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The Role of Digital Technology in Sustainability Accounting: Findings from Pharmaceutical Companies in Indonesia

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Abstract:

This study aims to explore the role of digital technology in sustainability accounting practices in the pharmaceutical industry in Indonesia. The use of technologies such as big data, artificial intelligence (AI), blockchain, and the Internet of Things (IoT) has enabled pharmaceutical companies to improve operational efficiency and transparency of sustainability reporting. This study also identified challenges faced by pharmaceutical companies, such as regulatory uncertainty, technology implementation costs, and data security issues. This research uses a Systematic Literature Review (SLR) approach to collect and analyse evidence from relevant studies. The results show that digital technology can improve the accuracy of sustainability reporting, reduce environmental impacts, and increase public trust in pharmaceutical companies. The findings support the need for investment in digital technology as part of a long-term sustainability strategy in the pharmaceutical sector.

Keywords: *Digital Technology, Sustainability Accounting, Pharmaceutical Industry, Transparency, Operational Efficiency.*

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1. Introduction

Corporate environmental and social responsibility is under pressure to be more transparent in sustainability reporting. International Financial Reporting Standards Sustainability 1 (IFRS S1) and International Financial Reporting Standards Sustainability 2 (IFRS S2) are global sustainability reporting standards published by the International Sustainability Standards Board (ISSB).

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One of the main objectives of the ISSB is to develop standards for companies in sustainability reporting. Sustainability accounting includes not only the reporting of environmental and social impacts but also the assessment of sustainable performance in creating long-term value. As part of sustainability accounting, environmental accounting has indicators of materials, energy, water, waste and emissions while social accounting incorporates various effects for stakeholders and local communities (Clarke-Sather et al., 2011).

In Indonesia, the pharmaceutical industry faces various challenges such as external regulatory uncertainty and increasing consumer demand for socially responsible products. Internal challenges such as low employee awareness, business process efficiencies that do not contribute directly to sustainability performance, challenges in limiting the use of hazardous compounds and no adequate balance between ISO certificate acquisition and management system implementation (Erwin et al., 2024). Technologies such as big data, artificial intelligence (AI) and blockchain offer solutions to collect, analyse and report sustainability data more accurately and efficiently (Debnath et al., 2023). In addition, the adoption of technologies such as IoT, blockchain, and robitka goes a long way in reducing waste and improving work safety.

According to Budi Gunadi Sadikin (Minister of Health), the pharmaceutical industry needs technology to continue to grow and compete, especially in terms of research and development (R&D). The new regulations implemented aim to improve the quality and safety of pharmaceutical products, improve the drug registration process and support innovation (Arka & Noviyanti, 2024).

According to research conducted by Riedel (2024), the application of technology in the pharmaceutical industry has several challenges such as lack of understanding and knowledge of stakeholders, regulatory certainty, security and privacy issues, implementation costs, resistance to change.

The purpose of this study is to explore the challenges and opportunities faced by the pharmaceutical industry in Indonesia in sustainability and corporate social responsibility reporting, focusing on the implementation of global standards such as IFRS S1 and IFRS S2. The article also aims to discuss the role of technologies such as big data, artificial intelligence (AI), blockchain, Internet of Things (IoT) and others in improving the efficiency of sustainability reporting as well as the social and environmental impact of companies. In addition, the article will highlight the barriers, such as regulatory uncertainty, implementation costs, data security and privacy, and resistance to change, to the adoption of these technologies in the pharmaceutical sector.

2. Theoretical Background

Digital technology & Sustainable accounting

In the context of pharmaceutical companies in Indonesia, sustainability accounting is increasingly relevant as awareness of social and environmental responsibility increases (Schaltegger & Wagner, 2011). By using information management systems and accounting software, companies can collect data efficiently, enabling better monitoring of resource use and emissions (Khan & Manwani, 2013).

Big data analysis plays an important role in helping companies understand their environmental impacts (Garriga & Melé, 2004). By utilising such data, companies can not only meet applicable regulations, but also identify areas for improvement, creating opportunities for more strategic and evidence-based decision-making (Adams, 2004).

In addition, innovation in product development is one of the main benefits of digital technology (Raut et al., 2021). Through in-depth data analysis, companies can design products that are more environmentally friendly, reduce the use of hazardous materials, and minimise waste. This not only improves the company's image in the eyes of consumers who are increasingly concerned about sustainability issues, but also helps create a competitive advantage in the market.

