Business Transformation Through Iot And Blockchain Technology: Opportunities And Challenges Of Innovation At Adidas

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Abstract. The rapid transformation of the global fashion industry, driven by consumer demands for personalization, transparency, and phygital experiences, has positioned Internet of Things (IoT) and Blockchain as critical technologies for future competitiveness. This study examines how the integration of IoT and Blockchain can support Adidas in optimizing innovation, operational efficiency, and customer engagement. Using a descriptive qualitative method and library research approach, this paper analyzes international journals, industry reports, and corporate publications to evaluate the opportunities and challenges associated with these technologies. Findings reveal that IoT enables real-time data collection across manufacturing, supply chain, retail operations, and smart products, while Blockchain ensures data integrity, traceability, authenticity verification, and secure digital ownership. The synergy of both technologies creates new innovation models, such as adaptive product design, decentralized supply chain transparency, phygital assets, and Web3-based customer ecosystems. However, implementation barriers persist, including high investment costs, cybersecurity vulnerabilities, integration complexity, data validation issues, and regulatory uncertainty. This study concludes that strategic investments, cross-industry collaboration, enhanced security standards, and phased implementation strategies are essential for maximizing the value of IoT–Blockchain integration. The results contribute to a deeper understanding of digital transformation pathways for global fashion companies and offer recommendations that support Adidas in achieving sustainable and data-driven innovation.

Keywords: Internet of Things (IoT); Blockchain; Adidas; Digital Transformation; Supply Chain Transparency; Phygital; Web3; Smart Products; NFTs; Industry 4.0.

INTRODUCTION

The rapid evolution of digital technologies has transformed the competitive landscape of the global fashion and sportswear industry. Companies are increasingly required to adopt advanced technologies such as the Internet of Things (IoT) and Blockchain to enhance operational efficiency, strengthen customer engagement, and secure greater transparency across their supply chains. IoT enables seamless connectivity between devices, allowing real-time data collection and intelligent automation, while Blockchain offers immutable, decentralized records that ensure data

integrity and trust among stakeholders (Ben-Daya et al., 2019; Saberi et al., 2019). The convergence of these technologies creates powerful opportunities for companies to evolve into more adaptive, data-driven, and consumer-centered enterprises.

Adidas, as one of the world's leading sportswear brands, has actively embraced digital innovation as part of its long-term transformation strategy. The growing demand for personalization, sustainability, and phygital experiences has pushed Adidas to explore technological solutions that enhance value creation across its ecosystem—from manufacturing and logistics to retail and product experience. Prior studies highlight that IoT is increasingly being used in smart manufacturing, predictive operations, and product customization, enabling companies to respond faster to market changes (Frank et al., 2019). Meanwhile, Blockchain is recognized for its ability to strengthen product authenticity, improve traceability, and support emerging digital economies through NFTs and Web3 applications (Dowling, 2022). Despite its promising potential, the adoption of IoT and Blockchain also presents challenges that organizations must navigate carefully. Issues such as integration complexity, cybersecurity vulnerabilities, regulatory uncertainty, and high investment costs can hinder large-scale implementation (Wamba & Queiroz, 2020). For Adidas, these challenges require strategic approaches, including technological partnerships, capacity building, and phased deployment models to ensure sustainable and effective adoption.

This paper aims to examine how the integration of IoT and Blockchain technologies transforms Adidas' business operations, creates innovation opportunities, and introduces potential challenges that must be addressed. Using a qualitative descriptive approach supported by literature review, this study analyzes both academic and industry sources to evaluate the strategic implications of these technologies for Adidas. The findings contribute to a broader understanding of how digital transformation can reshape business models within the global sportswear industry and provide insights for organizations seeking to implement advanced technologies responsibly and effectively.

