Evaluating the Use of Blockchain Technology in Enhancing Transparency and Security in Supply Chain Management

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Abstract
Blockchain technology is revolutionising UK supply chain management by improving security and transparency. This study examines how blockchain mitigates fraud, improves traceability, and optimises operational efficiency through Everledger, IBM Food Trust, Maersk TradeLens, and Walmart UK case studies. Results show that immutable blockchain ledgers and smart contracts improve supply chain integrity but are hindered by factors such as high implementation costs, shortage of technical expertise, and specific regulations such as GDPR compliance in the EU. Comparative analyses with the US, China, and the EU show the UK's regulatory leadership but underperformance in investment. The report suggests UK government incentives, blockchain standardisation across the industry, and workforce development to support wider adoption and help realise its potential in securing UK supply chains.

1. INTRODUCTION

1.1 Background

According to Atif and Hassan (2023), the transparency and security of the supply chain are essential components in the global market. This ensures a careful, seamless movement of goods and services across the landmark, carried out with integrity and efficiency (Atif & Hassan, 2023). That means the efficiency of S.C. is to ensure that supply chain processes can deliver goods and services to end customers promptly while ensuring that the cost attached is minimised and that the utilisation of that resource is maximised (Negi, 2020). The supply chain has been seen as a significant factor in the increase in the economy, and it is susceptible to various risks, which include fraud, counterfeiting, disruption from geopolitical tensions, or natural disasters (Emrouznejad et al., 2023).

However, with technological advancement, these risks can be reduced, and transparency can be enhanced. In doing this, there will be a need for excellent stand-in trust maintenance among its stakeholders and for it to keep up with the required regulatory demands. In developed countries such as the United Kingdom, there has been an increase in technology, which is creating an advantageous increase in the efficiency of the supply chain. For instance, the United Kingdom government introduced an initiative for funding competition, such as the Advanced Manufacturing Supply Chain Initiative (AMSCI), designed to advance the global competitiveness of the UK's advanced manufacturing supply chain. Therefore, implementing sophisticated inventory management systems will help reduce excess inventory levels, leading to cost savings and improved cash flow within supply chains (Atnafu & Balda, 2018).

Therefore, it is evident that the security of the supply chain cannot be overemphasised (Atnafu & Balda, 2018). The supply chain, therefore, is seen as the backbone of the global business world

in combinations of the supply chain processes, which include production, transformation, and distribution of goods. In a place with a disruption in the needed networks, there will likely be far-reaching repercussions that will affect business and the economy. This is seen in the case of COVID-19, where the fragility of global supply chains and increased shortages and delays were exposed (Aloqab et al., 2024).

From the study carried out by Burgess et al. (2024), transparency in supply chain management is said to be the visibility obtained from information and processes throughout the available supply chain network, which enables stakeholders to be able to track the movement of goods, monitor the processes and in the long run, ensuring that there is compliance with the layout ethical and regulatory standards. Transparency means that all stakeholders, from the manufacturer to end users, have access to accurate and timely information about products' origin, movement, and handling. This level of trust helps build trust with the stakeholders, especially in cases where consumers and regulators are more concerned about the ethical sourcing of products, the sustainability of the business environment, and the safety of the products produced (Awa et al., 2024). In ensuring these two observations in the supply chain, the United Kingdom has a set up regulatory initiative such as the Modern Slavery Act, which has encouraged companies to bring about an enhancement in transparency and secure delivery of goods and services to the end users by providing detailed information about their effort in combating forced labour and human trafficking (Pennington et al., 2023).

To ensure this, advanced technology such as blockchain technology is integrated into the supply chain, which helps to offer promising solutions to enhance security and transparency. According to Oriekhoe et al. (2024), blockchain technology helps provide a decentralised and immutable ledger for transaction recordings. Blockchain, on its own, has the inherent features of transparency and security, making it a reliable ideal tool for supply chain management. The use of BlockchainblockchainBlockchainblockchain in the recording of transactions is helpful in the verification and tamper-proof of the product's process from the primary sources to the final destination (Javaid et al., 2022). This can enhance transparency effectively by guiding against fraud, reducing counterfeit products, and ensuring compliance with legal standards binding supply chain management. This is seen in the pharmaceutical industry, which placed a premium on BlockchainblockchainBlockchainblockchain to track how authentic some drugs are to fight against counterfeit drugs (Zoughalian et al., 2022).

Therefore, with an emphasis on the supply chain in the United Kingdom, the study delves into the effectiveness of BlockchainblockchainBlockchainblockchain in securing and enhancing the transparency of goods and services.

1.2 Research Aims and Objectives

Aims

The study aims to provide access to and analyse blockchain technology's potential impact on supply chain management in improving its transparency and security, focusing on the United Kingdom.

Objectives

The following objectives are what the study intends to accomplish;

- To explore the current landscape of supply chain management, figuring out the key vulnerabilities and efficiencies that are compromising the security and transparency of the supply chain.

- To explore the role of blockchain technology in ensuring supply chain transparency and security.
- To analyse the synergistic effects of integrating BlockchainblockchainBlockchainblockchain into supply chain management.
- To address the potential challenges associated with adopting BlockchainblockchainBlockchainblockchain in supply chain management.

1.3 Research Questions

- What problems are faced by implementing traditional supply chain management, and what could be the possible root causes?
- What is blockchain technology's impact on supply chain management, and how can it improve the transparency and security of the supply chain?

1.4 Problem Statement

Because supply chain management has been experiencing an increase in interest and stakeholders' investment in blockchain technology, there is a gap in understanding the exact impacts BlockchainblockchainBlockchainblockchain brings in enhancing efficiency and transparency within the supply chain. In the place where numerous research studies have highlighted the potential benefits of BlockchainblockchainBlockchainblockchain in place of streamlining processes and improving transparency and security, there is still limited empirical evidence demonstrating its authentic effect on supply chain performance. Likewise, the evolving resolution of blockchain technology and its diverse applications also pose various challenges in assessing the effectiveness of BlockchainblockchainBlockchainblockchain and potential scalability in the context of the business world supply chain. A recent study emphasises the need for comprehensive empirical studies to evaluate the actual impacts of blockchain technology on supply chain efficiency, security, and transparency (Difrancesco et al.,2022). Because there are numerous theoretical frameworks binding the study topic, there is also a need for empirical evidence to validate these theories and provide guides for practical implementations of strategies. Moreover, as the supply chain becomes complex and more globalised, with different users and well-in-place environments, there is yet a pressing need for users to be as well able to understand how BlockchainblockchainBlockchainblockchain can help in address some specific challenges and deliver measurable improvements in the supply chain operations.

