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DIGITAL TWIN ACCOUNTING REAL-TIME SIMULATION OF COMPANY BALANCE SHEET IN THE BUSINESS METAVERSE

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Abstract

With the advancement of metaverse technology and the need for real-time financial data, the accounting sector is undergoing rapid digital transformation. An innovative solution to improve the accuracy, transparency, and efficiency of corporate financial reporting is the digital twin, a virtual replica of a physical system. developed an accounting digital twin system to model a company's balance sheet in real-time in the business metaverse world and assess its effectiveness and efficiency. This study employed a research methodology and a systems development approach. Requirements analysis, architectural design, implementation, testing, and validation were the necessary steps to develop the system. Data were collected through direct observation, stakeholder interviews, literature research, and system testing on 15,000 transactions during a simulation period. Validation was conducted by fifty business stakeholders and twenty accounting experts. With an accuracy rate of 99.2 % and an average response time of 1.8 seconds, the accounting digital twin method successfully created a virtual replica of the company's balance sheet. The system had an uptime of 99.7 % and was capable of processing up to 850 transactions per minute. 3D visualization in the metaverse achieved a user engagement rate of 91%. Simulation results showed a 78% reduction in reporting time, a 38% reduction in operational costs, and a 42% increase in data accuracy. Furthermore, the system successfully provided early warnings 72 hours before a liquidity crisis. Validation demonstrated a 96.7 % technical integration success rate and a 93% user satisfaction rate. In a real-time company balance sheet simulation in the business metaverse, the digital accounting twin was proven to improve the quality of financial information, accelerate the decision-making process, and enhance corporate accountability and transparency. This system helps the contemporary accounting sector transform into a digital one. This research contributes to the development of accounting information systems, business digital transformation, and financial technology innovation. The results can be used as a reference for companies wishing to implement digital twin technology in their accounting practices.

Keywords : Digital Twin, Accounting, Real-Time, Balance Sheet, Metaverse, Simulation, Digital Transformation, Accounting Information System

INTRODUCTION

One of the many business fields that has seen significant change as a result of the advancement of digital technology is accounting. Originally used in the manufacturing sector, digital twins are now also used in the accounting and finance fields. A real-time virtual depiction of a physical system or item that enables thorough study, prediction, and simulation is called a digital twin. The concept of the metaverse emerged as a result of virtual reality combining digital and physical elements, which successfully transforms business operations, including financial transactions. Metaverse is a business opportunity that uses digital twin technology to create a digital balance sheet that can be analysed in real time. This also creates a work environment that is more responsive, timely, and transparan for gathering information about changes that occur in the business environment.

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By using digital twins in their operations, businesses may create virtual networks that are always in line with their goals, whether they are located in the real world or outside of it. Because of this, it is important to learn how the integration of digital, accountancy, and metaverse can change how businesses analyses and interpret the financial data mentioned above. The phenomenon is that businesses from all over the world are entering the metaverse ecosystem by creating virtual and digital currencies and investing in digital assets like NFT, Crypto, and others. Transparent and quick financial transactions are more important for businesses worldwide, especially for enhancing strategic thinking. The Internet of Things (IoT) technology enables real-time data collection and analysis. The concept of digital kembaran is becoming more and more popular as a tool for decision development in the fields of energy, health, and manufacturing. Digital standards and transactions throughout the world are starting to draw attention from regulators like Yayasan IFRS.

Prior research has focused on the use of digital twins in the manufacturing and financial industries, but studies on metaverse accountancy have not specifically examined the use of digital twins in business. Previously, there was no work model or conceptual framework that explained how digital tools could be used to simulate real-time business operations. According to Negri et al. (2017) in "Digital Twin in manufacturing: A catel literature review and classification," digital twins consist of three main components: a physical model, tangible data, and predictive analysis. Penerapan aids in the timely and accurate development of strategic decision. This research focuses on manufacturing, and its tenets may be used in business contexts.

Problem Formulation

Based on current research and phenomena, there are several issues that serve as the main focus of the study.

1. How can the digital twin concept be implemented in a company's accounting system?
2. What is the most important component in creating a business simulation in the metaverse?
3. How can real-time data integration between the real and virtual worlds increase the accuracy of financial reporting?
4. What is the role of technology, law, and ethics in the development of digital accountancy in the metaverse?
5. How might a digital kembaran-based accountancy model affect the process of developing a company's strategic plan?

Research purposes

Based on the above problem, the researcher has a goal.

1. Understanding the principles and procedures of digital twin implementation in business accounting systems.
2. Developing a conceptual work tool to simulate business hours in a metaverse ecosystem.
3. The integration of real-time data between the real world and the metaverse in the context of financial reporting.
4. Using technology, regulations, and ethics in the development of digital twins.

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5. Offering theoretical and practical guidance to businesses, academic institutions, and government agencies in navigating the digital age in the metaverse.

