a skilled and knowledgeable team in Big Data storage and processing. Educational institutions need to develop adequate capabilities and infrastructure to ensure that Big Data can be managed effectively and generate useful insights for decision making and improving the quality of education.

3. Data Analysis for Decision Making

Data analysis in the context of decision making is the process of extracting insights, patterns and information hidden in data to support better decision-making processes and more accurate information. In education management, data analysis is used to inform decisions related to curriculum planning, developing learning strategies, increasing teaching effectiveness, identifying student needs, and evaluating educational programs. Following are some important aspects of data analysis for decision making:

a) Identification of Research Objectives and Questions [52]: Before conducting data analysis, it is important to identify the objectives and research questions you wish to answer. This will help focus the analysis on relevant aspects and support the desired decision making. For example, do you want to analyze the relationship between certain factors and student achievement, or do you want to evaluate the effectiveness of an educational program.
b) Selecting the Appropriate Analysis Method: There are a variety of data analysis methods that can be used, ranging from descriptive statistical analysis to complex predictive analysis. The selection of the appropriate analytical method depends on the type of data held, the research objectives, and the questions to be answered. For example, if you want to know the difference in achievement between two groups of students, you can use the different t-test. If you want to identify the factors that influence student achievement, you can use regression analysis.
c) Data Processing and Preprocessing: Before conducting analysis, data often needs to be processed and pre-processed to ensure its validity, cleanliness and quality. These steps can include cleaning the data (for example, dealing with missing values or outliers), transforming the data (for example, normalizing), and aggregating data from multiple sources. The goal is to ensure that the data used in the analysis is appropriate and reliable.
d) Extraction of Insights and Patterns: Data analysis is performed to explore the insights and patterns contained in the data. This involves applying relevant analytical methods to identify significant relationships, trends and patterns in the data. For example, correlation analysis can be used to find out if there is a relationship between students' participation and their academic performance.

[51]Rizki Rino Pratama, "Analisis Model Machine Learning," *Matrik: Jurnal Manajemen, Teknik Informatika dan Rekayasa Komputer* 19, no. 2 (May 30, 2020): 302–11, https://doi.org/10.30812/matrik.v19i2.688.

[52] Nasution, "Identifikasi Permasalahan Penelitian.," *Alacrity: Journal of Education,* 1, no. 2 (2021): 13-19.

e) Data Visualization [53]: Data visualization is an important tool in data analysis for decision making. By using graphs, charts or other visualizations, complex data can be presented in a way that is easier to understand. Effective visualization can help identify visually relevant patterns and trends, as well as communicate analysis results more clearly to education stakeholders.
f) Interpretation and Decision Making [54]: After data analysis is complete, the results need to be interpreted carefully. This involves a deep understanding of the findings of the analysis, as well as relating them to the relevant educational context. The results of the analysis obtained can then be used as a basis for making more informed decisions, be it in formulating educational policies, developing programs, or improving the learning process.

It is important to remember that data analysis is only an aid in decision making. Decisions taken must also consider other factors such as social context, values, and practical experience in education. Data analysis can provide valuable insights, but the final decision must be made using broader knowledge and judgment.

4. Use of Data Analysis Tools in Education Management

The use of data analysis tools in education management plays a critical role in turning data into useful insights for more effective decision making. The following are some examples of data analysis tools that are often used in the context of education management:

a) Spreadsheets [55]: Spreadsheets such as Microsoft Excel or Google Sheets are tools commonly used in data analysis. They provide features that enable simple data processing, statistical calculations, graphing, and data visualization. Spreadsheets are useful for relatively simple data analysis and allow for rapid data manipulation.
b) Statistical Analysis Software [56]: There are various special software designed for statistical analysis, such as IBM SPSS, R, or Python with data analysis packages such as Pandas or NumPy. This software offers more powerful capabilities in complex statistical analysis, including hypothesis testing, regression, multivariate analysis, and predictive modeling. They are also often used for processing larger and more complex data.
c) Data Visualization Tools [57]: Data visualization tools such as Tableau, Power BI, or Google Data Studio are used to create attractive and interactive visualizations from data. With this tool, data can be presented in the form of graphs, diagrams, maps, or other views that make it easy to understand and analyze data. Data visualization helps in identifying relevant patterns, trends and relationships in education data.
d) Machine Learning Algorithms [58]: Machine learning algorithms are used to identify complex patterns and make predictions based on data. In an educational context, these algorithms can be used to build predictive models, classify

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[53] Sudipa, et al, "Teknik Visualisasi Data.," 1st ed. (jambi: PT. Sonpedia Publishing Indonesia., 2023).