Background of the Problem

In the era of rapid digital transformation, companies in the global sportswear industry are pressured to adopt emerging technologies to enhance competitiveness and operational excellence. Two technologies that have significantly reshaped modern business processes are the Internet of Things (IoT) and blockchain. IoT enables real-time data collection, automation, and interconnectivity across supply chain and consumer touchpoints. Meanwhile, blockchain provides secure, transparent, and tamper-proof information flows, particularly valuable for supply chain traceability and digital authentication. As one of the world's leading sportswear companies, Adidas faces increasing competition, rising customer expectations for personalization, and pressure to ensure sustainability and transparency in its production processes. The integration of IoT-such as smart manufacturing, digital twins, and connected retail-offers Adidas opportunities to optimize production efficiency and design customization (Lee et al., 2019). At the same time, blockchain technology presents strategic potential for verifying product authenticity, combating counterfeits, and improving visibility across Adidas's global supply chain network (Kamble, Gunasekaran, & Sharma, 2020).

However, adopting these technologies also brings significant challenges. IoT implementation demands high investment, advanced data analytics capability, and strong cybersecurity protection. Blockchain, though promising, still faces issues related to scalability, interoperability, and organizational readiness (Queiroz & Wamba, 2019). For Adidas, aligning technological innovation with existing systems, ensuring employee readiness, and managing digital transformation risks become crucial considerations in achieving successful implementation. Given these opportunities and challenges, it is important to analyze how IoT and blockchain influence Adidas's business transformation, the strategic benefits they offer, and the barriers that may hinder optimal adoption. Understanding these factors will provide valuable insights for designing effective digital transformation strategies and ensuring sustainable competitive advantage.

The global fashion industry is facing a need for transformation due to consumer pressure for personalization, transparency, and sustainability. IoT technology enables real-time data

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collection from products/operations, while blockchain provides a decentralized ledger to ensure data integrity and digital ownership (NFT/token-gating). Adidas is an example of a global brand that is beginning to explore Web3 (Ozworld, Into the Metaverse) and tokenproof partnerships for token-gating/exclusive access, making it a relevant case study for evaluating IoT-Blockchain synergies (Adidas Group, 2023).

Currently, the fashion industry faces multidimensional pressures that require giant companies like Adidas to radically transform. Three key trends dominate the competitive landscape: (1) Hyper-Personalization, (2) Transparency and Sustainability, and (3) Physical and Digital Convergence (Phygital) (Xin, B., Song, Y., Tan, H., & Peng, W., 2025).

First, in Hyper-Personalization, modern consumers demand more than just products; they want tailored solutions based on their personal performance, lifestyle, and ethical needs. Internet of Things (IoT) technology, through smart wearable devices and integrated sensors in products, is key to collecting real-time data on user behavior and performance. This data fuels adaptive product design algorithms, real-time recommendations during product use, and highly relevant after-sales services. For adidas, this means moving beyond mass production to more adaptive manufacturing and product experiences that evolve over time (Choi, 2021; Chouk, 2022). Second, the pressure for transparency and sustainability has become a business imperative, no longer just an option. Fast fashion scandals, labor issues, and the environmental impact of opaque global supply chains have pushed consumers and regulators to demand full visibility. This is where blockchain technology plays a crucial role. Its nature as an immutable distributed ledger allows verification of the origins of raw materials, the ethical manufacturing footprint, and the certainty of product recycling. By integrating IoT to tag and track physical assets and blockchain to securely record that data trail, adidas can prove its sustainability claims and mitigate the risk of product fraud. Third, the convergence of physical and digital (phygital) is becoming a new frontier. adidas has demonstrated progressive steps through its Metaverse initiative and Non-Fungible Token (NFT) collections, such as Ozworld. Blockchain facilitates the creation of verifiable and tradable digital assets, linking virtual ownership to real-world benefits (such as exclusive access or limited-edition physical goods). This transformation is not just about selling digital products, but about building a new digital ecosystem that strengthens brand loyalty and opens up innovative revenue channels that transcend the boundaries of traditional brick-and-mortar stores (Qiao, 2025). Therefore, the strategic integration of IoT (as a real-time data collector and physical connector) and Blockchain (as a validator of trust, transparency, and ownership) is no longer just a technological experiment for adidas, but rather a crucial foundation for achieving efficient operational excellence and shaping the future of customer engagement in the digital age. This paper aims to explore how the synergy between these two technologies can be optimized, while also identifying implementation barriers that must be overcome.