In addition, the ability of blockchain solutions to scale up and become operators in different spare operations remains an essential concern for supply chain practitioners and business decision-makers. According to Duan et al. (2023), the study shows the importance of addressing technical limitations and standardisation issues to unlock the full capability of blockchain technology in the supply chain. In that case, without oper guidance and operative platforms, the adoption of BlockchainblockchainBlockchainblockchain is likely to face different barriers that may hinder its ability to achieve the intended benefits of efficiency, security, and transparency. From the view of these challenges, there is a compelling demand for additional research that can empirically evaluate the impact of blockchain technology on supply chain management security and transparency. From the conduction of tedious empirical research studies, researchers can provide valuable knowledge into the practical implementations of blockchain adoption, inform strategic decision-making from supply chain stakeholders, and contribute to the advancement of knowledge in this critical area of the research study.

2. LITERATURE REVIEW

The value of the application and use of blockchain technology in supply chain management is one of the key research topics in the academic field and industry. There has been advanced theoretical research on the supply chain, but there might still be an introduction of blockchain technology that will possibly be a cause of change in the information sharing and transmission of supply, which may as well improve the security of information and transparency of operations. Therefore, this section is targeted towards ensuring the understanding of blockchain technology, relevant theories attached to the supply chain, and how that blockchain is implemented in the supply chain industry.

2.1 Blockchain Technology

The idea of adopting a blocking chain has been in existence since 2008, published by the pseudonym Satoshi Nakamoto (Tripathi et al., 2023). This reduces the network actors' dependence on the centralised banking system, solving the double expense problem without the central authority's reliance (Tripathi et al., 2023). Double spending has been an issue in digital currencies, where currency can be spent more than once. This is applicable in the supply chain sector as well. Blockchain technology has grown to be a transformative tool that has helped enhance supply chain transparency and security, characterised by various operations features such as decentralised ledgers, immutability, and smart contracts (Payandeh et al., 2024).

According to Upadhyay et al. (2021), blockchain is said to be a peer network technology used to build and maintain distributed ledgers or to keep database records. Organisations using BlockchainblockchainBlockchainblockchain can be individuals as well, having access to relate and communicate among themselves and also providing detailed records such as localisation data, transaction records, and data acquired from sensors. Before the records or data are installed on the BlockchainblockchainBlockchainblockchain, they are well scrutinised, verified to determine whether it is from the right source, and validated using the exact consensus mechanisms (Upadhyay et al., 2021). Upon critical examination of data, the records are then combined together to make up what is called a block of data linked with some formal clocks that have already been collated, which later form what is called BlockchainblockchainBlockchainblockchain. Blockchain was built to operate with a small quantity of human intervention. This makes BlockchainblockchainBlockchainblockchain distinct from ERP or database systems that work with an intensive human effort (Kitsantas, 2022). This phase of advancement in BlockchainblockchainBlockchainblockchain is derived from its growth from phase 1.0 to 3.0 and now the 4.0 evolution of BlockchainblockchainBlockchainblockchain (Colomo-Palacios et al., 2020).

2.2 Blockchain and Supply Chain Security

To further buttress the notion, BlockchainblockchainBlockchainblockchain can provide the utmost security measures to enable supply chains to overcome fraud, cyber thieves and other unscrupulous actors. The decentralised nature of the BlockchainblockchainBlockchainblockchain coupled with cryptographic methods makes it almost impossible to alter some content without each participant in the network agreeing to it. This security aspect is so important in these industries when upstream and downstream supply chain security is essential, such as in the pharmaceutical industry or the sale of luxury products. Although this is a relatively new approach to supply chain management, it has many benefits – flexibility, responsiveness, and effectiveness. Agi and Jha (2022) further state the supply chain benchmarks given the blockchain feature, contributing further to elaborating the Blockchain's consequences for supply chains. More so, Xia et al. (2023) figured

out the need to deal with the security aspect or system stability in introducing blockchain integration into the supply chains. Also, there is traceability, transparency, and security, which can help enhance the supply chain operations. Butt et al. (2023) supported the need for more secure and reliable networks, especially in the enhanced blockchain supply chain networks. Similarly, the study carried out by Balcıoğlu et al. (2024) shows that due to the decentralised features of BlockchainblockchainBlockchainblockchain, there is a propensity for it to the management of information in CLSCs when it comes to traceability and security.

Case Studies

The use of blockchain technology to create more transparency and security within the supply chain in real life has been described in several practical examples. One such application is Walmart's use of technology to trace the origin of food, pork to be precise, in the Chinese market. Walmart teamed up with IBM to organise a Blockchain platform that helps Walmart track the source of pork products in minutes rather than days (Kamath, 2018). Besides increasing transparency, the system also increases food safety because the source of contaminated products is detected faster. The use of blockchain in the diamond industry and the deployment of the fight against conflict diamonds. Another example is the Everledger Company, which uses a blockchain for tracking diamonds.

Blockchain technology is used in the automotive industry to improve supply chain traceability, segment authentic parts suppliers, reduce counterfeit, and ensure smooth recall processes. Car manufacturers like BMW and Ford have used blockchain to track ethically sourced materials, such as cobalt used in electric vehicle (EV) batteries (Alardeau & Blome, 2018). Blockchain has also been used across the retail sector to verify the authenticity of products and prevent fraud. This technology is being used by commercial brands, including De Beers, where blockchain-powered ledgers secure the integrity of mapped-out luxury goods and diamonds through a tamper-resistant tool (Debeers Group, 2022). Walmart and Carrefour are also using blockchain-based food traceability systems to track perishable goods from the farm to the shelf in real time (Ellahi et al., 2024).

