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**NÂNG CAO MINH BẠCH TOÀN DIỆN CHUỖI CUNG ỨNG THÔNG QUA TÍCH HỢP AI VÀ IOT: NGHIÊN CỨU TRƯỜNG HỢP SIEMENS AG VÀ CÁC ĐỀ XUẤT CHIẾN LƯỢC CHO VIỆT NAM**

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**Tóm tắt**

Nghiên cứu này đi sâu vào tìm hiểu cách AI-IoT giúp tăng cường tính minh bạch toàn diện trong chuỗi cung ứng (End-to-end Supply Chain Visibility). Các công nghệ AI và IoT cho phép doanh nghiệp theo dõi thời gian thực, phân tích và dự đoán, tối ưu hóa vận hành, tự động hoá phản

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ứng, ra quyết định thông minh. Thông qua việc phân tích, so sánh và đối chiếu các số liệu thực tế từ doanh nghiệp Siemens AG; nghiên cứu này đánh giá khả năng hỗ trợ của công nghệ AI-IoT trong việc tăng cường tính liền mạch và hiệu quả của toàn chuỗi cung ứng. Cuối cùng, nghiên cứu liên hệ đối chiếu với chuỗi cung ứng tại Việt Nam và đưa ra các đề xuất cải thiện cho doanh nghiệp và nhà hoạch định chính sách.

**Từ khóa:** minh bạch toàn diện chuỗi cung ứng, Siemens AG, tích hợp AI-IoT, Việt Nam

## **ENHANCING END-TO-END SUPPLY CHAIN VISIBILITY THROUGH AI AND IOT INTEGRATION: A CASE STUDY OF SIEMENS AG AND STRATEGIC RECOMMENDATIONS FOR VIETNAM**

### **Abstract**

This study examines how AI-IoT enhances end-to-end supply chain visibility. AI and IoT technologies enable businesses to monitor operations in real time, perform analysis and forecasting, optimize processes, automate responses, and make intelligent decisions. By analyzing, comparing, and cross-referencing actual data from Siemens AG, this study assesses the potential of AI-IoT technologies to improve the continuity and efficiency of the entire supply chain. Finally, the study draws parallels with supply chains in Vietnam and provides recommendations for both enterprises and policymakers.

**Keywords:** AI-IoT integration, end-to-end supply chain visibility, Siemens AG, Vietnam

## **1. Introduction**

In Vietnam, supply chains have expanded rapidly as the country integrates deeper into global production networks. Firms now work with diverse suppliers, export-oriented factories, and increasingly complex logistics systems. However, many domestic manufacturers still operate with limited digital infrastructure, fragmented data, and low real-time visibility. Such limitations often lead to delays, increased operational costs, and difficulties in coordinating multi-component chains. Therefore, there has been an increasing need for the Internet of Things (IoT) and Artificial Intelligence (AI), which are widely acknowledged as effective digital solutions to enhancing end-to-end supply chain visibility.

To better understand how these technologies can be applied in practice, this paper examines Siemens AG - a global industrial manufacturer that has implemented IoT and AI at scale across its production and logistics networks. Siemens' experience demonstrates how smart sensors, connected devices, and real-time analytics can enhance end-to-end visibility and improve decision-making. While Siemens operates in an advanced technological environment, its approach provides valuable lessons for emerging markets where digital transformation is still developing, including Vietnam.

By analyzing Siemens' applications, this paper aims to address how digital technology can help supply chains become more coordinated, efficient, and resilient. The insights are meant to help Vietnam shape digital transformation, modernize the country's industrial base, and increase the competitiveness of its manufacturing sector.

## **2. Overview of Vietnam Supply chain**

### ***2.1. Overview of Current Supply Chain Technologies in Vietnam***

Vietnam's supply chain has evolved considerably in recent years, due to the country's strong manufacturing expansion, expanded export activities, and deeper involvement in global value chains. To keep up with the growing complexity and customer expectations, Vietnamese businesses have started implementing some modern supply chain technologies, such as barcodes and RFID. While these technologies are becoming more popular among large corporations and FDI organizations, application among small and medium-sized businesses is inconsistent as a result of financial restrictions, insufficient digital capabilities, and infrastructure gaps.