[54] Herson Anwar, "Proses Pengambilan Keputusan untuk Mengembangkan Mutu Madrasah," *Nadwa: Jurnal Pendidikan Islam* 8, no. 1 (April 19, 2014): 37–56, https://doi.org/10.21580/nw.2014.8.1.569.

[55] Anton Zulkarnain Sianipar, "PENGGUNAAN GOOGLE FORM SEBAGAI ALAT PENILAIAN KEPUASAN PELAYANAN MAHASISWA," *JISAMAR (Jurnal Sistem Informasi, Terapan, Manajemen, Akuntansi dan Riset)* 3, no. 1 (2019).

[56] Agus Purwanto, Masduki Asbari, and Teguh Iman Santoso, "Analisis Data Penelitian Marketing: Perbandingan Hasil antara Amos, SmartPLS, WarpPLS, dan SPSS Untuk Jumlah Sampel Besar," *Journal of Industrial Engineering* 2, no. 4 (2021).

[57] Sudipa, et al, "Teknik Visualisasi Data."

[58] Giarsyani,et al., "Komparasi Algoritma Machine Learning Dan Deep Learning Untuk Named Entity Recognition," *Jurnal Informatika Dan Rekayasa Elektronik,* 3(1), (2020): 48-57.

students based on behavior or preferences, or provide personalized recommendations in learning. Some examples of popular machine learning algorithms are logistic regression, decision trees, artificial neural networks, or the naive Bayes algorithm.

e) Data Mining Tools [59]: Data mining tools such as RapidMiner or Weka are used to explore hidden insights in educational data. They apply various techniques such as clustering, association, or data segmentation to identify relevant patterns, groups, or relationships in the data. Data mining aids in a deeper understanding of student characteristics, factors influencing academic success, or behavior patterns.

It is important to choose a data analysis tool that fits the educational institution's needs and technical capabilities. Availability of resources, analytical capabilities of the team, and the desired level of complexity of the analysis must be considered in choosing the right tool. In addition, training and developing data analysis skills is also important to maximize the benefits of using data analysis tools in education management

2. Benefits of Using Big Data in Education Management

a. Improving Education Administration Efficiency

The use of Big Data in education management can significantly increase the efficiency of education administration. The following are some of the ways in which Big Data can help in increasing the efficiency of education administration:

1) Administrative Process Automation [60]: Big Data can be used to automate a number of educational administration processes. For example, using a digital-based school management system can automatically collect student data, manage attendance, schedule, and other administrative tasks. This reduces reliance on manual processes that are time consuming and prone to errors.
2) Analysis and Prediction of Resource Needs: By analyzing data regarding the use of resources such as teachers, staff, facilities, and budgets, educational institutions can identify specific resource needs. Big Data can assist in identifying trends and patterns in resource use, thereby enabling better planning and more efficient allocation of resources.
3) Cost and Waste Reduction [61]: Through Big Data analysis, educational institutions can identify areas where waste occurs and take steps to reduce unnecessary costs. For example, by analyzing data on energy consumption or facility usage, educational institutions can identify inefficient usage patterns and take action to reduce consumption and associated costs.
4) More Efficient Data Management: Big Data helps in managing and storing data more efficiently. By using advanced data storage and processing technologies, educational institutions can better manage large volumes of data. This helps avoid data duplication, improves data accessibility, and simplifies the decision-making process.

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[59] Ainurrohmah, A, "Akurasi Algoritma Klasifikasi Pada Software Rapidminer Dan Weka.," vol. 4, 2021, 493-499).

[60] Lailatu Rohmah, "KONSEP E-LEARNING DAN APLIKASINYA PADA LEMBAGA PENDIDIKAN ISLAM," *AN NUR: Jurnal Studi Islam,* 3(2), (2011): 255-270.

[61] Samsuddin, et al., "Audit Dan Optimasi Energi Listrik Pada Gedung Kampus Menggunakan Metode Algoritma Genetika.," *Jurnal Nasional Teknologi Komputer Dan Informasi (JNKTI)* , 2 (1), (2019): 31-37.

5) Improving Reporting Quality [62]: Big Data enables educational institutions to produce more accurate, complete and timely reports. By analyzing data thoroughly, educational institutions can produce reports that provide in-depth insights into various aspects of education administration. Better and more comprehensive reports help in performance monitoring, program evaluation, and better decision making.

By using Big Data in educational administration, educational institutions can achieve higher efficiency, optimize the use of resources, and improve the overall quality of education services.