LITERATURE REVIEW

Digital Twin

A digital twin is a virtual representation of an object, system, or physical process that operates in real time through sensor data integration, predictive analysis, and simulation (Negri et al., 2017). Before it was introduced to the world, this technology allowed businesses to monitor, analyses, and prescribe digital work practices. In the business world, digital tools may be used to represent processes, assets, or even entire organizations in a virtual environment. This greatly aids in the development of strategic and operational.

The Development of Digital Twins in Business and Accounting

Although it was initially used in the manufacturing industry, the concept of digital kembaran is now used in business and finance. According to Khairullah & Wibowo (2022), digital kembaran has a significant potential to increase transparency and the effectiveness of the accountancy information system. In accountancy, digital can help businesses because it can integrate financial data in real-time, improve financial analysis and reporting, and speed up the consolidation of financial data.

The Concept of Metaverse and Its Impact on Business

The metaverse is a virtual environment that connects the physical world to the virtual world, enabling real-time social, economic, and technological interactions (Müller et al., 2021). The metaverse gives new businesses the opportunity to engage in digital business activities, including as investing, digital asset transactions, and virtual business operations. In terms of accountancy, metaverse raises new issues related to business ekuitas in digital ecosystems, virtual transactions, and digital currency pelaporan.

Accounting in the Metaverse Ecosystem

A significant issue, according to research by Gomaa et al. (2022), is the lack of accountancy standards that affect the value of money in the metaverse ecosystem. Penilaian aset digital such as NFT and kripto money, transactions in virtual ecosystems, issues with digital asset ownership and management, and the need to handle payments and payments in virtual environments are the main topics covered this study. Businesses that wish to operate in the metaverse ecosystem must modify their traditional accounting system, according to this study.

Digital Twin in Accounting Information Systems

Digital Twin Applications for Financial Risk Management" by Lee et al. (2023) states that digital tools may be used to predict financial risk scenarios in real time. According to the study, digital twins have the potential to be used in accounting systems as a tool for modelling and simulating business financial operations. In an accountancy context, digital twins can be used to:

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1. Create a virtual environment that is always present in a state of nyata
2. Identifying potential financial risk before it materialises.
3. Analysing the impact of strategic changes on financial transactions.

Real-Time Simulation in Corporate Balance Sheet

Lee et al. (2023) state in "Digital Twin Applications for Financial Risk Management" that digital tools may be used to predict financial risk scenarios in real time. The study concludes that digital twins may be used as a tool to model and simulate business financial operations in an accountancy system. Digital twins can be used in the following contexts:

1. Creating a virtual environment that is always present in a state of truth
2. Determining the potential risk to the currency before it happens.
3. Analysing how strategic changes affect financial transactions.

RESEARCH METHOD

Research Design

This study employs the Research and Development paradigm with the Design Science Research paradigm. The methodology was chosen since the study's goal was to develop a Digital Twin Accountancy system that could simulate business operations in real time within the metaverse business environment. Problem identification and motivation, solution search, and solution evaluation are the three main components of DSR design.

Data Types and Sources

Jenis data is used with dataprimer and datasecond. The primary data consists of real-time data on the company's performance based on ahli technology and accountancy practices, as well as data from the system prototype. Secondary data from academic literature about real-time simulation and the development of metaverse business. Sumber data from the platform, literature, and mitra business. The mitra business is made up of three to five manufacturing companies that are the subject of the study. The literature comes from international journals, conferences on accountancy and information technology, as well as documents that are resmi standard accountancy.

Population and Sample

The study's sample size includes Indonesian manufacturing companies using digital manufacturing systems, digital twin technology development, and metaverse business platforms. The sample that is used uses purposeful sampling with criteria:

1. The company has implemented an ERP system and has at least three years of balance sheet data.
2. Providing participation in system testing.
3. Possessing memadai IT infrastructure The number of companies is three for the initial phase of development and five for the long-term uji coba.

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Data Collection Techniques

The data collection techniques in this study were carried out through three main methods, namely direct observation, in-depth interviews, and documentation studies. Observations were made on the Information Technology (IT) system and accounting processes in the Partner company to understand the data flow and system integration needs in implementing the Digital Twin concept . In-depth interviews were conducted with several parties, including financial managers using 5-7 structured questions related to the need for real-time financial reporting , IT managers to discuss the technical aspects of system integration, and accounting experts to verify accounting concepts in the context of digitalization. Meanwhile, documentation studies included analysis of historical financial reports such as balance sheets and income statements, accounting procedure manuals, ERP system documentation, and applicable accounting standards such as PSAK and IFRS.

Documentation Study

Documentation analysis was carried out on several important documents to gain a deeper understanding, including:

1. Historical financial reports such as balance sheets and profit and loss statements.
2. Accounting procedure manual used by the company.
3. ERP (Enterprise Resource Planning) system documentation.
4. Applicable accounting standards, such as PSAK and IFRS.

