

Digital Twins: The AI Technology Driving Banpu's Energy Operations Efficiency

In the energy industry, production, transportation, and management processes operate continuously around the clock. Every moment a system underperforms leads to energy waste, rising costs, and unnecessary carbon emissions. Banpu Public Company Limited, a versatile energy company, has integrated digital technology to elevate operational performance. One of the key digital solutions is Digital Twins, which simulates and analyzes energy system operations in real time to improve efficiency, reduce costs, and support sustainable operations.

Digital Twins: What is it and How Does It Work?

Digital Twins are virtual replicas that connect real-world operational data to the digital world in real time, enabling continuous simulation, prediction, and optimization of systems. By mirroring a physical asset or process digitally, operators can monitor, analyze, and anticipate performance in advance, therefore referred to as the 'twins' of the physical system.

With the deployment of IoT (Internet of Things) sensors on machinery, the system collects data such as equipment conditions, production volumes, and logistics status of each operational point. The data is then transmitted to a digital system for AI-powered analysis. Advances in AI have made it possible to analyze and optimize operations in near real time, presenting results in a clear, accessible format that enables both operators and executives to make faster, more informed decisions. Banpu has applied this technology within its Next-Gen Mining business, one of its four core business pillars, to improve operational efficiency, reduce discrepancies, and enhance data-driven decision-making.

Elevating Efficiency from Mine to Port

Mining and port operations have historically faced significant constraints: data scattered across multiple systems, communication dependent on manual processes causing delays, and machinery idling, all contributing to higher costs and underutilized equipment capacity. Banpu has addressed these challenges by deploying Digital Twins at its coal mine and Bunyut Port in Indonesia, installing

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IoT systems on machinery to continuously collect and analyze operational data, shifting from reactive operations to systematic and predictive planning.

At the mine site, IoT data enables continuous analysis of hauling roads and equipment conditions, transitioning the operation from Reactive Maintenance (addressing problems after they occur) to Predictive Maintenance, which schedules servicing in advance, improving overall production output, fuel efficiency, and logistics performance, while reducing unnecessary idle time.

At the port, Banpu developed ZeNIXa, a Digital Twins platform that integrates data from machinery and logistics processes into a centralized digital system. ZeNIXa provides real-time visibility across the full production chain, from the Port Stockyard (PSY) through to cargo vessel loading. Previously, operational data was confined to the control room and communicated via radio or manual reports, causing delays in decision-making. ZeNIXa enables all teams to access the same data instantly, regardless of location, improving planning accuracy and cross-functional coordination. The process allows logistics planning 1 to 2 days ahead, particularly in aligning vessel schedules with available coal volumes, reducing demurrage costs, and improving inventory management accuracy.

Furthermore, improved conveyor belt continuity has reduced equipment idle time by approximately 15%. Loading rates have become more stable, increasing average throughput from 2,600 tons per hour to 2,900 tons per hour, a gain of approximately 9 to 10%, reflecting enhanced equipment utilization through more continuous and efficient operational processes.



Long-Term Value Across the Organization, Environment, and End Consumers

Digital Twins connect Banpu's operations from the field through to executive decision-making. Real-time data from mines and ports enables operators to monitor and adjust operations in real time, reducing process steps and communication errors while providing access to shared data that eliminates duplication and improves operational continuity. Office-based teams can analyze and plan with greater precision, while executives gain a comprehensive overview to support faster, data-driven decisions.

Improved efficiency in production and logistics, combined with reduced carbon emissions and the elimination of unnecessary costs, contributes to lower overall energy costs in the long run, benefiting

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consumers and society through more equitable access to energy, fair and reasonable pricing, and responsible stewardship of society and the environment.

Banpu's systematic and continuous investment in Digital Twins paves the way for the Company to utilize every unit of energy efficiently, minimize waste, and create value concurrently. This reflects the use of technology to advance Banpu's diverse new-era energy business in line with its Energy Symphonics strategy, supporting the responsible expansion of global energy capacity and creating sustainable value for all stakeholders.

Dr. Kirana Limpaphayom, Chief Operating Officer of Banpu Public Company Limited, stated, “Banpu believes that today's energy challenge lies in managing a diverse range of energy sources to work together with maximum efficiency. Digital Twins are a critical tool that enables us to connect data from real operations and gain a holistic view of our energy systems, from operational level through to strategic decision-making. The results achieved in Indonesia demonstrate that we can deliver measurable efficiency improvements, manage costs, and create asset value while conducting our business responsibly. This is the approach Banpu will apply as we expand our energy capabilities and grow alongside the countries where we operate.”

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About Banpu

Banpu Public Company Limited is a versatile energy company, operating across four business pillars under its Energy Symphonics Strategy: Next-Gen Mining, U.S. Closed-Loop Gas, Power+, and Future Tech – with operations in Thailand, Indonesia, China, Australia, Lao PDR, Mongolia, Japan, the United States of America, and Vietnam. The Company leads a responsible and sustainable energy transition by balancing reliable, affordable and sustainable energy.

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