Sustainability accounting is increasingly important in the pharmaceutical sector, especially in Indonesia, which faces pressure to improve transparency and accountability. Research by Jensen & Møller (2021), suggests that the application of digital technologies can strengthen sustainability accounting practices by increasing efficiency and transparency. In this context, technologies such as blockchain, Internet of Things (IoT), and data analytics offer significant solutions. The use of blockchain, for example, enables transparent and immutable recording of transactions, thereby increasing trust among stakeholders. In a study conducted by Kumar & Patel (2021), it was found that the ability to accurately track the supply chain is critical for pharmaceutical companies to ensure compliance with regulations and sustainability standards.

IoT also contributes by enabling real-time data collection. This data is used for sustainability analysis and assists companies in making better decisions. Research by Nguyen (2022), shows that automation through digital technology not only improves operational efficiency but also reduces costs, which is especially important in industries with tight profit margins.

However, the adoption of digital technology is not without challenges. Many pharmaceutical companies, especially smaller ones, experience difficulties in accessing the necessary technological infrastructure. Johnson (2023) notes that these limitations hinder their ability to effectively implement digital solutions. In addition, the lack of skills among employees is a major obstacle in the implementation of new technologies. Untrained employees may struggle to optimally utilise digital technologies, which can reduce the potential benefits that can be achieved. Data security issues are also a serious

concern, given the sensitive nature of information managed within the pharmaceutical sector. Data leaks and security threats can result in serious consequences, both legally and reputationally for the company. Brown (2022) emphasises the importance of developing strong policies regarding data security when adopting digital technologies.

Blockchain and Sustainability Impact

Blockchain technology offers significant potential in improving sustainability through transparency and efficiency in transaction and data management. According to Kamble (2020), these systems support better collaboration, reduce operational costs, and optimise business processes without requiring explicit incorporation of trust. This is particularly important in an environmental context, where monitoring of pollution and degradation can be done in real-time, enabling rapid and responsive decision-making (Riedel, 2024).

The ability of blockchain to improve supply chain sustainability is also highly recognised as it offers better accountability and security (Saberi et al., 2019). With democratic and decentralised principles, this technology has the potential to build fairer supply chains. Blockchain integration can help achieve sustainability goals, such as supply chain mapping and emission reduction, and support circular economy initiatives (Riedel, 2024).

Sustainability and Blockchain Technology in the Pharmaceutical Industry

In the pharmaceutical industry, blockchain brings five key factors: monitoring, reliability, traceability, authorisation and real-time functionality. According to Mackey & Nayyar (2016), the pharmaceutical supply chain is very different from other supply chains, where disruptions can directly impact the well-being of patients. Blockchain offers a solution for product traceability throughout its lifecycle, which is crucial given the high prevalence of counterfeit drugs, especially in developing countries (Debnath et al., 2023). The World Health Organisation (2017) reported that about 50% of drugs consumed in developing countries are counterfeit, indicating an urgent need for a more transparent system.

This technology is also beneficial in pharmaceutical waste management, which requires special handling to avoid threats to human health and the environment. Chaar (2020), notes that with a transparent system, blockchain can improve waste management through compliance, cost-effectiveness, and efficiency in collection and disposal.

Despite its promise, blockchain adoption in the pharmaceutical sector is also faced with challenges. Riedel (2024), identified the complexity and cost of integration into existing infrastructure as a major concern, along with scalability challenges essential for handling high transaction volumes. In addition, companies must ensure compliance with complex regulations, both existing and emerging specifically for blockchain technology.

3. Methodology

This study uses the Systematic Literature Review (SLR) methodology, which is a systematic, transparent, and repeatable research approach to evaluate the body of knowledge on a particular topic or technology (Sivarajah et al., 2017). This method

aims to review and collect evidence related to specific research questions so that the results can be replicated (Nassif et al., 2019). SLR is conducted with several objectives, including mapping the current state of a concept and providing a frame of reference to identify existing research gaps as well as opportunities for further study in the future (Sivarajah et al., 2017). This research also collected data and information from credible written sources, such as scientific journals, reference books, and other materials relevant to the research topic. Literature study involves several activities, including collecting literature data, reading, recording and organising written materials.