Another essential case is the energy sector, where blockchain technology makes the testing of P2P and transparent ethos possible. Power Ledger and WePower are essential examples of decentralised blockchain networks that allow consumers and businesses to track energy generation and distribution, decrease dependence on traditional power grids and increase the use of renewable energy (Ali et al., 2024). These insights demonstrate how blockchain's decentralisation, immutability, and cryptographic security provide valuable solutions in different industries, reinforcing the importance of blockchain technology in modern supply chain management. Despite these benefits, however, critical challenges facing blockchain adoption hinder its scalability and integration.

2.3 Opportunities and Challenges for Blockchain Adoption

Blockchain technology can improve transparency and security in supply chain management but faces several challenges to widespread adoption. Scalability is one of the biggest concerns. Hazari and Mahmoud (2020) pointed out that traditional blockchain networks such as Ethereum and Bitcoin are limited in how fast transactions can be processed, which compares unfavourably to credit card companies. Consensus mechanisms such as Proof-of-Work (PoW) require a huge amount of computational power, which results in aggregated interactions. In high-volume supply chain environments where thousands of transactions happen on a daily basis, this bottleneck

becomes a challenge. While solutions such as Proof-of-Stake (PoS) and Layer 2 scaling technologies are being considered, the possibilities for mainstream adoption are still in the early stages (Gao et al., 2019).

Integration with existing systems is another key obstacle. Most supply chains depend on ERP (enterprise resource planning) systems, such as SAP, Oracle, and Microsoft Dynamics, which were neither designed for the blockchain era nor interoperability. Xia et al. (2023) showed that integrating BlockchainblockchainBlockchainblockchain into these centralised systems involves significant financial and technical inputs, which tend to be met with resistance from organisations unwilling to dismantle existing infrastructure. Furthermore, blockchain-based supply chain solutions require consensus from multiple stakeholders, leading to governance complexities that hinder adoption (Wang et al., 2023).

Such compliance concerns become a significant challenge, particularly in jurisdictions such as the United Kingdom and European Union that have privacy laws (such as GDPR), which struggle to coexist with Blockchain'sblockchain'sBlockchain'sblockchain's immutability (Finck, 2018). Historically, the immutability of blockchain transaction records has proved challenging to reconcile with the right to be forgotten, making implementation a complex issue (Belen-Saglam et al., 2023). Additionally, questions remain about intellectual property (IP) rights and liability, especially regarding who owns and manages data recorded on a decentralised ledger. Such regulatory challenges imply we require regulatory clarity and standardised frameworks before Blockchain blockchain may act as a mainstream solution in supply chain management.

2.4 Theoretical Lens: Transaction Cost Economics and Resource-Based View

Theoretical analysis of BlockchainblockchainBlockchainblockchain in supply chain management BlockchainblockchainBlockchainblockchain has the potential to change how things are done. Transaction Cost Theory claims that firms will engage in market exchanges and invest in intra-firm capital and organisation to minimise transaction costs. Blockchain technology inherently reduce s These transaction costs by removing intermediaries (e.g., banks), automating contracts using smart contracts, and real-time transparency (Nur Hasanah, 2024).

On the contrary, the Resource-Based View (RBV) implies that firms may achieve sustainable competitive advantages by having unique resources (VRIN framework) that are valuable, rare, inimitable, and non-substitutable (Zimuto & Zvarimwa, 2022). When appropriately applied, BlockchainblockchainBlockchainblockchain acts as an enabling asset that routinely develops an association's capacity to avert stockouts, increase operational efficiency, and enhance trust between collaborators.

But, even if TCT and RBV rationalise potential benefits, it is also important to recognise practical constraints. Not all firms have the know-how and funding needed for an effective blockchain implementation in terms of capability and financial resources. Moreover, standardised blockchain protocols must be widely embraced by the industry for BlockchainblockchainBlockchainblockchain to succeed, a goal that cannot be achieved by individual companies but requires a collective effort across supply chain participants and one that is still a work in progress.

3. METHODOLOGY

3.1 Research Design

This study employs a secondary data approach; it reviews and synthesises the qualitative and quantitative findings from studies that have examined the implications of adopting blockchain technology in the UK supply chain management context. Considering the wide applicability of BlockchainblockchainBlockchainblockchain and its future potentialities, processing secondary data is a very efficient and economical way to explore trends, issues, and examples of implementation, which may not have been possible with primary data collection.

It will critically evaluate the available literature, including academic journal articles, industry reports, government documents and corporate case studies (Chigbu et al., 2023). Here, a multi-staged view will be adopted, including application, theoretical concepts, and empirical results regarding blockchain in the context of the supply chain.

3.2 Data Sources

The study draws on multiple secondary data sources for a more well-rounded understanding of how BlockchainblockchainBlockchainblockchain can be used to improve transparency and security in supply chains in the United Kingdom. The primary sources include:

- **Academic Literature:** Peer-reviewed journal articles accessed through databases like Scopus, Web of Science, or Google Scholar, which provide insights into the theoretical underpinnings, technological advancements, and empirical case studies for BlockchainblockchainBlockchainblockchain.
- **Industry Whitepapers and Reports:** This information provides insights into how well the technology works and its limitations in the real world. as good as the research itself, these whitepapers usually also contain practical use case studies, trends in the industry and expert opinions.
- **Government and Regulatory Reports:** These documents are also helpful in evaluating the impact of government policies and regulations on adopting blockchain in the supply chain.
- **Enterprise Blockchain Case Studies:** These reports contain empirical data that shows how blockchain hyperledger increases traceability, prevents fraud, and improves the operational efficiency of logistics networks.

3.3 Data Analysis Approach

The data collected is systematically reviewed using a thematic analysis approach (Dawadi, 2020). It is a method of identifying, analysing, and reporting patterns (themes) within data. It allows for a detailed understanding of the data, thus assessing blockchain in UK supply chains.

This study uses source triangulation—vetted academic literature, industry reports and regulatory documents—to cross-examine findings for reliability and validity. Also, it prioritises only very recent sources due to the rapid pace of technological developments and regulatory changes. This methodology allows for a robust examination of how blockchain secures and mends transparency in UK supply chain management by combining the qualitative and quantitative of its secondary data analysis.