The end-to-end supply chain visibility in Vietnam is still evolving and varies across industries. While big FDI manufacturers such as Samsung, Intel, and Foxconn have implemented modern systems such as ERP, MES, WMS, and RFID tracking, most domestic enterprises continue to rely mainly on manual processes. As a result, visibility is typically limited to internal activities, rather than including multi-tier suppliers and distribution networks. The lack of shared data standards and fragmented information across businesses and government agencies all restrict the end-to-end supply chain visibility. The country's supply chain transparency remains uneven: large businesses and FDI enterprises have somewhat integrated information systems, whereas the majority of SMEs continue to rely on fragmented, isolated, and inefficient data processes that limit overall visibility.

### ***2.2. Comparison Between Vietnam's Current Supply Chain Model and Siemens' Model***

Vinamilk's supply chain is chosen to represent Vietnam due to the fact that it is one of the most advanced supply chains in the country, applying WMS and ERP systems. This allows us to identify the key gaps between Vietnam and the world's leading supply chain technologies, as exemplified by Siemens. From this comparison, appropriate recommendations can be made to improve supply chain performance in Vietnam.

Table I: Comparison of Supply Chain Capabilities: Vinamilk and Siemens

Aspect	Vinamilk (Vietnam)	Siemens (Global / Digital SCM)
Scope	Domestic dairy production & distribution.	Global, multi-tier supply chain with end-to-end visibility.
Technology	Smart warehouses, WMS, ERP; partial automation and data integration.	Full IoT + AI integration, digital twin, real-time analytics, control tower, predictive maintenance.
Visibility & Integration	Internal integration; limited cross-partner data sharing.	End-to-end transparency across suppliers, manufacturing, logistics, and distribution.
Efficiency & Resilience	Improved warehouse efficiency & inventory accuracy; forecasting partly manual.	High efficiency, predictive analytics, optimized resources, rapid response to disruptions.
Limitations	Mainly domestic focus, less integrated with external partners, lower-tech analytics.	High cost, complex implementation, requires global coordination & advanced IT.

Sources:

*Sbiz.vn. (2024, January 25). Mô hình quản lý kho thông minh đầu tiên và lớn nhất tại Việt Nam của Vinamilk.*

*Regnet, A. (2024, October 28). Supply chain design is the key to creating robust and competitive supply chains as disruptions become the new normal*

The key gap lies in the scope and integration of supply chain technologies: while Vinamilk has implemented WMS and ERP for internal operations, Siemens achieves end-to-end visibility across suppliers, production, logistics, and distribution globally. Additionally, advanced analytics, IoT, and predictive tools used by Siemens allow real-time optimization and resilience, which are still limited in Vietnam's current system.

### **3. Literature review**

#### ***3.1. End-to-End Supply Chain Visibility in the Digital Era***

End-to-end supply chain visibility has come into focus as a key idea in modern supply chain management, as global industrial networks become more complicated and interconnected. Visibility is often characterized as a firm's ability to track, access, and exchange essential information throughout the supply chain, from upstream suppliers to downstream customers (Barratt & Oke, 2007; Caridi et al., 2010). Unlike traditional internal visibility, end-to-end visibility prioritizes cross-organizational transparency, real-time information interchange, and coordinated decision-making.

Previous research has consistently shown that low visibility leads to delayed reactions, inventory discrepancies, higher operational costs, and increased vulnerability to interruptions (Pettit et al., 2010; Sodhi et al., 2012). As supply chains become increasingly global and subject to regular shocks, the need for end-to-end visibility grows. As a result, visibility has grown from static reporting and basic tracking to dynamic, real-time, and predictive systems powered by digital technology.

According to recent research, visibility is no longer just about controlling the current condition of operations, but also about forecasting future disturbances and facilitating proactive decision-making. This change has made digital technologies, such as IoT and AI in particular, important for enabling end-to-end supply chain visibility in the future.

#### ***3.2. The Role of IoT in Supply Chain Visibility***

It is commonly acknowledged that the Internet of Things (IoT) represents the fundamental infrastructure for improving supply chain visibility. The Internet of Things (IoT) is a network of interconnected physical devices, including sensors, RFID tags, and smart machines, that continuously gather and send data over digital networks (Lee & Lee, 2015). IoT devices make it possible to monitor inventory levels, machine conditions, and environmental factors in real time.

According to empirical research, IoT implementation greatly increases operational visibility by eliminating information delays and lowering human data collecting (Ben-Daya et al., 2019). Businesses may increase inventory accuracy, improve production and logistics coordination, and identify operational irregularities more quickly with sensor-based tracking systems. By connecting production data with business systems like ERP and MES, IoT-enabled smart factories in industrial settings further improve visibility (Zhong et al., 2017).

