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Integration of Big Data and Blockchain for Strategic Analysis of Schools in Thailand

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Integration of Big Data and Blockchain for Strategic Analysis of Schools in Thailand

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Abstract. In the era of digital transformation, the information used for strategic management in schools needs to be utilized for maximum benefit, efficiency, and effectiveness. Further, it requires storage in a secure, transparent, and verifiable manner worldwide. Recognizing the importance of this research contribution, the researchers designed a strategic data storage and analysis system to be used in larger secondary schools by integrating big data, artificial intelligence, and blockchain technologies. The integrated system provides a platform to collect and analyze annual operational plans for schools by facilitating compatibility with text analytics and machine learning technologies of large, high-security schools in Thailand. The results showed that the plans and projects for each department in the school were encrypted at the time of login, and the system generated a starting block. Through each step of the corresponding analysis process, new blocks are created continuously, meaning each plan and project will generate a chain of blocks encrypted with the hash function until the plan and project are approved. Furthermore, the system has a high level of security and user satisfaction ($\bar{X}$= 4.00, SD. 0.76)). Thus, the system could be implemented and adopted in schools to support educational management in the 21st century.

Keywords: Big data, Artificial intelligence, Strategic analysis, Text Analytics, Blockchain

1 Introduction

The digital transformation era has caused a significant change in every dimension of work, especially in the education sector. Regarding current research on intelligence education administration management [1][2], many schools have been using advanced information technology, particularly the new age of artificial intelligence (AI) and big data, to support strategic management in schools and contribute to the comprehensive quality of teaching and learning [2][3]. With the rapid development of information and communication technology, there has been a dramatic increase in the collection, storage, use, exploration, and access of data in the era of "big data" [1][4].

The concept of "big data" has triggered a wave of technological innovation worldwide. Big data is defined as "a new generation of technologies and architectures

designed to economically extract value from very large volumes of a wide variety of data, by enabling the high-velocity capture, discovery, and/or analysis" [5][6]. Moreover, big data is characterized by the 6 Vs model, which includes volume, variety, velocity, veracity, value, and variability [5][6][7]. There are several activities involved in big data analysis, including the specification, capture, storage, access, and analysis of datasets to make content-supported decisions [5][6][8]. The benefits of big data include low cost, fast acquisition, processing, and analysis technology from a variety of large data with extraction [5][9]. The integration of big data technology with blockchain technology supports data analytics for effective and safe business transactions [10][11]. Blockchain technology decentralizes data to other parties in network systems, which can be applied in an array of industries such as finance, supply chain, healthcare, and education [12][13][14].

In recent times, blockchain technology has been implemented in school management to support academic research, reputation, e-portfolios, and intellectual property, as well as to connect lifelong learning and learning analytics platforms, credits, and school strategic development [15][16][17].

In the digital transformation era, especially during the post-COVID-19 period, school management has participated in these practices while adjusting to a world where technology plays a role in many areas of a country's development. For educational organizations in Thailand, policies are issued by the Ministry of Education at the secondary school level. In the fiscal year 2023, the Ministry of Education, under the administration of the Thai government, has adopted the policy and focus of the Ministry, which was announced in 2021 and designed to be compatible with the Thai government's 20-year National Strategy [5][11][18].

Recognizing this need, the researchers were inspired to develop a platform to help compile school-level strategies, Ministry of Education strategies, and national strategies by storing them in a large database management system called big data. Artificial intelligence technology was also utilized in text analytics and machine learning to help analyze the compatibility of these strategies with the Ministry of Education policy and the national strategy. In addition, the researchers incorporated blockchain technology to ensure security and transparency in school-level strategic planning.

This research aims to develop a platform that facilitates the effective management of action plans for large secondary schools in Thailand, ensuring consistency with national policies, Ministry of Education policies, and spatial context. The platform is based on artificial intelligence technology, text processing, big data databases, and blockchain technology, which provides maximum security, transparency, and traceability, making it a good example of how blockchain technology can be used for public administration. This research contributes to the Thai bureaucracy by facilitating the transition from traditional paperwork to electronic documents. It also adds to the existing research on the application of big data and information security technologies like blockchain at the strategic level in Thailand.

2 Review Literature

To obtain a platform for gathering, collecting, and analyzing high school strategic plans that align with the policies of the Ministry of Education of Thailand and the 20-year National Strategy of the Thai government, the research team has reviewed research and supporting data as follows.