This approach focuses on analysing written works, especially journal articles, on topics related to digital technology in sustainability accounting in the pharmaceutical industry. Through this approach, the research analyses the advancement of digital technologies that have been adopted and implemented in various countries, both developed and developing. Data collected from previous studies were systematically and critically analysed to provide a deeper understanding of the application of digital technology in sustainability accounting in the pharmaceutical sector. In addition, this study also examines 13 pharmaceutical companies listed on the Indonesia Stock Exchange, in order to gain empirical insight into the application of digital technology in sustainability accounting practices in these companies.

4. Empirical Findings/Result

The first company is Merck Tbk. The company has revenue in 2023 of Rp 961,433,965,000 and a total budget for CSR of Rp 4,625,000,000,000 of which 0.48% of its revenue is allocated to CSR. Merck Company has a total energy consumption of 7,807.86 MWh in 2023. There are several company commitments in energy reduction and emission generation such as replacing waste incineration to RDF (Refuse Derived Fuel) which is able to reduce GHG by 27 tonnes ofCO_2, replacing light bulbs to LES thus reducing GHG by 27.6 tonnes ofCO_2, and the company also replaces storage to cold chain reducing GHG by 70.01 tonnes ofCO_2. For technology development, the company has increased operational efficiency and improved product quality with software upgrades for tableting and packaging machines, as well as the installation of flowmeters to measure energy use at designated points. For sustainability, the company undertook a cooling tower blowdown reuse project, participation in sustainability awareness month, tree planting in the factory area, and implementation of initiatives that contribute to reducing waste and greenhouse gases.

The second company is Kalbe Farma Tbk. The company generates revenue in 2023 of

Rp 30,449,134,077,618 and a total budget for CSR of Rp 14,800,000,000 where 0.05% of its revenue is allocated for CSR. Kalbe Company has a total energy consumption of 17,365.97 MWh in 2023. There are several company commitments in energy reduction and emission generation such as the use of environmentally friendly primary, secondary, and tertiary packaging, planting more than 5,000 trees, reducing carbon emissions of Kalbe Nutritionals equivalent to 7,000 tonnesCO2eq, and the company also conducts environmentally-based waste treatment in 23 locations. For technology development, the company conducts Innovation, science and health technology

programmes in biomedical, genomic sequencing and cell therapy. In terms of sustainability, kalbe company will implement Environmental, Social, and Governance (ESG) principles to improve Access to Healthcare.

The third company is Phapros Tbk. This company generates revenue in 2023 of IDR 1,014,129,711,000 and a total budget for CSR of IDR 4,472,000,000 where 0.44% of its revenue is allocated to CSR. Kalbe Company has a total energy consumption of 19,470.00 MWh in 2023. There are several company commitments in energy and emission reduction such as tree planting of 1,130 trees and reduction of conventional emissions and greenhouse emissions by utilising 1.35 Ha of green open space. For technology development, the company applies HRIS technology to optimise HR management performance and the company also conducts waste water and rainwater efficiency programs as needed. In terms of sustainability, the company has implemented a sustainability strategy through 4 pillars of commitment, namely Commercial excellence, Operational excellence, Digitalisation and Organizational excellence.

The fourth company is Darya-Varia Laboratoria Tbk. The company has revenue in 2022 of IDR 1,917,041,442,000 and a total budget for CSR of IDR 800,000,000 where 0.04% of its revenue is allocated for CSR. Darya-Varia Laboratoria Company has a total energy consumption of 38,184 MWh in 2023. There are several company commitments in energy reduction and emission generation such as optimising the operating hours of heating, ventilation, air conditioning (HVAC) in the soft capsule production area to reduce energy by 1,542.9 GJ. The company also conducted a motion sensor lamp replacement program to reduce energy by 27 GJ. For technological development, the company implements the SAP ERP system which is used for monitoring the expiration date of finished products and raw materials, as well as managing inventory efficiently, the company also develops barcoding systems and serialisation systems. In terms of sustainability, the company prioritises focusing on SDGs Goals that are directly related to its core business and vision as a pharmaceutical company, namely SDGs Goal 3: Good Health and Wellbeing.