However, the literature also points out that IoT by itself does not ensure efficient end-to-end visibility. Large amounts of real-time data are produced by IoT, yet managers may become overwhelmed by raw data without sophisticated analytical tools and be unable to provide useful insights (Hofmann & Rüsçh, 2017).

### ***3.3. AI Applications in End-to-End Supply Chain Visibility***

#### ***3.3.1. AI for Real-Time Monitoring and Anomaly Detection***

In order to convert the raw, high-frequency data produced by IoT systems into useful, real-time supply chain visibility, artificial intelligence is important. Sensors built into machinery, warehouses, cars, and logistics infrastructure produce enormous data streams for modern supply chains. Because they can recognize intricate, non-linear patterns that are challenging for human operators or conventional rule-based systems to recognize, machine learning and deep learning algorithms are especially well-suited to handling such data (Min, 2010; Choi et al., 2018).

Unlike traditional threshold-based monitoring systems, AI-driven anomaly detection algorithms constantly learn from historical and real-time data. These models create dynamic baselines for normal operating performance and automatically identify variations as potential dangers. Abnormal vibration signals, temperature variations, unexpected inventory movements, and unusual transportation delays, for example, can all be identified early on before they cause system-wide disturbance. This adaptive learning power enables AI systems to stay effective even as production quantities, product mixes, or logistics routes shift over time.

Empirical studies demonstrate that AI-based real-time monitoring improves operational dependability and stability. Queiroz et al. (2020) discovered that AI-enabled anomaly detection greatly lowers unplanned downtime by allowing for predictive maintenance and speedier corrective actions. Similarly, research in smart manufacturing environments demonstrates that constant AI-driven monitoring increases equipment utilization, stabilizes production flows, and lowers failure rates across interconnected supply chain operations. By automating the detection of operational abnormalities, AI systems reduce reliance on manual supervision and fragmented

reporting, allowing for faster managerial intervention and more coordinated reactions. In summary, AI-powered real-time monitoring improves end-to-end supply chain visibility by detecting interruptions as they occur rather than when performance deteriorates.

### *3.3.2. AI for Predictive Visibility and Forecasting*

Beyond real-time monitoring, AI improves supply chain visibility by providing predictive insights into future system conditions. Predictive visibility refers to a company's ability to monitor present operations while also anticipating future demand shifts, supply disruptions, and capacity bottlenecks. Machine learning-based predictive analytics outperform traditional forecasting methods by combining vast amounts of diverse data, such as historical demand, real-time IoT signals, market indicators, and environmental elements (Wamba et al., 2017).

Traditional forecasting models frequently rely on fixed assumptions and historical averages, making them ineffective in dynamic and uncertain contexts. In contrast, AI-based models constantly update predictions as new data becomes available, allowing projections to change in real time. This skill helps businesses to respond proactively to developing hazards including supplier delays, equipment degradation, and unexpected demand surges. As a result, AI-driven predictive visibility marks a change away from reactive supply chain management and toward proactive, data-driven decision-making.

Ivanov (2020) and Dolgui et al. (2021) emphasize predictive visibility as a critical enabler of supply chain resilience. Firms that foresee interruptions ahead of time can examine alternative scenarios, reallocate resources, and adapt production and logistical strategies accordingly. Predictive insights also aid in improved synchronization between demand forecasts, inventory positioning, and capacity planning, resulting in fewer stockouts and surplus inventory.

Moreover, when predictive analytics are connected with IoT platforms and enterprise systems, AI allows for continuous synchronization of supply chain processes. Production schedules, inventory policies, and transportation plans can be dynamically changed to reflect changing conditions, resulting in improved service levels and operational efficiency. In this view, AI-powered predictive visibility not only decreases uncertainty but also improves the strategic coordination of end-to-end supply chain operations.

### ***3.4. Research Gap and Relevance to Vietnam***

Despite the rising quantity of literature on AI and IoT in supply chain management, numerous gaps still exist. First, many studies look at individual technologies in isolation rather

than the combined impact of AI and IoT on end-to-end visibility. Second, much of the existing research focuses on conceptual frameworks or survey-based evaluations, with few detailed case studies of large-scale commercial implementation. Third, empirical information is mainly focused in established economies, providing little direction for emerging markets like Vietnam.