2.1 The 20-year National Strategy

The 20-year National Strategy is a plan for national development that provides a framework and guidelines for government agencies in all sectors to follow. It aims to achieve the vision of a stable, prosperous, and sustainable Thailand with development guided by the philosophy of the sufficiency economy, as expressed by the motto "Stable, Prosperous, Sustainable" [18][19]. The objective of the strategy is to improve the quality of life of Thai people by promoting happiness, responding to national interests, and generating high income. It also seeks to create a stable society that is characterized by equality and fairness, and one that can compete effectively in the global economy.The 20-year National Strategy consists of 6 aspects comprising (1) stability, (2) competitive capability, (3) human resource development and enhancement, (4) opportunity and social equality, (5) growth in the quality of life that is friendly to the environment, and (6) balance and development of the public administration system.

2.2 Context of School in Research Area in Thailand

The research area is located in Sisaket Province, which is in the northeast region of Thailand. Several schools, particularly Sisaket Wittayalai School, participated in this research project. The reason for choosing Sisaket Wittayalai School is because the school has a prestigious reputation and is academically strong. Additionally, it is well prepared and has the potential to develop its systems. It is also a user of the integration of big data and blockchain system in the school's operations aiming to progress towards becoming a model school.

Fig. 1. SisaketWittayalai School the research area [19]

Sisaket Wittayalai School is located at No. 319 Moo 5, Wan LukSuea Road, Nong Khrok Sub-district in Mueang Sisaket District, Sisaket Province, covering an area of 145 rai. Originally named Khukhan Province School, it was established on May 17, 1912, under the name "Khukhan Rat Rangrak" using the Sala Rong Thammarat of MahaPhuttharam Temple (Wat Phra To). The school started with 3 classrooms, 28 students, and 3 teachers. Since then, SisaketWittayalai School has had 27 directors. Currently, SisaketWittayalai School provides education for Mathayom 1-6 students according to the Basic Education Core Curriculum B.E. 2551 (revised B.E. 2558). There are a total of 3,834 students (89 classrooms), 9 school buildings, and 15 compound buildings. Over time, SisaketWittayalai School has made significant progress in all aspects, making it a high-quality secondary school in Sisaket Province, Thailand [19].

2.3 Big Data in Education

The concept of big data has become a buzzword and gained popularity over the last decade [5]. However, there is still no official definition for big data, as different research studies have diverse definitions [5][20]. Generally, big data refers to large data sets that require complex computational platforms to be analyzed [21]. It is compiled from the proliferation of data, both structured and unstructured, as well as increased computer processing power, data storage capacity, the use of computers to mediate transactions and social interactions, and the density of sensors, all at decreasing costs [5][22].

Table 1. Big data system architecture [5][23]

	Calculation model	Describe	Developers
Hadoop	Batch processing	The first open-source implementation of a MapReduce paradigm	Apache
Spark	Flow calculation	Apache distributed flow of computing	TApache
Samza	Batch processing	Support data memory and the latest analysis system	UC Berkeley AMP Lab

The big data system architecture shown in Table1 consists of:

1) Hadoop uses the MapReduce distributed computing framework and the HDFS distributed file system developed based on Google File System (GFS) [5][23].

2) Spark supports the analysis of in-memory data and recovery capabilities and is based on Hadoop with several architectural improvements [24].

3) Samza is a real-time distributed stream processing framework. Samza streams data processing, with each Kafka cluster connected to a Yarn cluster to process Samza jobs, which process real-time streaming data such as log services, real-time services, and data tracking applications [5][25][26].

The research paper by Cui et al. [20] analyzes the development of online education and the impact of combining online education with big data. The paper introduces innovative online education technology and its results, highlighting the opportunities and development of online education under the influence of the COVID-19 pandemic using big data technology. By analyzing big data technology, the paper demonstrates the potential of combining big data technology and online education and concludes that this innovative approach could be applied in other areas beyond education.

The paper also examines the impact of this combination on the online education industry and other industries. The paper concludes that the combination of big data and online education is innovative since the emergence of COVID-19, and it provides a comprehensive introduction to the concepts and methods of integrating online education and big data technology. The online education platform provides a suitable introduction to the research paper by Cui et al. [20]. The paper can be used to understand the issues and challenges faced by innovative online education in the context of the COVID-19 pandemic as well as to explore future possibilities based on this combination of technologies.

Several studies have shown that effective teaching behaviors play a crucial role in student learning and outcomes. To measure the extent of effective teaching behavior, academics have developed various tools. In this study, an open-ended questionnaire was used in a survey of a large group of students. The researchers employed machine learning tools to separate teaching behavior topics from the open-ended responses of the students. They then tested the validity of the results by comparing them with the theoretical self-driven coding results based on expert judgment. The researchers utilized latent Dirichlet allocation (LDA) topic model analysis along with the Visualization Tool (LDAvis) to analyze qualitative data collected from 173,858 secondary school students in the Netherlands [26][27]. This approach enabled them to identify patterns and topics within the students' responses, providing insight into effective teaching behaviors.