4. ANALYSIS

Drawing on applications employed across various sectors, including luxury goods, food safety, maritime operations, and retail, this section critically evaluates the implications of blockchain for security and transparency in UK supply chains. Case studies of Everledger, IBM Food Trust, Maersk, and Walmart UK will cover how effective the technology is and where to use it practically. It will also compare the trends in blockchain adoption in the UK with those of other countries, such as the United States, China, and the European Union, emphasising differences in regulatory environments, investment levels, and industry adoption. Finally, this section outlines the obstacles and limitations that impede the adoption of blockchain technologies in the UK, such as scalability, compliance with data protection laws (GDPR) and interoperability issues.

4.1 Blockchain in Supply Chain Management in the UK

Everledger: Anti-counterfeiting in luxury goods

Everledger, a London-based blockchain firm, has transformed supply chain transparency in the luxury goods industry by employing BlockchainblockchainBlockchainblockchain to confirm the authenticity of diamonds, vintage wines, and other pricey collectables. The company created a cryptographically secure distributed digital ledger in which each diamond has a unique blockchain identity and accompanying carat weight, colour, clarity and provenance information. This effort has significantly reduced the flow of conflict diamonds by the Kimberley Process Certification Scheme (Everledger, 2020).

The impacts of fraud prevention have been significant. Based on reports by BBVA (2016), counterfeit diamonds account for an estimated $1.5 billion in fraudulent transactions in the global diamond market every year. Through leveraging blockchain, Everledger has tracked more than 2 million diamonds with immutable provenance records, minimising the presence of illicit diamonds in UK markets (Frontiers Media SA, 2020). On the other hand, the market increases trust for individual customers, as they may verify the validity of their purchase through certificates built on the blockchain. According to Swazan and Youn (2024), 78% of luxury consumers are more likely to buy a high-value item if its authenticity can be verified thanks to blockchain technology. The success of Everledger showcases how BlockchainblockchainBlockchainblockchain can guarantee the safety and visibility of luxury supply chains — a sign that other industries will soon follow suit as well.

IBM Food Trust & Tesco: Food Supply Chains

In the UK, Tesco and several other food retailers have worked with IBM Food Trust to improve food traceability and safety through BlockchainblockchainBlockchainblockchain (IBM Food Trust, 2021). Offering end-to-end transparency in the supply chain, the initiative provides real-time insights into food products, from the farm to the store shelf. This is especially important in the UK, and the cost of food fraud costs the economy an estimated £11.2 billion per year (Food Standards Agency, 2023).

An excellent example of how Tesco uses IBM Food Trust is to track fresh produce and dairy products in real-time. Tesco has cut the time it takes to identify the origins of tainted food from 6.5 days to seconds by using blockchain technology in its supply chain (David et al., 2022). Food traceability has accelerated, which plays a crucial role in improving the efficiency of food recalls and reducing the ramifications of food-borne diseases and contamination.

In addition, UK consumers have increasingly demanded supply chain transparency, with 67% of British shoppers indicating that they prefer food products with traceability records (GS1 UK,

2024). In the case of digitally substituting fraudulent products, such as non-organic produce for organic produce, it guarantees that it would be erased with this immutable property of blockchain technology, which stands as a relief for UK food retailers by intensifying the consumers' trust.

Maritime Logistics & Global Trade: Maersk TradeLens

The TradeLens blockchain platform for digitising and securing all types of maritime shipping documentation was developed by Maersk in collaboration with IBM and has helped drive the efficiency of UK trade to new heights (Hershko, 2022). With 95% of the UK imports and exports relying on maritime logistics, boosting security and minimising operational bottlenecks is economically vital (GOV.UK, 2022).

TradeLens saves understandable time by enabling customs clearance, shipment tracking, and document authentication on a single tamper-proof ledger for all relevant stakeholders, such as port authorities, shipping firms, and regulatory agencies (Department for Transport, 2022). Before the adoption of BlockchainblockchainBlockchainblockchain, to process this shipping documentation, more than 200 interactions were made for every container shipment, resulting in delays and inefficiencies (Department for Transport, 2022). The introduction of TradeLens has decreased paperwork-related delays by approximately 40%, saving UK-based shipping companies an estimated $220 million per annum (Bank of England, 2024).

Moreover, the maritime trade benefits from improved security due to blockchain. Prior to TradeLens, document forgery was a pervasive practice that caused a yearly $500 million loss due to fraudulent trade transactions (GOV.UK, 2019). UK authorities supported the solution through BlockchainblockchainBlockchainblockchain, lowering the rate of post-Brexit smuggling and other illegal trading activities thanks to the aforementioned reduction in the possibility of fake compliance certification by a customs facility (Botton, 2018). Maersk's success in improving efficiency, reducing fraud, and protecting its maritime supply chains is due to these and other benefits of BlockchainblockchainBlockchainblockchain.

Walmart UK: Retail and Supplier Traceability

Walmart UK is the following example of a company using blockchain technology. Walmart UK integrated blockchain technology into its supplier verification and inventory management, creating a much more transparent and easily verifiable retail supply chain. Walmart UK and IBM's Hyperledger Fabric installed a system necessary for real-time monitoring of goods from the supplier to the store (Hyperledger Foundation, 2023). Since counterfeit goods contribute to an £8 billion yearly loss for UK retailers, with the luxury and electronics sectors being the most brutal hit, it is vital to ensure transparency and accountability regarding sourcing (OECD, 2023).

Walmart UK's blockchain initiative significantly increased the number of accountable suppliers. Indeed, before implementing the technology, an auditor would take several weeks to determine whether a specific supplier complies with the ethical sourcing standards. However, with BlockchainblockchainBlockchainblockchain, the process is instantaneous. As a result, the rate of supplier-related fraud decreased by 35%. Inventory management was an issue, too. With blockchain tracking available, Walmart UK reduced its stock discrepancies by 28% and almost doubled the forecasted accuracy. Furthermore, 72% of Walmart UK shoppers trust retailers more when they are confident that sources are verifiable (Sristy, 2021).