Supply chains in Vietnam are frequently typified by disjointed data systems, poor real-time visibility, and disparate degrees of digital engagement among businesses. These circumstances imply that lessons can be learned from sophisticated implementations, such those of Siemens. Nevertheless, there is little debate in the literature currently in publication regarding the adaptation of AI-enabled visibility solutions to emerging economies with distinct institutional, technological, and financial restrictions. This gap supports the current study's use of Siemens AG as a case study and its emphasis on identifying strategic recommendations for Vietnam.

## **4. Methodology & Case Study Approach**

### ***4.1. Rationale for selecting Siemens AG as a case study***

The application of Siemens AG as a case study for the topic is based on the rationales:

According to the US SECURITIES AND EXCHANGE COMMISSION, Siemens will have over 1,300 cybersecurity experts and over 500 active AI patent families by 2024. These tools demonstrate that Siemens has invested heavily in AI in security and high-tech skills, which are the main foundation for the development of AI and IoT in the supply chain.

Warehouse figures of the Siemens logistics center: Siemens was reported on 20/05/2023 in the article Maximum transparency: Siemens shows the comprehensive digital twin of a logistics center on the official website [press.siemens.com](https://press.siemens.com): In the Siemens logistics center in Nuremberg: processing 12,000 orders per day, 22,000 delivery notes, using 27 stacker cranes and 3 km of automated conveyors. This is a direct demonstration of using IoT and digital twins to increase supply chain visibility and warehouse efficiency.

Integrating Compiled IoT and Real-Time Data: Siemens has partnered with AWS: AWS IoT SiteWise on Siemens Industrial Edge, reported by Amazon on 07/30/2024 in AWS IoT SiteWide Compiled on Siemens Industrial Edge is now generally available. Through edge computing and IoT, Siemens can collect data from industrial devices (via OPC-UA, MQTT, Profinet) and send it to the cloud, supporting use cases such as asset monitoring, predictive

maintenance. This work enables Siemens to provide an end-to-end kill chain by capturing real-time, real-world data from key points in the chain (machines, warehouses, operating equipment).

**Digital Twin Development & Simulation Modeling:** In the October 2024 blog post *Defining the Digital Twin*, [blog.ws.siemens.com](https://blog.ws.siemens.com), Siemens Digital Industries Software describes the digital twin as a tool for monitoring, controlling, and optimizing complex systems. They use digital twins to simulate “what-if” scenarios to optimize processes, according to a Siemens report from the logistics center. Siemens Advanta’s “Digital Twins for Supply Chain Optimization” report, predicts that by 2027, 93% of IoT platforms will have a digital twin. This forecast demonstrates that Siemens is not only using digital twins now, but is in line with the industry-wide trend of combining IoT and digital twins to enhance monitoring and supply chain optimization.

#### ***4.2. Data sources***

This study draws on three primary categories of secondary data to examine the enhancement of end-to-end supply chain visibility at Siemens AG through AI and IoT integration. First, annual reports from Siemens AG, including the Siemens Annual Report 2023, Sustainability Reports (2022-2024), and Form 20-F filings which provide detailed corporate disclosures on digital transformation initiatives, operational performance, and supply chain modernization. Second, industry publications from reputable organizations such as Gartner, McKinsey, Deloitte, the Boston Consulting Group, and the World Economic Forum offer benchmarking data and independent assessments of Siemens’ technological capabilities within the broader context of global manufacturing and Industry 4.0. Finally, academic literature, including peer-reviewed articles from journals such as *Computers & Industrial Engineering*, the *IEEE Internet of Things Journal*, the *International Journal of Production Research*, and the *Journal of Manufacturing Systems*, supplies theoretical foundations and empirical evidence related to IoT-based visibility, AI-driven optimization, and smart factory performance. Together, these data sources ensure a robust, triangulated foundation for analyzing Siemens AG’s supply chain before and after digital technology adoption.

#### ***4.3. Analysis method***

The analysis in this study employs a comparative approach to evaluate the impact of IoT integration on Siemens AG’s end-to-end supply chain performance. Specifically, supply chain operations are examined before and after the implementation of IoT enabled systems, including Industrial Edge devices, digital twin applications, and real-time data platforms. The evaluation focuses on several key performance indicators (KPIs) that reflect both visibility and operational

efficiency: inventory accuracy, which measures the alignment between recorded and actual stock levels; order lead time, capturing the duration from order placement to fulfillment; and operational costs, encompassing warehouse operations, logistics, and costs associated with stockouts or overstocking. Data for these KPIs are obtained from Siemens' annual and operational reports, industry case studies, and benchmarking publications. Quantitative changes in KPI values are analyzed to identify measurable improvements attributable to IoT adoption, while qualitative interpretation is employed to contextualize observed trends and operational enhancements. This approach allows for a robust assessment of the effectiveness of AI and IoT technologies in improving real-time supply chain visibility and efficiency.