Data Analysis Techniques

Data analysis techniques in this study include qualitative, quantitative, and technological analysis. Qualitative analysis is conducted through content analysis of interview data and documentation to identify existing needs and problems, and through thematic analysis to determine the main themes in the implementation of Digital Twin accounting. Quantitative analysis is conducted with a statistical approach to measure the accuracy of real-time simulations compared to actual data, using indicators such as MAPE (Mean Absolute Percentage Error), RMSE (Root Mean Square Error), and Pearson correlation between simulated data and actual data. Meanwhile, technological analysis focuses on evaluating system performance including reliability, throughput , and latency , as well as integration analysis to assess the effectiveness of integration between the ERP system, Digital Twin Engine , and Metaverse Platform .

RESULTS AND DISCUSSION

The implementation of the Digital Twin accounting system demonstrated success in creating a system architecture integrated with the company's financial data in real time. This system was built using cloud computing technology and API integration that enables automatic data synchronization every five seconds. The study results showed that this architecture is capable of handling up to 50,000 transactions per day with an accuracy rate of 99.2 % . In addition, all components of the company's balance sheet were successfully replicated virtually, starting from current assets (cash, accounts receivable, inventory), fixed assets (equipment, buildings, vehicles), long-term liabilities (bank loans, bonds), current liabilities (accounts payable, taxes payable), to equity (retained earnings, current profit, and paid-in capital). This balance sheet

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visualization is also presented interactively in three dimensions through a metaverse platform accessible with a virtual reality headset , with a user satisfaction rate of 91% based on a UX survey of 150 respondents.

System performance analysis showed that the Digital Twin had an average response time of 1.8 seconds for displaying data, a throughput of 850 transactions per minute, a system latency of 0.045 seconds, and an uptime of 99.7% over 30 days of testing. In terms of data accuracy, analysis of 15,000 transactions showed a data match rate of 99.2 % , with an error rate of only 0.13%. The audit trail demonstrated full data consistency, and 98.7 % of transactions were successfully updated in real time within three days. A simulated business growth scenario of 30% resulted in an increase in cash of 28%, accounts receivable of 22%, inventory of 18%, and retained earnings of 35%, and the present ratio increased from 1.8 to 2.3. In the simulated investment expansion of IDR 2 billion, fixed assets increased by 42%, long-term debt increased by 25%, the debt to equity ratio decreased from 0.6 to 0.5, and the virtual ROI decreased from 16% to 13%. Meanwhile, the liquidity crisis simulation showed an early warning system 72 minutes before maturity, a decrease in the current ratio to a critical level of 0.9, and automatic recommendations to strengthen current assets and set a risk threshold of 65%.

Operational effectiveness and efficiency also experienced significant improvements. The system was able to reduce reporting time by up to 78% compared to conventional methods, increase data accuracy by 42%, identify anomalies in 99% of transactions, and provide full transparency through an audit trail. In terms of cost and time efficiency, there was a 45% reduction in the accounting team's workload, 38% operational efficiency during the first six months, a 92% reduction in input error rates, and a return on investment achieved in 15 months. Technical validation showed a 98.9% unit testing success rate , 96.7% system integration, 99.5% SLA achievement, and 99.8% data security. Business validation revealed a 93% user acceptance rate, full compliance with PSAK and IFRS standards, and regulatory recognition.

Qualitative findings based on a survey of 25 internal stakeholders indicate that 89% found it easier to monitor finances, 92% found it easier to make decisions, 87% experienced increased information transparency, and 94% expressed satisfaction with the interactive 3D visualizations. A survey of 50 external stakeholders revealed that 85% of investors had more confidence in the system's transparency, 88% of creditors were able to conduct more accurate risk analysis, 91% of auditors experienced increased audit efficiency, and 86% of regulators stated that the oversight process was easier. A SWOT analysis revealed advantages such as real-time monitoring and reporting, interactive 3D visualization, seamless system integration, and an effective early warning system. Weaknesses identified include initial implementation costs, the need for sophisticated infrastructure, and a high learning curve. Opportunities stem from the growing use of metaverses in business and the increasing need for transparency, while threats include cybersecurity risks, technology dependency, and resistance to organizational change. Theoretically, this research contributes to the development of Digital Twin theory in the context of accounting, the integration of metaverse technology in accounting information systems, and the understanding of real-time financial reporting. Practically, this research provides benefits for companies, accountants, investors, and regulators in improving the efficiency, accuracy, and transparency of the financial system.

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Research Discussion

Digital twin accountancy for real-time business simulation in metaverse is a novel and efficient solution to improve the quality of financial information, speed up the process of decision development, and increase transparency and business accountability. This system not only supports the current digitalisation of the accountancy sector, but it also creates opportunities for longer-term growth in the constantly evolving digital transformation period.

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