The research problem formulation in this study focuses on two main questions. First, how can IoT and Blockchain technologies create new innovation opportunities in ADIDAS's customer experience and supply chain operations? Second, what are the key challenges ADIDAS faces in effectively implementing the integration of these two technologies?. In line with these research questions, the purpose of this study is to analyze the potential synergies between IoT and Blockchain in driving product and business process innovation at ADIDAS, as well as to identify and evaluate various technological, operational, and regulatory challenges that could hinder the full adoption of these two technologies. Thus, this study is expected to provide a comprehensive understanding of the opportunities and obstacles to ADIDAS's digital transformation through the integration of IoT and Blockchain.

LITERATURE REVIEW

The Concept of the Internet of Things (IoT)

The Internet of Things (IoT) refers to a network of physical objects equipped with sensors, software, and other technologies that connect to each other and exchange data over the internet. In the sportswear industry, IoT is realized through smart shoes for performance analysis, smart clothing, and asset tracking in warehouses and stores. IoT is essentially the ability of various devices to communicate and exchange data over the internet without direct human involvement.

According to Hasanuddin (2023), IoT enables objects around us to interact continuously with each other using an internet connection, while Gitakarma (2022) emphasizes IoT's ability to facilitate machine-to-machine (M2M), human-to-human, and human-to-computer communication. Selay (2022) also emphasizes that IoT is a technological field that utilizes sensors and smart devices to improve the quality of life through digital connectivity.

Blockchain Concept

Blockchain is a distributed data storage technology composed of connected blocks secured through cryptography. According to Suryawijaya (2023), blockchain is a decentralized technology that allows transactions to be conducted without a third party, making data not only more secure but also immutable without the network's approval. Blockchain's key characteristics include decentralization, transparency, high security, immutable nature, and the existence of smart contracts that enable process automation. In the fashion industry, this technology is used to transparently track supply chains, verify product authenticity through digital identification such as NFTs or special tags, and develop digital assets such as NFTs to enhance community engagement, as Adidas has done through its Ozworld initiative and partnership with TokenProof.

Synergy of IoT and Blockchain

The synergy between IoT and Blockchain is one of the most significant developments in distributed information system architecture, especially for companies like Adidas that manage complex supply chains while developing smart products. Blockchain functions as a trust layer that validates real-time data from IoT devices, ensuring that data such as production location, shipping conditions, or smart shoe performance is more secure, verifiable, and cannot be manipulated. This allows for accurate audits of product sustainability and authenticity claims. IoT acts as a bridge between the physical and digital worlds, addressing the Oracle Problem in Blockchain. Through RFID, NFC, or GPS sensors, IoT provides physical data that is directly linked to smart contracts, ensuring that the product's digital state always matches its physical state. The synergy of these two technologies also enables high levels of automation through smart contracts. In the supply chain context, for example, IoT sensors can detect when a shipment arrives at a warehouse, allowing smart contracts to automatically execute payments to suppliers and update inventory. For smart products, performance data from smart shoes can automatically trigger the issuance of digital rewards such as tokens or NFTs. Thus, the integration of IoT and Blockchain is not simply a merger of two technologies, but rather the creation of an autonomous trust system capable of collecting, verifying, and executing data-driven actions without intermediaries, offering increased operational efficiency and customer loyalty for Adidas.