The fifth company is Ikapharmindo Putramas Tbk. The company generated revenue in 2023 of IDR 441,136,955,186.00 and the company did not budget its revenue to be allocated to the CSR budget. Ikapharmindo Putramas Tbk has a total energy consumption of 6,207 MWh in 2023. There are several company commitments in energy and emission reduction such as using energy-saving lamps in each warehouse, scheduling electricity

use, turning off any electronic devices that are not in use, and saving the use of operational vehicles to reduce fuel use. For technology development, the company implemented a technology system for operational data and information management, which supports efficiency in decision-making and improves accuracy in recording financial transactions. In terms of sustainability, the company implements an efficient waste management system to reduce environmental impact, including efforts to recycle reusable materials, and the company is also involved in programmes that support community welfare and environmental preservation, such as environmental education and participation in community activities.

The sixth company is Organon Pharma Indonesia Tbk. The company generates revenue in 2023 of IDR 2,747,529,515,000 and a total budget for CSR of IDR 1,120,000,000 where 0.04% of its revenue is allocated to CSR. Organon Pharma Indonesia has a total energy consumption of 10,060,470 MWh in 2023. There are several company commitments in energy reduction and emission generation such as saving electricity by turning off unnecessary electricity in 2023, a decrease of 807,150 from the previous year. For technology development, the company built a PWS (Purified Water System) tech installation. In addition, the company also conducts integrated wastewater treatment between domestic and industrial wastewater. In terms of sustainability, the company will continue the Life Cycle Analysis (LCA) Programme that supports Create the Future. This LCA assists in modelling and analysing the environmental impact of the products produced and as a basis for process development during production.

The seventh company is Pyridam Farma Tbk. The company generated revenue in 2023 of IDR 702,067,615,605.00 and a total budget for CSR of IDR 3,693,819,426 where 0.53% of its revenue is allocated to CSR. Pyridam Farma Company has a total energy consumption of 17,365.97 MWh in 2023. There are several company commitments in energy reduction and emission generation such as efficient use of boiler fuel and generators by changing diesel fuel to gas where the efficiency per month reaches 43% and in value reaches approximately 40-50 million per month, and also the company uses environmentally friendly materials and tools. For technological development, the company builds resilient infrastructure, promotes inclusive and sustainable industries, and encourages technological innovation. In terms of sustainability, the company cooperates with PT Wastec International in hazardous waste management.

The eighth company is Penta Valent Tbk. This company generated revenue in 2023 of Rp 2,484. 675,637,301.00 and a total budget for CSR of Rp 3,400,000,000 where 0.14% of its revenue is allocated for CSR. There are several company commitments in energy and emission reduction such as using energy-efficient electronic equipment, replacing conventional lights with LED lights, using electrical equipment only when used, routinely conducting vehicle emission tests, managing domestic waste by using waste disposal systems, and using air conditioners with environmentally friendly freons. For its technological development, the company builds infrastructure, promotes inclusive and sustainable industries, in accordance with applicable laws and regulations. In terms of sustainability, the company is committed to managing hazardous and toxic waste with

the principles of reduce, reuse, recycle, and recovery (4R) through improving the quality of waste disposal, handling hazardous and non-hazardous waste, and preventing waste spills.

The ninth company is Indofarma Tbk. The company generates revenue in 2023 of IDR 1,869,020,000,000 and a total budget for CSR of IDR 1,500,000,000 where 0.08% of its revenue is allocated for CSR. Indofarma Company has a total energy consumption of 17,141.83 MWh in 2023. The company is committed to energy and emission reduction by implementing efforts to reduce energy consumption in the factory, such as efficient use of electricity and fuel and also the use of low-carbon technology, such as boiler conversion from diesel fuel to gas. For its digital technology development,

Indofarma collaborates with PT Telemedika Teknologi Indonesia (GetWell) to provide digital health services integrated with medical devices based on the Internet of Medical Things (IoMT). In terms of sustainability, the company implements the Triple Bottom Line strategy (People, Planet, Profit) which includes economic, social and environmental values based on the principles of good corporate governance.