1) Provide Insights and Insight Information about Students

The use of Big Data in education management provides the ability to provide in-depth insights and information about students. By analyzing the data collected, whether from exam results, involvement in extracurricular activities, class participation, to learning preferences, educational institutions can gain a better understanding of each individual student. Following are some of the benefits provided by Big Data in providing in-depth insights and information about students:

a) A Holistic Understanding of Students [63]: Big Data enables educational institutions to collect data from various sources and combine them to provide a more holistic understanding of students. Data can include academic information, behavior, interests, special needs, and learning preferences. By understanding students as a whole, educational institutions can design learning approaches that are more effective and meet their individual needs.
b) Identification of Student Needs and Challenges [64]: Through Big Data analysis, educational institutions can identify the needs and challenges faced by students. The data can reveal patterns related to student engagement, attendance rates, achievement levels, or certain behavioral tendencies. This information helps in designing appropriate interventions and support programs that can help students overcome the barriers they face.
c) Personalization of Learning [65]: By analyzing student data in depth, educational institutions can apply a learning approach that is more personal and tailored to the needs of each student. Information about students' learning preferences, learning styles, strengths, and weaknesses can be used to design more effective learning strategies. Personalized learning helps increase student motivation, participation, and learning outcomes.
d) Monitoring and Evaluation of Student Progress [66]: Big Data enables educational institutions to continuously monitor and evaluate student progress. By analyzing student performance data over time, educational institutions can identify trends and patterns in student achievement. This helps in identifying students who need additional attention, providing timely feedback, and planning appropriate interventions to improve student achievement.

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[62] Emyana Ruth Eritha Sirait, "IMPLEMENTASI TEKNOLOGI BIG DATA DI LEMBAGA PEMERINTAHAN INDONESIA," *Jurnal Penelitian Pos dan informatika* 6, no. 2 (December 29, 2016): 113, https://doi.org/10.17933/jppi.2016.060201.

[63] Arti Prihatini, "Pembelajaran multiliterasi," *SENASBASA* (Vol. 4, No. 1). (2020).

[64] Entot Suhartono, "SYSTEMATIC LITERATUR REVIEW (SLR): METODE, MANFAAT, DAN TANTANGAN LEARNING ANALYTICS DENGAN METODE DATA MINING DI DUNIA PENDIDIKAN TINGGI,", *Jurnal Ilmiah INFOKAM,* 13(1). (2017).

[65] Ananda Hadi Elyas, "PENGGUNAAN MODEL PEMBELAJARAN E-LEARNING DALAM MENINGKATKAN KUALITAS PEMBELAJARAN," *Warta Dharmawangsa* (56). (2018).

[66] Said Alhadi and Agus Supriyanto, "SELF-REGULATED LEARNING CONCEPT: STUDENT LEARNING PROGRESS," *In Seminar Nasional Bimbingan Konseling Universitas Ahmad Dahlan* (Vol. 2). (2017).

e) Student Welfare Monitoring [67]: Apart from academic performance, Big Data can also be used to monitor student welfare as a whole. By analyzing data related to mental health, attendance, social interaction and involvement in school activities, educational institutions can identify students who need special support and provide appropriate support services.

Through the use of Big Data, educational institutions can provide deeper insights into students, enabling a more personalized approach to learning, more appropriate interventions, and effective monitoring of student progress. With a better understanding of students, educational institutions can optimize students' learning experiences and support their academic success and well-being.

2) Support Curriculum Development that Focuses on Student Needs

The use of Big Data in education management can also support curriculum development that focuses on student needs. By analyzing the data collected about students, educational institutions can identify the strengths, weaknesses, interests, and learning preferences of individual or group students. The following are some of the ways in which Big Data supports curriculum development that focuses on student needs:

a) Identify Learning Needs and Trends [68]: Through Big Data analysis, educational institutions can comprehensively identify student learning needs and trends. Data can reveal learning preferences, special interests, learning styles, and students' level of understanding of learning material. This information allows curriculum developers to adapt learning approaches, materials, and teaching methods to meet students' learning needs more effectively.
b) Curriculum Personalization [69]: By using Big Data, educational institutions can design curricula that are more personal and adapted to the needs and interests of students. Information about students' learning preferences and interests allows curriculum developers to provide more relevant and interesting material choices. Curriculum personalization helps increase student motivation, engagement, and achievement.
c) Measurement of Individual Progress [70]: Big Data allows for more accurate measurement of individual student progress. By analyzing data on test results, assignments or other assessments, educational institutions can gain a deeper understanding of students' academic development. This information is used to identify additional learning needs, adjust instruction, or provide support needed to increase student achievement.
d) Evaluation of Curriculum Effectiveness [71]: Big Data can be used to evaluate the effectiveness of the existing curriculum. By analyzing student performance data, curriculum developers can assess whether learning objectives are being achieved, whether there are aspects of the curriculum that need improvement, and whether

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[67] Asep Nanang Yuhana and Fadlilah Aisah Aminy, "Optimalisasi Peran Guru Pendidikan Agama Islam Sebagai Konselor dalam Mengatasi Masalah Belajar Siswa," *Jurnal Penelitian Pendidikan Islam* 7, no. 1 (June 11, 2019): 79, https://doi.org/10.36667/jppi.v7i1.357.