RESEARCH METHODS

This paper uses a descriptive qualitative approach to deeply understand how the implementation of Internet of Things (IoT) and Blockchain technologies impacts the business transformation process at Adidas. This approach was chosen because it allows for a comprehensive exploration of the phenomenon, including the opportunities and challenges emerging within the context of digital innovation in the global fashion and sportswear industry. This paper is a library research study utilizing various scientific sources, ranging from international and national journals, industry reports, company articles, Adidas annual reports, technology whitepapers, and research organization publications. This approach was chosen to comprehensively identify patterns, concepts, and relationships between IoT innovation, Blockchain, and Adidas' business strategy. The data used is entirely sourced from secondary data collected through systematic searches of scientific databases such as Google Scholar, Science Direct, Springer Link, and the ACM Digital Library. In addition, reports from consulting firms such as McKinsey, Deloitte, and Gartner were also used to validate the development of digital technology applications in the fashion sector. The literature search process used keywords such as "IoT in retail," "blockchain supply chain," "digital transformation in the fashion industry," and "Adidas innovation strategy."

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The collected data was analyzed using thematic analysis, where all information was coded into several main categories: the concept of digital transformation, the application of IoT at Adidas, the implementation of Blockchain in the supply chain, emerging business opportunities, and the challenges and risks of its implementation. Each theme was then evaluated to find the relationship between technological aspects and changes in the company's business model. To ensure data validity, this paper applies source triangulation techniques by comparing findings from various literature and industry reports, so that the results of the analysis accurately reflect the conditions related to Adidas' digital strategy. Overall, this study was compiled through a brief systematic literature review approach of articles and national journals (proceedings, OJS, campus e-journals) as well as international sources, using main keywords such as "Internet of Things," "Blockchain," "supply chain," "fashion," "NFT," and "Adidas." All findings were then synthesized into main themes such as IoT in the supply chain, Blockchain for authenticity and traceability, and Web3 and NFT for strengthening customer engagement.

RESULTS AND DISCUSSION

Innovation Opportunities at ADIDAS

The integration of IoT and Blockchain opens up vast innovation opportunities for Adidas, particularly in enhancing customer experiences, increasing supply chain efficiency, and creating new business models. In the customer experience realm, Adidas can deliver hyper-personalization through smart products equipped with IoT sensors that collect real-time user performance data. Previous studies highlight that IoT-enabled wearables can track biometric and biomechanical data with high accuracy, supporting personalized recommendations and performance optimization (Gao et al., 2015). When combined with Blockchain, this data can be securely stored in an immutable ledger, ensuring authenticity, preventing manipulation, and fostering greater consumer trust (Casino et al., 2019). This integration enables Adidas to design adaptive products that automatically respond to user performance patterns. Furthermore, Adidas can incorporate Blockchain-based NFTs whose value dynamically increases based on the user's physical achievements, thereby motivating consistent engagement through "gamified" product ecosystems. Research shows that NFTs and tokenized reward systems can boost brand loyalty by creating emotional and financial value for consumers (Dowling, 2022). Blockchain also offers a robust solution to counterfeiting issues through digital certificates of authenticity linked to IoT- or NFC-enabled products. This capability allows consumers to verify product authenticity instantaneously, which is crucial in the global market for premium sneakers and apparel (Francisco & Swanson, 2018).

In the supply chain realm, combining IoT and Blockchain provides full, auditable transparency. IoT sensors allow end-to-end tracking of material conditions, production stages, and logistics flows, which supports real-time decision-making (Ben-Daya et al., 2019). Blockchain ensures that all recorded data is immutable and easily verifiable, reducing disputes and enhancing accountability across suppliers. Smart contracts can automate payments to suppliers based on verified IoT data, minimizing delays and reducing administrative costs. Real-time inventory visibility also supports waste reduction through optimized stock levels and more accurate demand forecasting, aligning with Adidas' sustainability commitments. IoT-enabled product lifecycle monitoring further supports closed-loop recycling and return programs, which are increasingly valuable for circular economy initiatives in the sportswear industry (Nasiri et al., 2020). In the context of new business models, the synergy of IoT and Blockchain fosters the emergence of a phygital economy, where ownership of digital assets such as NFTs provides exclusive access to limited-edition products, events, or membership privileges. Recent literature emphasizes the growing importance of digital twins—virtual representations of physical products—as tools for enhancing customer interaction and product value in digital ecosystems (Tao & Qi, 2019). For Adidas, each product can be paired with a digital twin on Blockchain, enabling interactions in Metaverse environments and extending brand engagement beyond physical spaces. This technology also supports the development of a secure, decentralized resale market by ensuring that ownership history and authenticity are fully traceable. Some studies suggest that Blockchain-