The tenth company is Kimia Farma Tbk. The company generates revenue in 2023 of Rp 9,960,000,000,000 and a total budget for CSR of Rp 8,340,000,000 where 0.08% of its revenue is allocated to CSR. Kimia Farma Company has a total energy consumption of 59,287 MWh in 2023. There are several company commitments in energy reduction and emission generation such as using solar street lights, using motion sensors in the warehouse area, replacing diesel to Compressed Natural Gas (CNG) as boiler fuel, using environmentally friendly refrigerants that do not damage ozone, and conducting reforestation programmes around the company area. For its technology development, the company replaced diesel to Compressed Natural Gas (CNG) as boiler fuel. In terms of sustainability, the company balances the three interrelated dimensions of sustainability namely profit, people, and planet or economic, social, and environmental.

The eleventh company is the herbal and pharmaceutical industry Sido Muncul Tbk. This company generates revenue in 2023 of IDR 3,565,930,000,000,000 and a total budget for CSR of IDR 11,500,000,000 where 0.32% of its revenue is allocated for CSR. There are several company commitments in energy reduction and emission generation such as reducing GHG emissions from operations, improving energy and water efficiency, implementing an environmental management system for environmental management. For its technology development, the company is using WWTP technology for water efficiency by replacing belt press machines to JD. In terms of sustainability, the company developed an existing farmer group and one agrofarm producer farmer partner group.

The next company is Soho Global Health Tbk. This company generates revenue in 2023 of IDR 8,197,755,000,000.00 and its total energy consumption is 3,464 MWh. There are several company commitments in reducing energy and emissions such as reducing GHG emissions also includes planning initiatives to use renewable energy to be cleaner, more sustainable, and free from carbon emissions. Tree planting and landscape greening in the

factory area also contribute to absorbing CO2 from the surrounding environment, and the company also ensures that the management of all direct emissions from boiler operations, production machinery, and standby generators always meets current regulations. For its technology development, the company takes a collaborative approach with various research institutions, including government agencies, universities, and the private sector. In terms of sustainability, the company focuses on clean production, structured environmental management, efficient use of resources, employee welfare and safety, harmonious industrial relations, mutually beneficial partnerships with suppliers and farmers, community development initiatives, and commitment to product quality and safety.

The last company is Tempo Scan Pasific Tbk. The company generates revenue of IDR 13,119,784,555,987.00 and a total budget for CSR of IDR 6,700,000,000.00 where 0.05% of its revenue is allocated for CSR. There are several commitments of the company in reducing energy and emission such as using solar panels (solar PV), making efficient use of energy savings, and using more environmentally friendly natural gas. For its technological development, the company developed an integrated ordering application, TiMOS Application, and utilised the advancement of information technology, back-end, Distribution Requirement Planning, and the adoption of Warehouse Management System that enables operational activities to be carried out digitally. In terms of sustainability, the Company started calculating its carbon emissions to achieve product and service sustainability strategies through environmental social responsibility (ESG) initiatives. The Company also applies the 3R principles of Reduce, Reuse and Recyle in its operational activities to contribute to environmental sustainability.

5. Discusion

The role of digital technology in sustainability accounting in pharmaceutical companies in Indonesia is crucial in the face of current environmental, social and economic challenges. One of the main roles of digital technology is to improve operational efficiency which results in reduced energy consumption and carbon emissions. For example, Merck Tbk. has installed flowmeters to measure energy usage at specific points, helping to identify areas that can be optimised. This supports the S1 dimension of sustainability, which is economic, as this technology helps reduce operational costs through energy savings, while contributing to S2 through resource optimisation and environmental impact minimisation.

Pharmaceutical companies are also utilising digital technology to improve accuracy and precision in sustainability reporting. With Enterprise Resource Planning (ERP) in place, companies can manage inventory, monitor energy consumption and reduce waste more efficiently. Darya-Varia Laboratoria Tbk, has implemented an ERP system to better manage product expiry dates and raw materials. This technology helps to ensure that production and distribution run according to standards, thereby strengthening the social

dimension in S1 by reducing potential waste and improving operational efficiency that can support employee welfare.

In addition, digital technology also enables pharmaceutical companies to implement data-driven sustainability strategies, as implemented by Kalbe Farma Tbk. in its health science and technology innovation programme, involving the fields of genomic sequencing and cell therapy. This programme not only enhances the company's competitiveness but also opens access to healthcare for the community, in accordance with Environmental, Social, and Governance (ESG) principles in Indonesia. This initiative is linked to S2, as the use of technology helps minimise environmental impact in a more sustainable and innovative way.