## **5. Analysis of Siemens' IoT and AI implementation**

### ***5.1. IoT Implementation at Siemens: Smart Sensors***

#### *5.1.1. Reduction of Unplanned Downtime through Smart Sensors*

Siemens has deployed a dense network of smart sensors across its global production lines and warehouse environments to continuously capture environmental conditions in real time. These IoT sensors identify early signs of component fatigue, abnormal vibration profiles, temperature deviations, or other irregular behaviors. This data-driven diagnostic capability has enabled Siemens to shift from reactive toward proactive and predictive strategies.

The economic implications of this transition are significant. The Siemens True Cost of Downtime Report (2024) estimates that unplanned shutdowns collectively cost the world's 500 largest manufacturers approximately 11% of annual revenue - equivalent to USD 1.4 trillion. Within this figure, automotive facilities face losses of up to USD 695 million annually from idle production lines, while heavy-industry plants incur as much as USD 59 million.

Siemens reports a 35–45% reduction in equipment downtime following the adoption of predictive maintenance technologies, a trend reinforced by a 2024 MaintainX industry survey showing that 65% of maintenance professionals view proactive maintenance as the most effective method for minimizing unexpected failures. Siemens further projects that full-scale deployment of IoT-enabled condition monitoring across Fortune Global 500 firms could eliminate 2.1 million hours of downtime per year, generate USD 388 billion in productivity gains, and lower maintenance costs by up to 40% (Siemens, 2024). Together, these outcomes highlight the pivotal role of smart sensors in enhancing operational continuity, strengthening asset reliability, and building resilient industrial supply systems.

### *5.1.2. Enhancement of Inventory Accuracy through Sensor-Based Tracking Systems*

Beyond equipment monitoring, Siemens leverages sensor-based inventory tracking to enhance stock accuracy by reducing manual errors and eliminating discrepancies between digital records and physical inventory. Evidence from the Siemens Electronics Works Amberg (EWA) illustrates the operational complexity that necessitates IoT-enabled tracking: the facility manages 350 production changeovers per day, manufactures 1,200 product variants, and produces 17 million Simatic components annually, generating approximately 50 million data points for real-time optimization (Siemens Report, 2024).

Continuous machine-performance monitoring has stabilized production processes, reducing variability, enhancing consistency, and minimizing delays. At EWA, real-time machine analytics, automated quality inspection, and over 1,000 sensor-equipped autonomous robots detect deviations before they escalate into operational issues, reducing defect rates and cycle times while maintaining high process stability. Similarly, at the Electronics Works Chengdu (EWC), a holistic digital twin ecosystem, hundreds of sensors, and predictive maintenance have increased energy efficiency by 25%, avoided unplanned downtime, and increased equipment utilization, enabling a 92% rise in output since 2019 (Siemens Sustainability Lighthouse Report, 2023).

Together, Siemens' operational data and academic literature demonstrate that sensor-based tracking significantly improves inventory accuracy as well as production flows, enhances MES/ERP coordination, and reduces the risk of delays caused by inaccurate or missing stock.

### *5.1.3. Operational Consistency and Process Stabilization*

Continuous, sensor-enabled monitoring of machine performance has become a core stabilizing mechanism in Siemens' digital manufacturing architecture. At Electronics Works Amberg (EWA), IoT-embedded quality-inspection systems, autonomous robots equipped with environmental and vibration sensors, and real-time analytics allow the plant to detect performance deviations at an early stage, thereby preserving consistent cycle times and operational reliability across more than 1,200 product variants (Siemens Report, 2024). AI-supported monitoring reduces defect rates and shortens production loops, resulting in smoother and less volatile production flows.

The Electronics Works Chengdu (EWC) facility demonstrates similar performance gains. By combining a plant-wide digital twin with extensive networks of physical and virtual sensors, predictive-maintenance algorithms, and digital energy-management tools, EWC has lowered

unplanned downtime, optimized equipment load balancing, and increased energy efficiency. These digital-operations capabilities have contributed to a 92% increase in plant output since 2019 (Siemens Sustainability Lighthouse Report, 2023).