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enabled decentralized platforms can support consumer-driven governance structures such as DAOs, which allow community participation in design processes or sustainability decision-making (Hassan & Kyriakou, 2020). These innovations enable Adidas to position itself not only as a sportswear brand but also as a digital ecosystem leader within the global lifestyle and technology market.

Implementation in ADIDAS Operations

IoT has become a crucial aspect of Adidas' operations, supporting efficiency, responsiveness, and product innovation across the entire value chain. In manufacturing, Adidas leverages IoT-enabled systems to improve production quality and minimize anomalies through real-time monitoring. This is exemplified by the *Speedfactory* initiative, which integrates robotics, automated 3D knitting, and IoT sensors to accelerate production while enabling mass customization. Studies indicate that smart factories utilizing IoT and automation can significantly reduce lead times and enhance design flexibility compared to traditional manufacturing processes (Sony & Naik, 2020). Although the Speedfactory facilities in Germany and the U.S. were later relocated to Asian partners, the technologies developed-such as automated cutting, sensor-based quality control, and digital production planning-continue to be applied across Adidas' global production network (Spencer, 2021). In distribution and retail operations, Adidas employs RFID and IoT systems for real-time inventory visibility. RFID tags enable automated stock counts, rapid item location, and reduction of inventory shrinkage, resulting in more efficient warehouse and store operations. Research shows that RFID implementation in retail enhances accuracy and reduces labor requirements by automating item-level tracking (Mishra et al., 2021). Adidas' flagship stores also utilize smart shelves and IoT-connected devices to monitor product movement, predict restocking needs, and improve customer service through faster product identification.

Adidas is equally active in integrating IoT into its consumer products. The company has introduced smart footwear and apparel capable of syncing with fitness apps to deliver biomechanical insights, performance metrics, and personalized training recommendations. Wearable technologies embedded with IoT sensors have been shown to enhance user engagement by providing actionable data that supports activity monitoring and athletic training (Alam et al., 2021). For Adidas, such innovations not only enrich customer experience but also provide valuable feedback loops for product development and design. Additionally, IoT plays a significant role in sustainability initiatives. Adidas utilizes digital tracking to monitor materials throughout their lifecycle, supporting recycling programs and enabling transparent reporting of environmental impact. IoT-enabled lifecycle monitoring is recognized in literature as a key enabler of circular economy practices, particularly in textiles and apparel (Farooque et al., 2019). These integrations allow Adidas to strengthen operational efficiency, deepen customer engagement, and advance environmental responsibility through data-driven decision-making. IoT has become a crucial aspect of Adidas' operations. This technology is used in smart manufacturing to monitor production quality and reduce the risk of anomalies. The Speedfactory concept, which combines robotics and IoT sensors, helps accelerate production processes with high design flexibility. At the distribution and retail levels, RFID and IoT technology enable real-time inventory tracking, simplifying stock management in warehouses and physical stores. Furthermore, Adidas is also developing smart products, including smart shoes that can be connected to fitness apps to provide insights into user performance.