[68] Tejo Nurseto, "Membuat Media Pembelajaran yang Menarik," *Jurnal Ekonomi dan Pendidikan* 8, no. 1 (April 10, 2012), https://doi.org/10.21831/jep.v8i1.706.

[69] Shofia Hattarina et al., "Implementasi Kurikulum Medeka Belajar Di Lembaga Pendidikan," *SENASSDRA* (Vol. 1, No. 1, (2022): 181-192).

[70] Siti Zubaidah, "KETERAMPILAN ABAD KE-21: KETERAMPILAN YANG DIAJARKAN MELALUI PEMBELAJARAN," *Seminar Nasional Pendidikan* (Vol. 2, No. 2, (2016): 1-17).

[71] Agus Salim Salabi, "EFEKTIVITAS DALAM IMPLEMENTASI KURIKULUM SEKOLAH," *Journal of Science and Research.* 2, no. 1 (2020).

there are changes that need to be made in the teaching approach. These evaluations help in the development of curricula which are continuously improved and improved.

e) Evidence-Based Curriculum Development [72]: By using Big Data, curriculum development can be based on strong evidence. Through extensive data analysis, educational institutions can identify effective learning practices, successful teaching methods, or the most efficient learning materials. This information helps curriculum developers to select and combine the best elements in designing an evidence-based and effective curriculum.

Through the use of Big Data in curriculum development, educational institutions can present learning approaches that are more relevant, interesting and effective, according to the needs and interests of students. This has the potential to improve the quality of education, increase student engagement, and drive better academic achievement.

3) Provides Objective Measurement of Teacher and School Performance

The use of Big Data in education management can also provide more objective measurements of teacher and school performance [73]. By collecting and analyzing relevant data, educational institutions can obtain accurate information about teacher performance and overall school effectiveness. Here are some of the ways in which Big Data supports objective measurement of teacher and school performance:

a) Evaluation of Teacher Performance: By collecting data on teacher performance, such as student exam results, assessments by students and colleagues, participation in professional activities, and level of involvement in teaching, educational institutions can carry out more objective evaluations of teacher performance. This data can be used to identify strengths and areas for improvement in teaching practice, provide timely feedback, and develop appropriate professional development programs.

b) Identify Best Practices: By analyzing teacher performance data from various sources, educational institutions can identify teaching practices that are most effective and deliver good results. This data can be used to discover patterns and trends in teacher performance as it relates to student achievement. This information can form the basis for developing better teaching guides, sharing best practices with other teachers, and improving the overall quality of teaching in schools.

c) School Performance Measurement [74]: Big Data can be used to measure school performance as a whole. Data such as student graduation rates, exam results, absenteeism rates, participation rates in extracurricular activities, and student and parent satisfaction can be used to evaluate school effectiveness. Objective measurement of school performance helps identify areas for improvement, plans strategies for improvement, and monitors school progress over time.

d) Comparison with Standards and Benchmarks [75]: By using Big Data, educational institutions can compare the performance of teachers and schools with established standards and benchmarks. The data can be used to compare student performance, academic success rates, and other indicators with standards set by

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[72] Ramah and Salem, "Pengembangan Kurikulum." (sumatra utara: PT. Mifandi Mandiri Digital, 2023).

[73] Ahmad Shidqi Dian Arifandi, "EVALUASI KINERJA GURU," *Edukais: Jurnal Pemikiran Keislaman*, 4(2), (2020): 106-119.

[74] Siti Julaiha, "Alternatif Pengukuran Kinerja Lembaga Pendidikan," *Dinamika Ilmu.* 2, no. 1 (2011).