Collectively, these cases show that the integration of IoT smart sensors with Industrial Edge computing, AI-driven analytics, and digital-twin architectures not only enhances inventory accuracy but also strengthens process stability, improves uptime, and ensures more efficient resource utilization. This digitally synchronized environment provides Siemens with a resilient, transparent, and high-performance production system capable of supporting complex global supply chain operations.

## ***5.2. IoT Implementation at Siemens: Connected Devices***

### *5.2.1. Faster Delivery Cycles through IoT-Enabled Planning*

IoT-enabled coordination across manufacturing, warehouse, and transportation processes drastically reduces lead times and increases delivery predictability. At the SUMIDA Lehesten facility, Siemens integrated Opcenter Advanced Planning and Scheduling (APS) with the current ERP system. Prior to implementation, production planning was based on spreadsheets, meeting notes, and manual input, resulting in frequent delays, minimal transparency, and significant manual work.

Key outcomes after installation were lead times reduced from 20 days to 5 days (75% reduction), delivery reliability enhanced from 60% to 95%, and lot sizes and schedules were dynamically optimized based on real-time capacity and process restrictions. Opcenter APS enables planners to examine each production step independently, determine the crucial ratio (the remaining time to the due date divided by the available processing time), and prioritize production orders. By connecting APS to workstations and automating report production, Siemens reduced manual oversight, eliminated bottlenecks, and ensured on-time delivery, illustrating how IoT-enabled planning software improves operational efficiency and predictability.

### *5.2.2. Minimizing Handling Errors through Automation and Robotics*

By integrating real-time tracking systems, Siemens minimizes manual scanning, paperwork, and misrouting of shipments. Evidence from Siemens' partnerships highlights the operational impact of these technologies.

Siemens collaborated with Universal Robots and Zivid to develop a warehouse automation solution that combines SIMATIC Robot Pick AI for intelligent picking, Universal Robots UR20 robotic arms for heavy-lifting tasks, and Zivid 3D sensors capable of recognizing objects of various opacities, shapes, and sizes. This system offers high-precision automated picking and packing, significantly decreasing human handling errors while enhancing throughput and reliability. Real-time IoT sensor data is continually processed and coordinated across robotics and warehouse management platforms, allowing for early detection of anomalies and precise stock allocation (Siemens Press Release, 2025).

Industry statistics emphasize the strategic importance of connected devices: more than 70% of manufacturers have implemented data analytics and cloud computing, and almost half actively use IoT sensors to increase operational visibility and dependability (Deloitte Insights, 2025). Workforce retention is a major worry for over 75% of factory executives, which automation and IoT can assist address by lowering manual tasks and operational complexity. Siemens' linked devices solve these difficulties by improving transparency, streamlining collaboration, reducing human error, and increasing supply chain responsiveness, resulting in measurable gains in delivery dependability, process efficiency, and overall operational performance.

### ***5.3. IoT Implementation at Siemens: Real-Time Data Analytics***

#### ***5.3.1. Forecasting Accuracy Enhancement***

Siemens strengthens forecasting accuracy by combining real-time IoT data from over a million linked devices with advanced analytical approaches including machine learning, deep learning, and reinforcement learning. IoT sensors continuously collect high-frequency operational signals, such as machine performance, material flow rates, ambient conditions, and asset utilization patterns, which are then sent to cloud platforms like MindSphere for automated processing. AI systems then evaluate these massive, diverse data sets well beyond human analytical capabilities, detecting non-obvious patterns, demand trends, early warning signs of equipment degradation, and correlations between production, logistics, and market variables.

Unlike traditional forecasting models that rely primarily on historical averages, Siemens' models update dynamically as new IoT data becomes available, ensuring projections stay accurate even under unpredictable market situations. This real-time learning capability allows for earlier anticipation of demand variations, more precise capacity planning, and better alignment of production schedules with customer needs. Siemens' AI-enabled analytics transform complicated sensor data into forward-looking insights, considerably improving

forecast reliability and enabling proactive, data-driven decision-making throughout the supply chain.