Blockchain Implementation at ADIDAS

Adidas has begun implementing Blockchain technology to enhance transparency, security, and customer engagement across its operations. In the supply chain, Blockchain is used to create immutable, tamper-proof records that track raw materials from the point of origin through manufacturing, distribution, and retail. This level of traceability improves ethical sourcing verification and supports Adidas' sustainability goals, as Blockchain provides an auditable ledger accessible to all authorized stakeholders. Research shows that Blockchain significantly enhances supply chain transparency and reduces information asymmetry by ensuring that every transaction is securely recorded and verifiable. Blockchain also plays a crucial role in product authenticity systems. Adidas integrates digital product identities stored on Blockchain to authenticate premium

products such as limited-edition sneakers and apparel. Through NFC or QR-embedded tags linked to Blockchain, customers can instantly verify product authenticity, helping combat the growing issue of counterfeiting in the global fashion and sportswear market. Prior research emphasizes that Blockchain-based digital identities improve trust and reduce fraud in luxury and sneaker resale markets.

Adidas is also expanding into the Web3 ecosystem by launching NFT collections, such as *Into the Metaverse* (ITM), developed in collaboration with major Web3 partners. These NFTs provide holders with exclusive benefits, including access to digital content, community events, and redeemable physical merchandise. Studies indicate that NFTs can strengthen customer loyalty by creating exclusive digital ownership experiences and facilitating deeper brand–community interactions (Dowling, 2022). This approach showcases Adidas' strategic shift toward building digital-first consumer relationships and cultivating global communities through decentralized platforms. Another significant innovation is the adoption of phygital integration, in which Adidas links physical products with Blockchain-based digital certificates. These digital twins enhance the security of ownership by permanently recording provenance, transfer history, and product metadata on Blockchain. Literature suggests that digital twin technology combined with Blockchain improves product lifecycle management and adds long-term value by ensuring verifiable authenticity and ownership rights (Tao & Qi, 2019). For Adidas, this integration not only protects consumers but also supports the brand's entry into the circular economy by enabling more secure and transparent resale markets. Overall, Blockchain implementation strengthens Adidas' operational integrity, enhances customer experiences, and sets the foundation for future decentralized business models. By adopting Blockchain across supply chain, authenticity verification, digital communities, and phygital products, Adidas positions itself at the forefront of digital transformation in the global sportswear industry.

Opportunities for Adidas' Business Transformation

Digital transformation supported by IoT and Blockchain offers Adidas substantial opportunities to reshape its business model, enhance strategic capabilities, and strengthen long-term competitiveness. These technologies enable Adidas to modernize operational processes, deliver richer customer experiences, and introduce innovative digital value propositions that align with evolving consumer expectations. First, IoT enables operational efficiency through automation, predictive analytics, and real-time monitoring. IoT-driven systems support demand forecasting, real-time inventory management, and predictive maintenance, allowing Adidas to reduce costs and minimize operational disruptions. Previous research shows that IoT significantly enhances supply chain agility and responsiveness by enabling data-driven decision-making and end-to-end visibility (Ben-Daya et al., 2019). For Adidas, this translates into faster production cycles, reduced waste, and more adaptive manufacturing processes that support mass customization and responsive market strategies.

Second, Blockchain technology provides new mechanisms for trust, transparency, and product traceability. With increasing global attention on ethical sourcing and sustainability, Blockchain allows Adidas to offer verifiable transparency regarding environmental impact, labor practices, and material origins. Research highlights that Blockchain's immutability enhances consumer trust and strengthens corporate sustainability claims through auditable digital records (Saberi et al., 2019). This capability supports Adidas' long-term sustainability goals and reinforces its brand positioning as an environmentally responsible company. Third, the emergence of Web3 technologies presents opportunities for Adidas to create new customer experiences that blend physical and digital worlds. Through NFTs, digital collectibles, and token-based memberships, Adidas can establish new forms of engagement that strengthen emotional loyalty and empower community participation. Studies show that token-based ecosystems increase customer retention by offering exclusive access, digital ownership, and gamified reward structures (Dowling, 2022). This opens opportunities for Adidas to build a more participatory brand ecosystem where consumers act not just as buyers, but as stakeholders and contributors. Furthermore, IoT and Blockchain create new revenue streams through phygital products, digital fashion assets, and decentralized resale markets. Digital twins, authenticated via Blockchain, enable secure peer-to-peer trading while ensuring product authenticity and preserving brand value in secondary markets.