4.2 Role of Blockchain in Providing Security & Transparency

4.2.1 Improving the Security of UK Supply Chains

Blockchain technology provides the required tamper-proof tamper-proof tamper-proof transactions to enhance supply chain security with a high degree of cryptographic safety. This makes it an ideal choice for digital files requiring integrity, as the decentralised ledger system means that no single participant in the network has the ability to change or remove the data recorded without an agreement from all the participants. This is especially important in the UK, where types of fraud, including supply chain fraud and counterfeit goods, cost businesses billions of pounds each year (UK Finance, 2023).

Hashing is a blockchain's most potent security mechanism, keeping sensitive supply chain data secure. Blockchain-based solutions have been implemented by the likes of Tesco and Sainsbury's to track food sourcing and prevent the fraudulent substitution of ingredients. Also, the UK pharmaceutical industry has used blockchain to help prevent bogus drugs from entering the supply chain in a sector where counterfeit medicines have a significant bearing on both public health and financial loss (Soesanto et al., 2022).

4.2.2 A New Approach to Transparency in UK Supply Chains

Transparency remains a significant challenge in complex and multi-tiered UK supply chains where unethical practices, supplier fraud, and sourcing opacity are widespread. This is where BlockchainblockchainBlockchainblockchain comes to the rescue, allowing end-to-end traceability so that every transaction — from raw material procurement to product delivery — is recorded and verifiable.

In the UK food supply chain, the adoption of IBM Food Trust by Tesco allowed direct tracking of perishable goods with the availability of accurate product information to the consumer (IBM, 2020). By scanning a QR code, shoppers are able to see a product's entire journey, including where it came from, where it was processed and how it got to where it is for sale. This degree of transparency is vital when UK consumers are becoming increasingly demanding of retailers, and over 60% of UK shoppers have claimed in surveys that they would instead buy products if they could confirm where the products came from (Institute of Customer Service, 2024).

The immutable ledger offered by BlockchainblockchainBlockchainblockchain also adds to transparency, as it cannot be tampered with. Everledger’s blockchain solution has played a big part in reducing diamond fraud in industries such as luxury goods, ensuring that UK consumers buying high-value items receiv e legitimate and ethically sourced diamond goods (Everledger, 2020).

Although BlockchainblockchainBlockchainblockchain has its advantages, it is not without these restrictions. This reduces fraud and increases transparency but does not eliminate risk; instead, it transfers vulnerabilities to new realms, especially cybercrime. Blockchain networks are also not invulnerable to attacks, and with increased adoption in the UK, fears of 51% attacks, private key security breaches, and flaws in smart contracts have all surfaced (Popoola et al., 2023).

4.3 Comparative Analysis: UK vs. Other Countries

While the UK is at the forefront in terms of developing its blockchain regulatory framework, it is far behind other global players in terms of investment and state-backed blockchain initiatives.

The USA surpasses the UK in terms of blockchain investments and start-up funding, where in the same year, the US got a total VC blockchain investment of over $6.6 billion against only $1.2 billion in the UK (Statista, 2023). Through faster adoption in industries that have been able to

raise capital through tokens, such as logistics, pharmaceuticals, and food safety — where companies like Walmart US and Pfizer have already implemented BlockchainblockchainBlockchainblockchain as a part of their supply chain (Sharma & Kumar, 2021). However, UK firms are already struggling under the more significant compliance burden of GDPR, particularly in those sectors dealing with sensitive consumer data (GOV.UK, 2023).

Blockchain adoption is heavily state-driven; the Chinese government invested $4 billion into its blockchain infrastructure and supply chain finance projects in 2023 (Duan et al., 2024). The People's Bank of China has leveraged blockchain-based financing solutions to facilitate cross-border trade; exporters can receive financing within 24 hours versus an average of 5–10 days within the private UK banking system (Duan et al., 2024). While private sector companies are responsible for most supply chain blockchain initiatives in the UK, China's supply chains have government support, which results in lower costs for domestic firms adopting BlockchainblockchainBlockchainblockchain.

The EU's Blockchain Partnership Initiative brings all 27 member states together on blockchain standardisation, and the UK, now an independent nation after Brexit, has chosen an independent regulatory path (Dinçkol et al., 2023). The UK has more signalling space for regulatory decisions but lacks a pan-European blockchain that enables easier integration of cross-border supply chains. Nestlé and Carrefour are among the European companies that use a blockchain based on the European Blockchain Services Infrastructure (EBSI) to improve food traceability across the EU (Nestlé, 2019). UK firms, though, are expected to build their standalone blockchain frameworks, leading to higher operational costs and regulatory fragmentation.

Notwithstanding these variances, the United Kingdom is a critical nation in adopting BlockchainblockchainBlockchainblockchain as a use case with a specific focus on luxury items, marine logistics and food safety. On the other hand, failure to step up government investment and cross-border blockchain cooperation may leave the UK trailing the US and China in the global supply chain blockchain race.

4.4 Obstacles and Barriers to the Adoption of Blockchain in the UK

The adoption of BlockchainblockchainBlockchainblockchain in supply chain management in the UK has notable barriers to entry, especially for small and medium-sized enterprises (SMEs) experiencing high implementation costs, a shortage of technical expertise, and a restrictive regulatory environment. This means that while corporate giants like Tesco, Maersk, and Everledger have overcome this barrier and incorporated the Blockchainblockchainblockchain into their supply chain, the industry has been unable to overcome many financial and operational barriers.

Cost Constraints

The implementation costs are one of the most prohibitive factors for UK businesses adopting Blockchain blockchain blockchain blockchain. This can entail enormous investment in infrastructure, smart contracts, security protocols, and trained personnel. Tech Nation UK found that for most SMEs in logistics and retail, over 70% said the main reason for not yet adopting BlockchainblockchainBlockchainblockchain was cost (Orji et al., 2020). The price tag for the initial setup around blockchain integration could cost a company between £250,000 to £1 million, depending on the scale of deployment. This investment can be prohibitive for smaller firms (Notomoro, 2023).