[75] Suluri Suluri, "Benchmarking Dalam Lembaga Pendidikan," *Jurnal Dinamika Manajemen Pendidikan* 3, no. 2 (October 1, 2019): 82, https://doi.org/10.26740/jdmp.v3n2.p82-88.

governments or educational institutions. This information helps in evaluating success and setting improvement targets to achieve the set standards.

e) Decision Making Supported by Data [76]: The use of Big Data in measuring teacher and school performance helps educational institutions in making decisions that are more objective and evidence-based. The data collected and analyzed provides reliable and in-depth information about the overall performance of individuals and institutions. Decisions regarding teaching improvements, staff development, resource allocation, or policy improvements can be made on a sound basis from available data.

With objective measurement of teacher and school performance using Big Data, educational institutions can increase accountability, plan more appropriate improvements, and encourage improvements in the overall quality of education.

4) Improving Predictions and Interventions Against Educational Risks

The use of Big Data in education management also has the potential to improve the prediction and intervention of educational risks. By analyzing the data collected about students, educational institutions can identify risk factors that may affect student achievement, absenteeism, behavior or engagement. The following are some of the ways in which Big Data can improve the prediction and intervention of educational risk:

a) Identify Vulnerable Students: By analyzing student data, such as academic records, exam results, absenteeism rates, or participation rates in extracurricular activities, educational institutions can identify students who are at risk of experiencing academic difficulties, high dropout rates, or behavioral problems. This data helps in identifying patterns or trends that indicate risk and allows action to be taken before the problem gets worse.

b) Predictive Analysis [77]: By using data analysis algorithms and predictive modeling techniques, educational institutions can develop predictive models to identify students who may potentially face educational risks in the future. Historical data and predictor variables such as test scores, absenteeism levels, or social and economic factors can be used to build models that can predict a student's likely risk. This allows educational institutions to conduct timely and effective interventions.

c) Targeted Interventions: Through Big Data analysis, educational institutions can identify effective intervention strategies for at-risk students. The data collected can provide insight into the types of interventions that are most successful for increasing student achievement or addressing behavior problems. Targeted interventions help avoid wastage of resources and ensure that intervention efforts are focused on areas of greatest need.

d) Early Warning Systems [78]: By using Big Data, educational institutions can develop early warning systems that assist in identifying students who are at high risk early on. Data such as absenteeism rates, exam results or behavioral assessments can be used as indicators in early warning systems. When students

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[76] Anastasia Lipursari, "PERAN SISTEM INFORMASI MANAJEMEN (SIM) DALAM PENGAMBILAN KEPUTUSAN," *JURNAL STIE SEMARANG* 5, no. 1 (2013).

[77] Moh. Irvan, Yohanes Purnama, and Rendika Vhalery, "MODEL PREDIKTIF UNTUK AKREDITASI SEKOLAH TINGKAT SEKOLAH MENENGAH PERTAMA (SMP)," *Research and Development Journal of Education* 5, no. 2 (June 24, 2019): 03, https://doi.org/10.30998/rdje.v5i2.3747.

[78] Hendrik, "EARLY WARNING SYSTEM UNTUK MONITORING KINERJA DOSEN," *Insan Pembangunan Sistem Informasi Dan Komputer (IPSIKOM)* 4.2 (2019).

show signs of risk, the early warning system will notify relevant parties, such as teachers, counselors or parents, to intervene immediately.

e) Development of Intervention Programs [79]: By analyzing data on the effectiveness of previously implemented intervention programs, educational institutions can develop intervention programs that are more effective and measurable. The data can provide insight into the factors that contributed to the success or failure of previous intervention programs, thereby assisting in future program improvements.

By increasing the ability to predict and intervene in educational risks through the use of Big Data, educational institutions can respond more proactively to the needs and challenges faced by students. This can help reduce dropout rates, increase academic achievement, and provide more effective support to students in need

3. Challenges in Implementing Big Data

a. Challenges in Complex Data Collection and Analysis

The collection and analysis of complex data in an educational context can pose challenges that need to be overcome [80]. The following are some common challenges that may be encountered in complex data collection and analysis:

1) Large Data Volume [81]: In using Big Data, the amount of data collected can be very large. The main challenge is managing large volumes of data efficiently. Infrastructure and systems are needed that are capable of storing, accessing, and processing data on a large scale.
2) Diversity of Data Sources [82]: Data in the context of education can come from various sources, such as school management systems, online learning platforms, mobile devices, or even social media. The challenge is integrating and managing data from different sources, which may have different formats and structures.
3) Variable Quality of Data: Data collected in educational contexts can vary in quality. The challenge is to ensure that the data collected is accurate, complete and reliable. Poor quality data can produce unreliable analysis results and cause errors in decision making.
4) Depreciation of Data Value: In some cases, the data collected may depreciate in value over time. The challenge faced is ensuring that the data used for analysis is still relevant and represents current conditions. A sound data management strategy, including regular updating and maintenance of data, is required to overcome this challenge.
5) Complexity of Analysis: Complex data analysis is also a challenge in using Big Data in education management. Understanding and applying the right analytical techniques, such as statistical analysis, predictive modeling or machine learning, requires specialized skills. This challenge can be overcome through adequate training and development of data analysis skills.