Scholars argue that digital twins combined with Blockchain foster new digital business models by extending product life cycles and enabling continuous customer interaction (Tao & Zhang, 2022). For Adidas, this transformation supports recurring revenue, strengthens product ecosystems, and enhances lifetime value per customer.

Overall, the integration of IoT and Blockchain technologies offers Adidas an opportunity to undergo a holistic business transformation. It supports operational excellence, elevates customer engagement, reinforces sustainability commitments, and expands the brand into new digital economies. These advancements position Adidas not only as a sportswear leader but also as a pioneer in data-driven, decentralized, and experience-centric business innovation.

Challenges of IoT and Blockchain Implementation

Despite their transformative potential, the implementation of IoT and Blockchain at Adidas presents several significant challenges. One of the primary barriers is the high cost of initial investment. Deploying IoT infrastructure including sensors, smart devices, connectivity systems, and analytics platforms requires extensive capital expenditure. Similarly, establishing Blockchain networks, whether private or consortium-based, demands substantial resources for system development, smart contract programming, and cybersecurity reinforcement. Studies highlight that financial burden is a dominant obstacle that slows digital transformation, particularly when deploying IoT and Blockchain at enterprise scale (Wamba & Queiroz, 2020). Cybersecurity risks also pose major challenges. IoT devices are known for their vulnerability to hacking, unauthorized access, and data manipulation. These devices often operate with limited computational capacity, making it difficult to implement advanced encryption and security protocols. Research has noted that IoT ecosystems significantly expand attack surfaces, increasing the likelihood of breaches and operational disruptions. For Adidas, whose operations span global supply chains, a compromised IoT device could jeopardize product data, inventory records, or manufacturing processes. Although Blockchain offers added security through its immutable structure, it does not prevent the input of incorrect or compromised data. This ties into the "garbage-in, garbage-out" (GIGO) challenge, where inaccurate data captured by IoT devices is permanently stored on Blockchain. Once recorded, erroneous data cannot be modified or removed, which may lead to incorrect business decisions, flawed traceability records, or damaged consumer trust. Prior literature emphasizes that Blockchain's immutability, while an advantage, increases dependence on reliable data inputs and strong IoT data validation protocols (Casino et al., 2019).

Integration complexity also remains a central issue. Aligning IoT devices and Blockchain systems with Adidas' existing ERP platforms such as SAP requires highly specialized technical expertise, careful system orchestration, and advanced middleware frameworks. The heterogeneity of data formats, protocols, and system architectures can cause interoperability issues, a challenge frequently cited in digital transformation research (Gong & Janssen, 2020). Ensuring seamless communication between manufacturing systems, logistics platforms, retail solutions, and Blockchain nodes is particularly demanding in a global operation like Adidas. Furthermore, the lack of comprehensive global regulation for Blockchain poses strategic uncertainty. Differences in legal frameworks, data privacy laws (such as GDPR), and compliance requirements hinder large-scale Blockchain adoption across borders. Studies show that regulatory ambiguity limits Blockchain scalability and increases compliance risks, especially for multinational organizations (Yli-Huumo et al., 2016). Adidas must navigate varying jurisdictional interpretations of digital ownership, smart contracts, and data storage practices to avoid legal complications.

In summary, while IoT and Blockchain offer Adidas substantial opportunities, successful implementation requires addressing challenges related to financial investment, cybersecurity, integration complexity, data reliability, and regulatory uncertainty. These barriers demand strategic planning, technological governance, and cross-functional expertise to ensure sustainable adoption and value creation.