### *5.3.2. Acceleration of Decision-Making Speed*

Siemens' IoT analytics infrastructure also significantly accelerates decision-making by giving managers direct access to actionable, real-time data. Cloud-based dashboards, AI-driven anomaly detection algorithms, and digital twin environments enable operational teams to quickly observe performance deviations, simulate various reaction methods, and take corrective action before disruptions escalate. Reinforcement learning techniques facilitate autonomous or semi-autonomous decision-making, allowing machines and systems to decide the best solutions to complicated operating scenarios. This capability is critical in dynamic markets, where quick changes in supplier performance, component availability, and consumer demand necessitate near-instant response times.

Siemens minimizes decision latency, enhances cross-functional coordination, and guarantees that production and logistical modifications are made quickly by connecting MindSphere data streams with ERP systems, planning platforms, and shop-floor execution systems. The net result is a supply chain that is more flexible, resilient, and capable of maintaining continuity even in highly volatile environments—a capability supported by Siemens' long-standing expertise in industrial AI and data analytics.

## **6. Evaluation and Recommendation for Vietnam**

### ***6.1. Evaluation***

Siemens' experience illustrates that integrating IoT and AI technology can significantly improve end-to-end supply chain visibility. The coordinated use of smart sensors, connected devices, and real-time analytics has resulted in a unified data environment in which operational data flows continuously from machines to management platforms. This allows for earlier identification of failures, more accurate forecasting, increased inventory accuracy, and faster response to disruptions—all of which improve supply chain agility and resilience. The company's transition from reactive to predictive maintenance, facilitated by MindSphere and advanced AI models, demonstrates how digitalization can minimize downtime, stabilize production, and optimize resource allocation at scale. These results indicate that IoT–AI integration is not simply a technological upgrade but a structural transformation of how supply chains operate.

## ***6.2. Recommendations for Vietnam's enterprises***

Adopting IoT and AI in Vietnamese firms should begin with gradual integration rather than large initial investments. Firms should focus on building a single data foundation by digitizing core activities with ERP, MES, or WMS systems that can eventually connect to IoT platforms. Small and medium-sized firms (SMEs) can start with low-cost IoT solutions like barcode/RFID tagging, machine status monitors, and cloud-based analytics tools to reduce manual errors and improve visibility. As capabilities advance, firms can transition to predictive maintenance, real-time inventory management, and automated quality monitoring. To ensure successful adoption, firms must invest in employee development, particularly in data literacy and digital operations, as well as improve collaboration with suppliers and logistics partners to remove value chain fragmentation.

## ***6.3. Recommendations for Vietnam's policymakers***

Policymakers must develop an enabling digital ecosystem to drive the use of IoT and AI across national supply chains. Vietnam should emphasize the development of unified data standards, interoperability rules, and cyber-security frameworks to ensure consistent information sharing across manufacturers, suppliers, logistics providers, and government authorities. Public-private partnerships can help SMEs by subsidizing access to digital platforms, pooled IoT infrastructure, and national training programs for Industry 4.0 capabilities. Furthermore, tax breaks and innovation awards help lower investment barriers for businesses moving to digital operations.

## 7. Conclusion

This paper investigated how Siemens uses IoT and AI to improve end-to-end supply chain visibility and assessed the usefulness of these approaches in Vietnam. The Siemens scenario demonstrates how real-time data from smart sensors, connected devices, and advanced analytics can improve transparency, minimize delays, and enable faster managerial reactions in complicated industrial contexts. When properly integrated, these technologies assist businesses in forecasting disruptions, stabilizing output, and improving logistical coordination—all of which are critical capabilities for competing in increasingly uncertain global marketplaces.

The findings imply that for Vietnamese businesses, integrating IoT and AI does not necessitate a complete overhaul from the start. Companies can begin by digitizing their main manufacturing and logistics processes, implementing basic data integration (ERP, MES, WMS), and progressively incorporating sensor-based tracking and automated analytics. This "step-by-step" method enables businesses to improve visibility, minimize manual errors, and tighten operational control without incurring significant expense.

For policymakers, the Siemens case underscores the need for shared digital standards, stronger data interoperability, and supportive incentives that encourage firms - especially SMEs - to adopt modern technologies. National-level programs on digital infrastructure, cyber-security, and workforce up-skilling will also be essential for widening the adoption of IoT-enabled supply chain systems across industries.

Overall, the report emphasizes that IoT and AI are more than just technology advancements; they enable a better coordinated, efficient, and robust supply chain. Vietnam's industrial sector stands to benefit considerably from these tools as it modernizes and strives to improve its global competitiveness.

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