Based on the data-driven machine learning analysis, the researchers identified eight themes of teaching behavior domains including clear descriptions, a supportive, student-centered learning atmosphere, a variety of lesson characteristics, teachers who arouse interest, follow-up comprehension, and others. Additionally, the researchers randomly selected 864 student responses from the same dataset and conducted theoretical content analysis to write their own code. This resulted in nine teaching behavioral domains and 19 subdomains. The results of the study suggest that the relationship between machine learning and human analytics is complementary. By combining the two approaches, researchers can gain a more comprehensive understanding of effective teaching behaviors. The use of machine learning tools provides an efficient and effective method for analyzing large datasets, while human analytics provides a more nuanced and detailed understanding of the data. Together, these approaches can improve the accuracy and validity of research findings in the field of education.

2.4 Blockchain

Blockchain is a technique for storing data in the form of blocks, which the hash and block system cannot handle; this makes the blockchain ideal for storing sensitive data. One of them is drug information. Therefore, research has been carried out on blockchain technology for medical use in terms of using it to store patient records utilizing smart contracts. For the goal of blockchain applications with pharmaceuticals, drug information from manufacturers can be viewed and purchased directly from buyers.

The research by Jaya et al. (2023) [27] builds upon blockchain research and innovation by applying it to drug data storage. The researchers implemented the Ethereum blockchain and found that the stored data could be integrated effectively into a smart contract. Smart contracts can support and facilitate transactions between producers and buyers while keeping information safe. Access rights in smart contracts can be used to maintain data integrity and security. Ultimately, privacy, decentralization, transparency, and authenticity in drug information can be ensured through the use of blockchain technology and smart contracts for every transaction.

In research by Wang et al. [28], the objective was to solve online learning problems in isolated areas, particularly the problem of sharing data. To address this issue, the researchers proposed an educational data management model based on blockchain technology. The model aimed to facilitate the sharing of data and resources for online learning using verification codes and third-party key mechanisms. Additionally, the study introduced a smart contract-based mechanism for sharing online learning data, and the system’s efficiency was evaluated in terms of security analysis.

2.5 Text Analytics

Text analysis, also known as text mining, refers to a set of methods used to collect, process, and interpret unstructured text data [29]. These methods typically involve converting large amounts of text data into a structured format, which can then be analyzed to identify key facts, relationships, and patterns. Common examples of text analysis include response retrieval (such as Apple's Siri or IBM's Watson), sentiment analysis/opinion mining, text summarization, and the integration of structured data into databases, data warehouses, or dashboards for descriptive, inferential, or predictive analytics. Natural Language Processing (NLP) is a field of study that deals with the processing and analysis of text data using machine learning algorithms. NLP algorithms can handle vast amounts of textual information consistently and reliably as well as interpret concepts within complex contexts and decode linguistic ambiguity.

The study by McLaughlin et al. [29] aimed to provide guidance and explanations for text analysis. The study presented a methodological literature review that provided an overview of text analysis, including its brief history, contemporary techniques, and basic steps. The authors illustrated this approach with several examples of common text analysis techniques. The study also offered practical recommendations to support the use of text analysis in pharmaceutical education. These recommendations included clarifying the purpose of text analysis, ensuring that research questions were relevant and based on the literature, developing a processing strategy and creating a dictionary,

exploring tools for analysis and visualization, being tolerant of errors, training, calibrating, and validating analytical strategies, and collaborating and preparing.

The authors also discuss the potential impact of text analysis, which provides a systematic approach to generating information from the textual content. The approach has several benefits, such as improving the efficiency of text analysis and explaining new knowledge. Despite recent developments in text analysis techniques, however, the study highlights the limitations of this approach. The authors suggest that efforts to improve the usability and accessibility of text analytics continue and pharmacy educators should position their work in the context of these constraints.