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[79] Endah Tri Priyatni, "PENGEMBANGAN BAHAN AJAR MEMBACA KRITIS BERBASIS INTERVENSI RESPONSIF," *LITERA* 13, no. 1 (July 3, 2014), https://doi.org/10.21831/ltr.v13i1.1900.

[80]Anwar Darwis and Hilal Mahmud, "Sistem Informasi Manajemen Pada Lembaga Pendidikan Islam," *Kelola: Journal of Islamic Education Management* 2, no. 1 (April 25, 2017), https://doi.org/10.24256/kelola.v2i1.444.

[81]Supriyanto, et al, "Peran Big Data Dalam Implementasi Pembelajaran Jarak Jauh.," *Paedagoria: Jurnal Penelitian, Penelitian Dan Pengembangan Pendidikan* , 12 (1), (2021): 61-68.

[82]Awal Kurnia Putra Nasution, "INTEGRASI MEDIA SOSIAL DALAM PEMBELAJARAN GENERASI Z," *Jurnal Teknologi Informasi dan Pendidikan* 13, no. 1 (April 17, 2020): 80–86, https://doi.org/10.24036/tip.v13i1.277.

6) Data Privacy Protection [83]: In data collection and analysis, data privacy protection is important. Educational institutions need to ensure that the data of students and related parties is properly protected and not misused. These challenges include complying with data privacy regulations, protecting against cyberattacks, and using strict privacy policies.

Addressing the challenges of complex data collection and analysis requires a holistic approach, including investing in the right technology infrastructure, developing data analysis expertise, sound privacy policies and practices, and effective data management strategies. By addressing these challenges, educational institutions can harness the full potential of Big Data in education management and make more informed, evidence-based decisions.

b. Privacy Protection and Data Security

Privacy protection and data security are very important in the use of Big Data in education management. Here are some aspects that need attention in maintaining data privacy and security:

1) Privacy Policy [84]: Educational institutions need to have a clear and firm privacy policy that regulates the collection, use and disclosure of student, teacher and other related party data. This policy must comply with applicable privacy laws and regulations and must be informed to all parties involved in the use of data.
2) Protection of Personal Data [85]: Personal data of students, teachers and staff must be protected with appropriate security measures. This includes using data encryption, using strong passwords, and controlling access to data by authorized parties only. In addition, data must be stored securely and protected from risks of loss or theft.
3) Required Use of Data [86]: Only data necessary for educational purposes should be collected and used. Educational institutions must ensure that data collection is carried out with clear objectives and within reasonable limits. Data that is irrelevant or unnecessary must be avoided so that individual privacy is protected.
4) Regulatory Compliance: Educational institutions must comply with applicable data privacy regulations in the region or country in which they operate. This includes compliance with laws such as the General Data Protection Regulation (GDPR) in the European Union or national data privacy laws that apply in certain countries. Institutions must ensure that their systems and practices comply with the regulatory requirements.
5) Awareness and Training: Awareness of the importance of data privacy and security should be instilled in all educational organizations. All parties involved, including teachers, students and staff, need to be given training on the importance of maintaining data privacy and the actions that must be taken to prevent data security breaches.
6) Vendor Management and Contracts: If educational institutions use services or products from third parties that involve data processing, it is important to implement effective vendor management. Contracts must include strict security and privacy

[83]I Gede Hartadi Kurniawan et al., "PENYULUHAN ASPEK HUKUM PERLINDUNGAN PRIVASI DAN DATA PRIBADI," *Jurnal Abdimas Volume* 08 (2022): 5.

[84]Rama Dhianty, "Kebijakan Privasi (Privacy Policy) dan Peraturan Perundang-Undangan Sektoral Platform Digital vis a vis Kebocoran Data Pribadi," *Scripta: Jurnal Kebijakan Publik dan Hukum* 2, no. 1 (2022).

[85]Budi Hartono, "Ransomware: Memahami Ancaman Keamanan Digital," *Bincang Sains dan Teknologi,* 2, no. 02 (2023): 55–62.

[86] Ulfah Ulfah, Yuli Supriani, and Opan Arifudin, "Kepemimpinan Pendidikan di Era Disrupsi," *JIIP - Jurnal Ilmiah Ilmu Pendidikan* 5, no. 1 (January 7, 2022): 153–61, https://doi.org/10.54371/jiip.v5i1.392.

clauses to protect data. Vendor risk assessment and selection of a reliable service provider should also be a priority.