However, the UK has seen some low-cost blockchain pilot programs. Provenance, a blockchain start-up focused on supply chain transparency, launched an affordable digital ledger system for independent retailers and ethical brands (Provenance, 2015). As a proof of concept, Co-op UK showcased how blockchain technology could enhance food traceability for a soap product at 356 times less than conventional means while enabling it to also reduce supply chain inefficiencies by 30% with minimal operational costs (Ellahi et al., 2024). Even so, scalability is just as difficult, as most SMEs have no budget to go beyond blockchain trials into commercial use.

Technical Know-how

A shortage of trained professionals in the UK has also stifled the widespread adoption of blockchain. According to the UK Blockchain Skills Report (2023), only 12% of supply chain companies had in-house expertise in blockchain development, resulting in costly reliance on external consultants (Vu et al., 2024). This skills gap is especially problematic in industries like pharmaceuticals and maritime logistics, where diverse data-sharing needs and regulatory compliance requirements can make adopting blockchain more challenging.

A significant barrier is integration with legacy Enterprise Resource Planning (ERP) systems, including SAP, Oracle, and Microsoft Dynamics, which are commonplace in UK industries. Most ERP platforms were not originally designed to work with BlockchainblockchainBlockchainblockchain; instead, most ERP tools will need much adjustment for perfect interoperability (Kitsantas, 2022). With standard frameworks for blockchain-ERP integrations not yet established, many businesses are still wary of blockchain adoption, fearing operational disruptions.

Regulatory & Compliance Constraints

The most significant barrier to blockchain adoption in UK supply chains continue s to be regulatory uncertainty. This creates a fundamental conflict with the UK General Data Protection Regulation (GDPR), which obliges the right to be forgotten, but that cannot be reconciled with the characteristic immutable and cryptocurrency records of BlockchainblockchainBlockchainblockchain (Belen-Saglam et al., 2023). This concern has strained retail and finance industries, making customer data protection a legal requirement.

Outside of GDPR, the absence of blockchain standards across UK industries poses a problem for interoperability, as companies cannot quickly implement a singular blockchain solution. Previously, Europe took this blanket approach to standardisation for blockchain companies and digital companies to build across borders (e.g. the European Union's Blockchain Partnership Initiative); however, the UK chose a more decentralised regulatory response, leaving companies to navigate independent compliance pathways on their own (European Investment Bank, 2022). This has hindered the widespread adoption of blockchains, as businesses are cautious about the long-term legal and regulatory ramifications.

5. SUMMARY AND CONCLUSION

5.1 Summary of Key Findings

Through comparative analysis and consideration of existing issues, this study has revealed how Blockchainblockchain can improve transparency and security in supply chain management in the UK context. The analysis reveals that through cryptographic security, immutable ledgers, and smart contracts, BlockchainblockchainBlockchainblockchain considerably enhances supply chain security by making transaction logs tamper-proof tamper-proof and verifiable, showcasing the

potential utility of important infrastructure to reduce order fraud. Blockchain also enables end-to-end traceability, enabling businesses and consumers to track product origins, movements, and authenticity.

Everledger, IBM Food Trust, Maersk TradeLens, and Walmart UK case studies demonstrate successful applications of blockchain in luxury goods, food safety, containerised maritime logistics, and retail supply chains. Everledger has decreased the number of counterfeit transactions for diamonds, while IBM Food Trust has increased food traceability for Tesco, leading to more efficient recalls and consumer confidence. Maersk's TradeLens platform has simplified documentation processes in global shipping, reducing administrative delays and fraud, while Walmart UK has made supplier verification and inventory accuracy more robust.

Different economies outperform the UK in terms of supporting blockchain investment and state-backed initiatives despite the UK having a mature regulatory framework. The US funding of blockchain start-ups and China's state-backed blockchain projects have decreased supply chain inefficiencies in cross-border trade. The EU members modelled a standardised blockchain infrastructure through the collaborative regulatory approach, leaving the UK independent and fragmented in their strategy post-Brexit , which created ambiguity for supply chain adoption.

Widespread blockchain adoption in the UK has been challenged by the high costs of implementation, a lack of technical expertise, and regulatory compliance issues. Moreover, for SMEs, the financial cost involved and the complexities of integrating blockchain infrastructure into legacy ERP platforms make it challenging. Moreover, GDPR compliance is at odds with immutable records on the BlockchainblockchainBlockchainblockchain, creating legal uncertainties that are inhibiting adoption — especially in data-sensitive industries such as retail and finance.

5.2 Findings in the Context of Existing Research

Blockchain's ability to provide transparency and security to a supply chain was emphasised by Payandeh et al. (2024) through the use of decentralised ledgers, cryptographic security, and smart contracts.

Findings also support the Transaction Cost Theory (TCT) framework highlighted, where blockchain reduces transaction costs by removing intermediaries and automating contract execution (Nur Hasanah, 2024). Furthermore, evidence supports the Resource-Based View (RBV) perspective, which posits that BlockchainblockchainBlockchainblockchain provides firms a sustained competitive advantage through greater supply chain efficiency and security (Zimuto & Zvarimwa, 2022).

On the other hand, Xia et al. (2023) acknowledged the scalability and regulatory challenges of BlockchainblockchainBlockchainblockchain, which were confirmed by the findings of this study regarding high implementation costs, difficulties integrating with legacy ERP systems and GDPR compliance conflicts. Existing research provides theoretical insights highlighting the importance of policy interventions, standardisation efforts, and further technological development to restrain, standardise, and maximise blockchain benefits in UK supply chains.

5.3 The Opportunity for Blockchain to Strengthen UK Supply Chain Security

The extent to which blockchain may be adopted in UK supply chains as a future-oriented solution is subject to the scalability, economic case, and clarity of regulations surrounding it. The UK's increasing digital transformation agenda and government efforts, such as the National Data Strategy, offer an opportunity for blockchain standardisation and broader industry adoption.

Blockchain may enable speedy clearance at the border of post-Brexit Britain, decrease fraud in cross-border transactions, and facilitate real-time logistics tracking, given the seamless implementation.

Technological developments, including layer-2 blockchain solutions, zero-knowledge proofs and interoperability frameworks, can remedy existing scale and integration challenges. Moreover, implementing AI-assisted blockchain analytics can strengthen security, as it may benefit from improved risk detection and predictive analytics in supply chains.