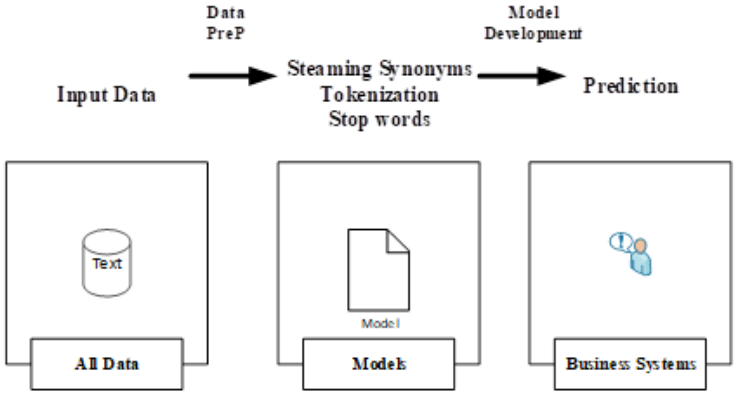

Fig. 2. Text Analytics Operations [30]

Text analytics is a technology that combines machine learning suites with statistical and linguistic techniques to process large amounts of unstructured text or text without a predetermined pattern. Its purpose is to gain insights and patterns that enable businesses, governments, researchers, and the media to leverage vast amounts of content to make critical decisions. Text analysis employs a variety of techniques, including sentiment analysis, topic modeling, named entity recognition, word frequency, and event extraction [30].

3 Methodology

3.1 Research Framework

In order to obtain a strategic analysis platform for high school administration that integrates blockchain technology within, the researchers designed the architecture of the system into three tiers, in line with the inputs of school administration, analysis process and plan management, and reports for executive level.

The work of the system architecture starts from the department or the learning group adds the operational plan data into the system, which adds this data to create a new

block into the system, when the data is saved in the database system. Central by stamping the Hash Key, such information is considered information that can guarantee the identity of the entity that enters the transaction, then will be analyzed for the consistency of the plan with the national strategy and the focus of Ministry of Education, where the information that has been processed from the beginning of the data entry until the consistency analysis will be presented to the school administrators in the form of Summary Reports.

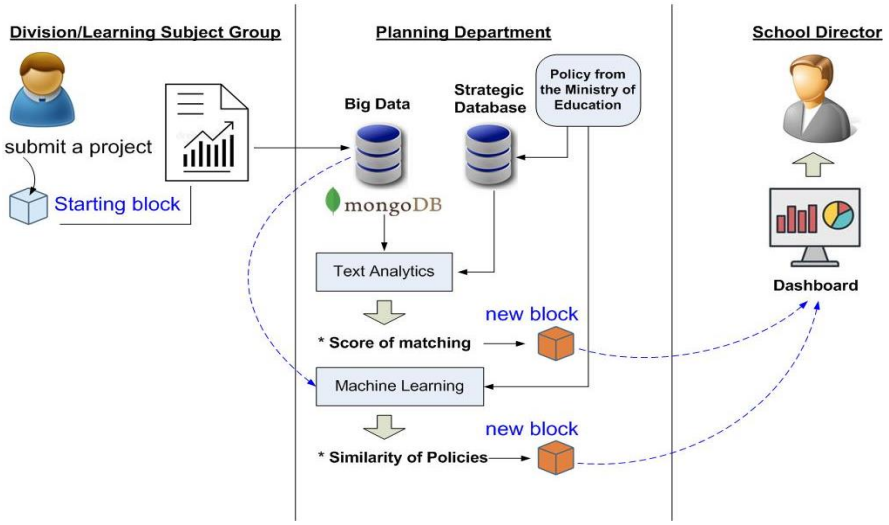

Fig. 3. Research Framework

3.2 System Development Life Cycle

The researchers aimed to develop a platform that could collect and analyze high school strategic plans in accordance with the policies of the Ministry of Education of Thailand and the Thai government's 20-year National Strategy. To accomplish this, they employed a system development process known as SDLC. There are five steps as following:

1) System analysis: of an existing system the research team conducted a detailed feasibility study of the operational plan for Sisaket Wittayalai School. The details of this study are presented in the action plan at Sisaket Wittayalai School and was originally made into a booklet on paper [19]. Also, the research team reviewed relevant research pertaining to the school context, management structure, the 20-year National Strategy, Ministry of Education policy, big data research, blockchain research, and text analytics research.
2) System design: architecture design involved dividing the system into three parts: (1) divisions and subject groups, (2) the planning department, (3) school administrators as show in Figure 4
3) System development: involved database design and the creation of a set of instructions for performing all three tasks. The system development part includes:

(1) database design, (2) table design, (3) input form design, (4) blockchain module design, (5) design. Analyzing the consistency of the agency's work plan with the Ministry of Education's focus, (6) Designing a summary report.