7) Security Monitoring and Response: Educational institutions should have an effective monitoring system to detect security threats and cyber attacks. In the event of a security breach or data privacy breach, institutions must have a well-defined response plan to deal with the incident quickly and effectively.

Protecting data privacy and security is the main responsibility of educational institutions in the use of Big Data. By implementing the right policies, involving all relevant parties, and following best practices in data security, institutions can ensure that the data collected and used in education management remains secure and individual privacy is protected.

c. Supporting Infrastructure System Development

The development of a supporting infrastructure system is an important factor in the utilization of Big Data in education management [87]. The following are several aspects that need to be considered in building a supporting infrastructure system:

1) Scale and Capacity: The infrastructure must be able to handle the large volumes of data generated in an education context. This involves selecting the right hardware, such as servers with sufficient storage capacity, and a network that can accommodate high data traffic. Scalability is also important to ensure that the infrastructure can grow along with increasing data needs in the future.
2) Connectivity [88]: Infrastructure must support reliable and fast connectivity. A stable and high-speed internet connection is required to collect, send and receive data efficiently. Educational institutions need to ensure that their network can handle high data loads and has redundancy to deal with connectivity disruptions that may occur
3) Security [89]: Infrastructure must be designed with data security as a top priority. This involves using firewalls, data encryption, strict access controls, and proactive security monitoring. The infrastructure must also be able to detect security threats and respond quickly to protect data from security breaches.
4) System Integration [90]: Infrastructure must be able to integrate various systems and platforms used in the educational context, such as school management systems, online learning platforms, digital evaluation tools, and others. Good integration enables seamless data exchange between systems, minimizes data duplication, and improves data management efficiency.
5) Data Storage and Processing [91]: Infrastructure should provide adequate storage capacity for data collected in an educational context. Scalable and easily accessible data storage is important. Data processing also needs attention, with the adoption of technology and data analysis tools that enable fast and efficient processing.
6) Availability and Reliability: Infrastructure must be continuously available and reliable. Minimal downtime and fast disaster recovery are key in ensuring data and services remain available to users. Educational institutions must have a good

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[87] Jamiludin Usman, "Pengelolaan Infrastruktur Teknologi Informasi dan Komunikasi Dalam Mendukung Kinerja Layanan Pendidikan di STAIN Pamekasan," *JAS-PT (Jurnal Analisis Sistem Pendidikan Tinggi Indonesia)*, 1(2), (2018): 79-92.

[88]Maksum Tanubrata and Hendaryanto Wiryopranoto, "Pelelangan Proyek Konstruksi Berbasis Internet," *Jurnal Teknik Sipil* 11, no. 1 (March 29, 2019): 29–43, https://doi.org/10.28932/jts.v11i1.1397.

[89]Edy Susanto et al., "Analisis Keamanan Informasi PT. Indofood Sukses Makmur, Tbk : Studi Kasus tentang Peran Objek Vital, Pengamanan File, dan Pengamanan Cyber" 1, no. 3 (2023).

[90]Yuliana, R, "INTEGRASI APLIKASI DAN INFORMASI KONSEP DAN PENERAPANNYA." (Bandung: WIDINA BHAKTI PERSADA BANDUNG, 2022).

[91]Nugroho, Abdullah, and Wulandari, "KEAMANAN BIG DATA DI ERA DIGITAL DI INDONESIA."

disaster recovery strategy and maintenance policy in place to maintain the availability and reliability of the infrastructure.

Building a supporting infrastructure system requires the right investment in hardware, software, and human resources with expertise in IT infrastructure management. By having good infrastructure, educational institutions can maximize the potential for using Big Data in education management and increase efficiency and effectiveness in decision making.

d. Enhanced User Capabilities and Skills

Improving user capabilities and skills is important in implementing the use of Big Data in education management. Here are some steps that can be taken to improve user capabilities and skills:

1) Training [92]: Educational institutions need to provide comprehensive training to relevant users, including administrative staff, teachers, and school leaders. This training should include an understanding of Big Data concepts and principles, data collection and analysis, use of data analysis tools, and data-driven interpretation and decision-making. Training can be carried out internally through workshops, online training, or involving external experts who are experienced in the field.
2) Selection of Expert Team: Educational institutions may consider establishing a team of experts or contracting a consultant with specific knowledge and expertise in Big Data and education management. This team of experts can provide guidance, consultation and technical support in the use of Big Data, as well as assist in interpreting and applying the results of data analysis in decision making.
3) Collaboration and Knowledge Exchange: Educational institutions can collaborate with other educational institutions, industry, or research institutions to share knowledge and experiences in using Big Data in education management. This knowledge exchange can be carried out through seminars, conferences, workshops, or through online platforms that facilitate discussion and collaboration between education professionals.
4) Technology Resources and Support [93]: Educational institutions need to ensure that the resources and technological support needed for the use of Big Data are available and easily accessible. This includes access to the necessary hardware and software, as well as adequate technical support to assist users in overcoming obstacles or problems that may arise in the use of Big Data.
5) Data-Driven Culture [94]: Educational institutions need to build a culture that encourages the use of data in decision making. This involves raising awareness about the importance of using data in improving education quality, rewarding individuals or teams who use data effectively, and integrating data-driven practices into existing decision-making processes.

By increasing user capabilities and skills, educational institutions can optimize the use of Big Data in education management, better deal with technical challenges, and make more effective decisions based on relevant evidence and data.

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[92]Dasmo Dasmo et al., "ANALISIS INDIKATOR KEPEMIMPINAN TEKNOLOGI KEPALA SEKOLAH SEBAGAI PEMIMPIN IMPLEMENTASI TEKNOLOGI ABAD 21," *Idaarah: Jurnal Manajemen Pendidikan* 5, no. 2 (December 8, 2021): 240, https://doi.org/10.24252/idaarah.v5i2.24095.

[93] Nurdyansyah, N, "Sumber Daya Dalam Teknologi Pendidikan." (Universitas Muhammadiyah Sidoarjo., 2017).

[94] Mujiono Mujiono and Aina Musdholifah, "Pengembangan Data Warehouse Menggunakan Pendekatan Data-Driven untuk Membantu Pengelolaan SDM," *IJCCS (Indonesian Journal of Computing and Cybernetics Systems)* 10, no. 1 (January 31, 2016): 1, https://doi.org/10.22146/ijccs.11184.

D. Kesimpulan

The conclusion from this article is that the use of Big Data in education management has great potential to improve the quality of education. In the education context, extensive and detailed data collection and analysis can provide valuable insights for stakeholders, such as teachers, students, and school administration.

Implementation of big data in education management through data collection, data collection methods and sources including academic data, surveys and questionnaires, observations, interviews, administrative data, technology and information systems. Big data storage and processing, aspects that need to be considered in big data storage and processing include data collection, structured and unstructured, data processing, data security and privacy, data analysis and machine learning. Data analysis for decision making, important aspects of data analysis for decision making include identifying objectives and questions, selecting appropriate analytical methods, processing and preprocessing data, extracting insights and patterns, data visualization, interpretation and decision making. And the use of data analysis tools, data analysis tools that are often used include spreadsheets, statistical analysis software, data visualization tools, machine learning algorithms, data mining tools.

The benefits of using big data in education management include increasing the efficiency of education administration, several ways in which Big Data can assist in increasing the efficiency of education administration include automation of administrative processes, analysis and prediction of resource requirements, reduction of costs and waste, more efficient data management, improvement reporting quality. Support curriculum development that focuses on student needs, some of the ways in which Big Data supports curriculum development that focuses on student needs include identifying learning needs and trends, personalizing curriculum, measuring individual progress, evaluating curriculum effectiveness, evidence-based curriculum development. Providing objective measurement of teacher and school performance, some of the ways in which Big Data supports objective measurement of teacher and school performance include evaluation of teacher performance, identification of best practices, measurement of school performance, comparison with standards and benchmarks, decision-making supported by data. And improving predictions and interventions on educational risks, there are several ways in which Big Data can improve predictions and interventions on educational risks including identification of vulnerable students, predictive analysis, targeted interventions, early warning systems, development of intervention programs.

Challenges in implementing big data include: complex data collection and analysis. Common challenges that may be faced in complex data collection and analysis include large data volumes, diversity of data sources, varying data quality, depreciation of data values, analysis complexity, data privacy protection. Privacy protection and data security, several aspects that need attention in maintaining data privacy and security include privacy policies, personal data protection, required data use, regulatory compliance, awareness and training, vendor and contract management, security monitoring and response. Development of a supporting infrastructure system, several aspects that need to be considered in building a supporting infrastructure system include scale and capacity, connectivity, security, system integration, data storage and processing, availability and reliability. And increasing user capabilities and skills, steps that can be taken to improve user capabilities and skills through training, selecting a team of experts, collaboration and exchange of knowledge, resources and technology support.

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