Some pharmaceutical companies also develop technologies for waste management and resource reutilisation, such as the 4R system (reduce, reuse, recycle, and recovery) adopted by Penta Valent Tbk. These principles play a role in minimising environmental impacts and supporting the balance between profit, planet, and people in S1. By applying digital technology in waste management, the company can be more targeted in reducing emissions and supporting a cleaner and healthier environment.

Furthermore, collaboration between pharmaceutical companies and research institutions or the government is also strengthened by digital technology for sustainability innovation. Soho Global Health Tbk, for example, collaborates with universities and government agencies to develop environmentally friendly technologies in the production process. This step not only supports economic sustainability but also reflects the company's social responsibility towards the surrounding community, which is closely related to the S1 principle.

The use of clean energy is another commitment made easier by digital technology. Kimia Farma Tbk, for example, implements solar lights and motion sensors to reduce emissions from more environmentally friendly resources. This approach strengthens the economic aspect of S1 by reducing long-term energy costs and supporting environmental conservation, which is aligned with the principle of resource efficiency in S2. In addition, digital technology plays a role in supporting pharmaceutical companies to achieve long-term sustainability goals, as done by Organon Pharma Indonesia Tbk through its Life Cycle Analysis (LCA) Programme. This technology allows companies to monitor the environmental impact of products thoroughly. LCA helps companies make more informed decisions regarding production processes, thus supporting long-term sustainability in the economic and environmental dimensions in S1 and the principle of impact minimisation in S2.

Pharmaceutical companies are also starting to utilise digital technology to monitor and measure carbon emissions accurately, as implemented by Tempo Scan Pacific Tbk. with solar panels and digital systems for emissions monitoring. The utilisation of this technology not only fulfils the economic principle in S1, but also drives the company towards greener and more sustainable operations, which is the main focus in principle

S2.

The use of energy-efficient technology is important in maintaining the balance between economy and environment in the pharmaceutical sector. Pyridam Farma Tbk, for example, converts diesel fuel into gas to improve fuel efficiency. This step shows how digital technology and energy innovation play a role in supporting operational cost savings, improving efficiency, and strengthening environmental sustainability in S1 and S2. On the social aspect, companies such as Indofarma Tbk. seek to facilitate access to healthcare through services based on Internet of Medical Things (IoMT) technology. This technology allows the company to provide affordable digital health services, reaching more people. This shows the company's responsibility in improving access to health, which is an important aspect of S1, while still paying attention to environmental sustainability in the long run.

The implementation of technology in water management also shows the responsibility of pharmaceutical companies towards the preservation of natural resources. Sido Muncul Tbk, for example, uses a WWTP system for efficient water use in its operations. Thus, this technology plays a role in minimising the environmental impact of water consumption, which supports the principle of resource efficiency in S2, while upholding the economic and environmental aspects in S1. Pharmaceutical companies are increasingly aware of the importance of sustainability in their business strategies. By utilising digital technology, companies can continuously monitor, measure and report their sustainability impacts in a transparent manner. These practices not only help companies comply with government regulations but also strengthen their sustainability commitments on economic, social and environmental aspects under S1, and support impact minimisation under S2 for future sustainability.

6. Conclusions

The research reveals that the adoption of digital technologies in Indonesia's pharmaceutical industry is instrumental in improving operational efficiency and transparency of sustainability reporting. Technologies such as blockchain and IoT enable companies to manage data more accurately and transparently, while the use of AI and big data supports better decision-making regarding environmental and social impacts. While there are challenges related to regulation, cost, and data security, the benefits derived from the adoption of these technologies far outweigh the constraints. Overall, this study emphasises the importance of investing in digital technologies as a key element to achieving long-term sustainability goals in the pharmaceutical industry. Future research is recommended to further explore the empirical analysis of the impact of the use of digital technology on the sustainability performance of pharmaceutical companies in Indonesia. In addition, a field study involving small and medium-sized pharmaceutical companies could provide more comprehensive insights into the challenges faced in the implementation of digital technology. Research can also examine effective strategies to overcome barriers to technology adoption, including skills training for employees and

the development of stronger data security policies. Comparative analysis between pharmaceutical companies in Indonesia and other countries can also provide a global perspective on the effectiveness of digital technology in sustainability accounting.

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