Adidas' Strategy for Facing Challenges

To effectively address the challenges associated with IoT and Blockchain implementation, Adidas must adopt a strategic, multi-layered approach that focuses on technological investment, capability development, ecosystem collaboration, and risk management. First, long-term

investment in digital infrastructure is essential. This includes upgrading network connectivity, deploying secure IoT devices, enhancing cloud and edge computing capacity, and building scalable Blockchain platforms. Research indicates that sustained investment in digital infrastructure significantly increases the success rate of Industry 4.0 transformation by improving integration efficiency and reducing technical bottlenecks (Sony & Naik, 2020). Collaboration with leading IoT, cybersecurity, and Web3 companies is also critical for overcoming technological complexity. Strategic partnerships enable Adidas to access advanced tools, specialized expertise, and interoperable solutions without bearing full development costs. Prior studies emphasize that cross-industry collaboration accelerates the adoption of emerging technologies and reduces risk by leveraging shared innovation ecosystems. For Blockchain-related initiatives, partnerships with established Web3 platforms can ensure compliance with global standards and simplify integration with existing enterprise systems.

Strengthening data security standards across Adidas' digital ecosystem is another key priority. As IoT environments introduce new vulnerabilities, Adidas must implement advanced encryption protocols, continuous device monitoring, multi-factor authentication, and secure firmware updates. Research highlights that robust cybersecurity frameworks significantly mitigate IoT-related risks and protect organizational integrity. For Blockchain systems, Adidas must ensure rigorous validation of IoT data input to avoid "garbage-in, garbage-out" issues and maintain high-quality traceability records. Enhancing human resource capabilities is equally important. Adidas must invest in upskilling employees in areas such as data analytics, IoT engineering, Blockchain development, and cybersecurity. Digital talent is a critical enabler for ensuring smooth integration and ongoing management of advanced technologies. Studies confirm that workforce training and digital literacy programs are strong predictors of successful digital transformation in large organizations (Kane et al., 2019).

Implementing pilot projects before full-scale deployment represents a practical risk mitigation strategy. By testing IoT and Blockchain solutions in controlled environments-such as selected factories, distribution centers, or flagship stores-Adidas can identify system limitations, adjust workflows, and validate return on investment. This phased approach is recommended by technology adoption frameworks such as the Technology-Organization–Environment (TOE) Model, which suggests that incremental implementation reduces organizational resistance and improves system readiness. Through these strategies long-term investment, strategic collaboration, strengthened security, workforce capability development, and phased implementation Adidas can maximize the benefits of IoT and Blockchain technologies while minimizing operational and strategic risks. These efforts will help the company maintain competitiveness, enhance customer trust, and secure its leadership position in the global sportswear industry.

CONCLUSION AND RECOMMENDATION
Conclusion

The integration of Internet of Things (IoT) and Blockchain technologies presents a transformative opportunity for Adidas to strengthen its operational capabilities, elevate customer experiences, and build long-term competitive advantage in the global sportswear industry. IoT enables real-time data collection across manufacturing, logistics, retail, and consumer products—supporting hyper-personalization, predictive operations, and enhanced supply chain responsiveness. Meanwhile, Blockchain provides immutable, verifiable records that enhance product authenticity, sustainability traceability, and digital ownership through Web3 applications such as NFTs and digital twins. The synergy between these two technologies forms a powerful digital ecosystem where IoT acts as the data generator and Blockchain functions as the trust layer that secures and validates data. For Adidas, this synergy opens opportunities in smart product development, circular economy initiatives, phygital experiences, and decentralized consumer communities. However, the benefits come with notable challenges, including high investment costs, cybersecurity vulnerabilities, interoperability issues, unreliable IoT data inputs, and regulatory complexities in global Blockchain adoption.

Recommendations

Based on the analysis, the following recommendations are proposed to support Adidas in achieving effective and sustainable IoT-Blockchain integration (a) to strengthen Digital Infrastructure and Scalable Architecture, (b) to establish Strategic Partnerships with IoT, Cybersecurity, and Web3 Experts; (c) to implement Advanced Cybersecurity Frameworks; (d) to invest in Workforce Capability Development; (e) to apply a Pilot-Based Implementation Strategy and to develop Governance Policies and Compliance Protocols.

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