Nevertheless, regulatory reform will play a massive role in shaping the future of blockchain in the UK. The UK government should clarify blockchain's legal status in the context of data protection laws and create interoperability standards to support a seamless flow practice across sectors.

5.4 Policy Recommendations for UK Businesses and Policymakers

Government Investment & Policy Development

- The UK government can implement incentives to encourage the adoption of BlockchainblockchainBlockchainblockchain, including tax breaks and grants for SMEs willing to adopt the blockchain of BlockchainblockchainBlockchainblockchain in their supply chains.
- One such strategy is for policymakers to craft a standardised blockchain regulatory framework that can help address GDPR compliance concerns and interoperability challenges.
- It should also consult with industry stakeholders to establish tailored guidelines for each sector, ensuring that BlockchainblockchainBlockchainblockchain is utilised to cultivate trust and encourage widespread adoption.

Cost-Effective Solutions for SMEs

- Provenance's blockchain traceability pilot for ethical retailers would be ideal, scalable, low-cost and designed for SMEs.
- The UK needs to establish cross-industry EU-style blockchain partnerships to reduce operational costs for SMEs.

Blockchain Skills: Building Future Workforce

Programs in universities, vocational training programs, and public-private partnerships that can create first-rate blockchain professionals to join the workforce and help implement BlockchainblockchainBlockchainblockchain must come to the forefront to combat the shortage of blockchain talent within the UK.

Conclusion

B lockchain technology could help revolutionise security and transparency to optimise supply chain management in the UK by offering solutions to fraud, inefficiencies, and compliance risks. Pragmatic solutions for blockchain adoption exist based on case studies in different industries, but cost barriers, lack of technical expertise and regulatory concerns make up for its slow adoption. Filling these gaps is possible only with government incentives, uniform regulation and investment in blockchain education in the UK. In this way, blockchain can be a pillar for security, resilience, and innovation in the supply chains of the UK post-Brexit economy.

REFERENCES

Agi, M. A. N., & Jha, A. K. (2022). Blockchain technology in the supply chain: An integrated theoretical perspective of organisational adoption. International Journal of Production Economics, 247(108458), 108458. https://doi.org/10.1016/j.ijpe.2022.108458

Alardeau, T., & Blome, C. (2018). How Industry 4.0 drives sustainability in supply chains: Analysis of the automotive industry.

Ali, S., Naveed, M., Youssef, M., & Yousaf, I. (2024). FinTech-powered integration: Navigating the static and dynamic connectedness between GCC equity markets and renewable energy cryptocurrencies. Resources Policy, 89(104591), 104591. https://doi.org/10.1016/j.resourpol.2023.104591

Aloqab, A., Hu, W., Abdulraqeb, O. A., Mohammed, O., & Raweh, B. (2024). The impact of the coronavirus on supply chains: Opportunities and challenges. Review of Economic Assessment, 2(4), 37–48. https://doi.org/10.58567/rea02040002

Atif, S., & Hassan, A. (2023). Evaluating the blockchain-based e-procurement System: A Systematic Literature Review and Future Research Directions. Core.ac.uk. https://core.ac.uk/download/616675715.pdf

Atnafu, D., & Balda, A. (2018). The impact of inventory management practice on firms' competitiveness and organisational performance: Empirical evidence from micro and small enterprises in Ethiopia. Cogent Business & Management, 5(1), 1503219. https://doi.org/10.1080/23311975.2018.1503219

Awa, H. O., Etim, W., & Ogbonda, E. (2024). Stakeholders, stakeholder theory and Corporate Social Responsibility (CSR). International Journal of Corporate Social Responsibility, 9(1). https://doi.org/10.1186/s40991-024-00094-y

Balcıoğlu, Y. S., Çelik, A. A., & Altındağ, E. (2024). Integrating blockchain technology in supply chain management: A bibliometric analysis of theme extraction via text mining. Sustainability, 16(22), 10032. https://doi.org/10.3390/su162210032

Bank of England. (2024). *A portrait of the UK's global supply chain exposure*. Bankofengland.co.uk. https://www.bankofengland.co.uk/quarterly-bulletin/2024/2024/a-portrait-of-the-uks-global-supply-chain-exposure

BBVA. (2016, April 12). *Leanne Kemp, from Everledger, at the BBVA Open Talent 2015 finals*. NEWS BBVA. https://www.bbva.com/en/diamon ds-blockchain-and-banks-the-story-of-every ledger/

Belen-Saglam, R., Altuncu, E., Lu, Y., & Li, S. (2023). A systematic literature review of the tension between the GDPR and public blockchain systems. *Blockchain: Research and Applications*, *4*(2), 100129. https://doi.org/10.1016/j.bcra.2023.100129

Bhavana, G. B., Anand, R., J Ramprabhakar, Meena, V. P., Vinay Kumar Jadoun, & Benedetto, F. (2024). Applications of blockchain technology in peer-to-peer energy markets and green hydrogen supply chains: a topical review. *Scientific Reports*, *14*(1). https://doi.org/10.1038/s41598-024-72642-2

Botton, N. (2018). *Blockchain and Trade: Not a Fix for Brexit, but Could Revolutionise Global Value Chains (If Governments Let It)*. https://ecipe.org/wp-content/uploads/2018/01/ECIPE_PB0118_V3.pdf

Burgess, P., Sunmola, F., & Wertheim-Heck, S. (2024). Information needs for transparency in blockchain-enabled sustainable food supply chains. International Journal of Information Management Data Insights, 4(2), 100262. https://doi.org/10.1016/j.jjimei.2024.100262

Butt, U. J., Hussien, O., Hasanaj, K., Shaalan, K., Hassan, B., & al-Khateeb, H. (2023). Predicting the impact of data poisoning attacks in blockchain-enabled supply chain networks. Algorithms, 16(12), 549. https://doi.org/10.3390/a16120549

Chigbu, U. E., Atiku, S. O., & Du Plessis, C. C. (2023). The Science of Literature Reviews: Searching, Identifying, Selecting, and Synthesising. *Publications*, *11*(1), 2. MDPI. https://doi.org/10.3390/publications11010002