4) System was then subjected to testing in the Sisaket Wittayalai School for 4 months (one semester November 2022-February 2023)
5) System evaluation: by teacher and staff at the school 30 people. The research team conducted an experiment to evaluate the efficiency of the developed platform in terms of user interface quality and system acceptance to support plan analysis, by testing with 30 system users. Usability, stability, accuracy and completeness, with an average score in all aspects at 4.00 as in

4 Results

This research resulted in a tool to help compile and analyze projects and plans at a large secondary school in Thailand, namely Sisaket Wittayalai School in Sisaket Province. After the personnel at Sisaket Wittayalai School in Sisaket Province submit their fiscal year project into the system, the system will analyze its compliance with the Ministry of Education's policies for the year 2023 and indicate the corresponding points as well as percentage of compliance. The system adding blockchain-based security to the project upload process takes an average of only 1 second, which is a very short processing time. In terms of the percentage of the project's consistency with the 20-year National Strategy and the Ministry of Education's policy, projects having 50% or more compliance with both policies will be considered.

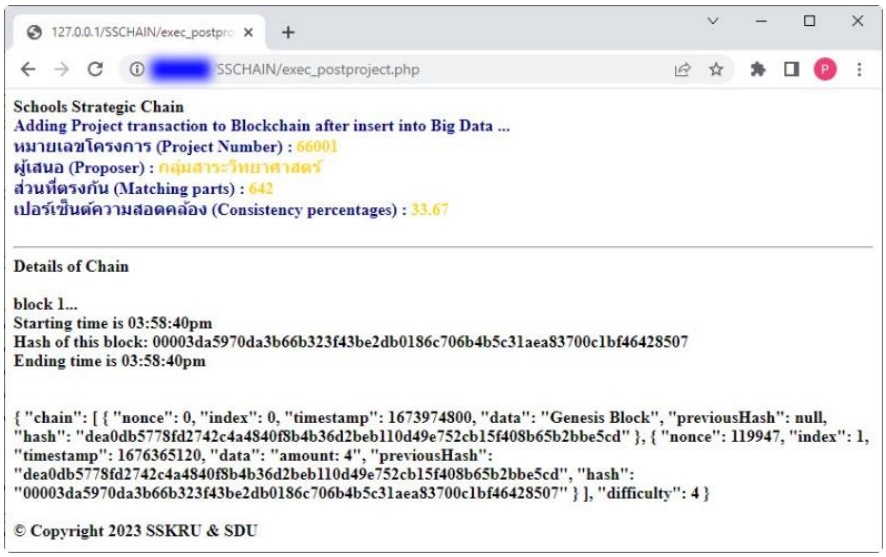

Fig. 4. Integration of big data and blockchain for strategic analysis of schools in Thailand result

Fig. 4. Project information that has been analyzed for compliance with the policy of the Ministry of Education and recorded in the big data system will be encrypted with blockchain. The research team conducted an experiment to evaluate the efficiency of the developed platform in terms of user interface quality and system acceptance to support plan analysis, with 30 users. work, stability, accuracy and completeness with an average score of 4.00 (Mean 4.00, SD. 0.76) as shown in Table 2.

Table 2. System Evaluation

Evaluation Indicators	Issue	Means	SD.
Usability	1.1 Easy to use.	4.00	0.85
	1.2 Easy to access.	4.00	0.77
Stability	2.1 Stability of the systems	4.00	0.65
	2.2 Network stability.	4.00	0.87
	2.3 Run time error.	3.50	0.55
Accuracy	3.1 System accuracy.	4.50	0.89
Completeness	4.1 System completeness.	4.00	0.98
	Overall	**4.00**	**0.76**

The results of the evaluation of the efficiency and satisfaction of the system users presented in this research are shown in the table above. The research team found an average score of 4.0, which concluded that overall performance and user satisfaction with the developed platform were good.

After adding data to the big data database system, a list of projects will be created as a transaction in the blockchain system to ensure transparency and accountability for any additions, changes, or amendments made to the details of such projects.

5 Conclusion & Discussion

This research developed a platform for collecting, archiving and analyzing the strategic plans for large secondary school in line with Thailand's Ministry of Education policy and the Thai government's 20-year National Strategy. The goal was to make the process of managing secondary schools in the age of competition more effective, given the limitation of budget.

To ensure consistency in each project at Sisaket Wittayalai School, the research team chose to use artificial intelligence technology, specifically text analytics, to assist in identifying the consistency of each project's message with the policy of the Ministry of Education. Compatibility was determined using machine learning, specifically supporting vector machines. To ensure transparency and accountability in the project submission, review, and revision processes, the researchers incorporated a blockchain mechanism after inserting project data into the big data DBMS.

The use of big data technology in this research aligns with the research guidelines of Cui et al. [20]. The use of text analytics in analyzing secondary school projects and the

policies of the Ministry of Education aligns with the research guidelines of McLaughlin et al. [29][30]. The application of blockchain to the Ministry of Education's annual project proposals improves transparency, data security, and research consistency [26][30].

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