Colomo-Palacios, R., Sánchez-Gordón, M., & Arias-Aranda, D. (2020). A critical review on blockchain assessment initiatives: A technology evolution viewpoint. Journal of Software (Malden, MA), 32(11). https://doi.org/10.1002/smr.2272

David, A., Kumar, C. G., & Paul, P. V. (2022). Blockchain Technology in the Food Supply Chain. *International Journal of Information Systems and Supply Chain Management*, *15*(3), 1–12. https://doi.org/10.4018/ijisscm.290014

Dawadi, S. (2020). Thematic Analysis approach: a Step by Step Guide for ELT Research Practitioners. *Journal of NELTA*, *25*(1-2), 62–71. https://files.eric.ed.gov/fulltext/ED612353.pdf

De Beers Group. (2022, May 5). *De Beers Group introduces the world's first blockchain-backed diamond source platform at scale*. Www.debeersgroup.com. https://www.debeersgroup.com/media/company-news/2022/de-beers-group-introduces-worlds-first-blockchain-backed-diamond-source-platform-at-scale

Department for Transport. (2022). *Future of Freight: A Long-term Plan*. https://assets.publishing.service.gov.uk/media/62b9a2ec8fa8f53572e3db68/future-of-freight-plan.pdf

Dinçkol, D., Ozcan, P., & Zachariadis, M. (2023). Regulatory standards and consequences for industry architecture: The case of UK Open Banking. *Research Policy*, *52*(6), 104760. ScienceDirect. https://doi.org/10.1016/j.respol.2023.104760

DiFrancesco, R. M., Meena, P., & Kumar, G. (2022). How blockchain technology improves sustainable supply chain processes: a practical guide. Operations Management Research. https://doi.org/10.1007/s12063-022-00343-y

Duan, K., Pang, G., & Lin, Y. (2023). Exploring the current status and future opportunities of blockchain technology adoption and application in supply chain management. Journal of Digital Economy, 2, 244–288. https://doi.org/10.1016/j.jdec.2024.01.005

Duan, K., Pang, G., & Lin, Y. (2024). Exploring the current status and future opportunities of blockchain technology adoption and application in supply chain management. *Journal of Digital Economy*, *2*(3). https://doi.org/10.1016/j.jdec.2024.01.005

Ellahi, R. M., Wood, L. C., & Bekhit, A. E.-D. A. (2024). Blockchain-Driven Food Supply Chains: A Systematic Review for Unexplored Opportunities. *Applied Sciences*, *14*(19), 8944. https://doi.org/10.3390/app14198944

Emrouznejad, A., Abbasi, S., & Sıcakyüz, Ç. (2023). Supply chain risk management: A content analysis-based review of existing and emerging topics. Supply Chain Analytics, 3(100031), 100031. https://doi.org/10.1016/j.sca.2023.100031

European Investment Bank. (2022). *Artificial intelligence, BlockchainblockchainBlockchainblockchain and the future of Europe*. https://www.eib.org/attachments/thematic/artificial_intelligence_blockchain_and_the_future_of_europe_report_en.pdf

Everledger. (2020, May 8). *Blockchain Luxury Goods: Everledger is improving trust and sustainability*. Everledger. https://everledger.io/blockchain-luxury-goods-helping-to-improve-trust-and-sustainability/

Finck, M. (2018). Blockchains and Data Protection in the European Union. *European Data Protection Law Review*, *4*(1), 17–35. https://doi.org/10.21552/edpl/2018/1/6

Food Standards Agency. (2023). *The Cost of Food Crime Phase 2 - Executive Summary*. Food Standards Agency. https://www.food.gov.uk/research/the-cost-of-food-crime-phase-2-executive-summary

Frontiers Media SA. (2020, March 5). *FIGURE 5 | Overview of the Everledger Blockchain application in the...* ResearchGate; ResearchGate. https://www.researchgate.net/figure/Overview-of-the-Everledger-Blockchain-application-in-the-diamond-industry_fig5_339721595

Gao, Y., Kawai, S., & Nobuhara, H. (2019). Scalable Blockchain Protocol Based on Proof of Stake and Sharding. *Journal of Advanced Computational Intelligence and Intelligent Informatics*, *23*(5), 856–863. https://doi.org/10.20965/jaciii.2019.p0856

GOV.UK. (2019). *Tackling fraud in government with data analytics Starting the conversation Thought Paper*. https://assets.publishing.service.gov.uk/media/5d1a294240f0b609e0f06b0e/Tackling_fraud_in_government_with_data_analytics.pdf

GOV.UK. (2022). *Embracing the ocean: a Board of Trade paper (web version)*. GOV.UK. https://www.gov.uk/government/publications/board-of-trade-report-maritime/embracing-the-ocean-a-board-of-trade-paper-web-version

GOV.UK. (2023). *Data: A new direction - government response to the consultation*. GOV.UK. https://www.gov.uk/government/consultations/data-a-new-direction/outcome/data-a-new-direction-government-response-to-consultation

GS1 UK. (2024). *GS1 UK | The importance of traceability in an increasingly transparent world*. Www.gs1uk.org. https://www.gs1uk.org/insights/thought-leadership/the-importance-of-traceability

Hazari, S. S., & Mahmoud, Q. H. (2020). Improving Transaction Speed and Scalability of Blockchain Systems via Parallel Proof of Work. *Future Internet*, *12*(8), 125. https://doi.org/10.3390/fi12080125

Hershko, R. (2022, November 29). *A.P. Moller - Maersk and IBM will discontinue TradeLens, a blockchain-enabled global trade platform*. Www.maersk.com. https://www.maersk.com/news/articles/2022/11/29/maersk-and-ibm-to-discontinue-tradelens

Hyperledger Foundation. (2023, July 8). *How Walmart brought unprecedented transparency to the food supply chain with Hyperledger Fabric*. Lfdecentralizedtrust.org; The Linux Foundation. https://www.lfdecentralizedtrust.org/case-studies/walmart-case-study

IBM. (2020, August 25). *Food logistics on BlockchainblockchainBlockchainblockchain*. Www.ibm.com. https://www.ibm.com/blockchain/resources/food-trust/food-logistics/

IBM Food Trust. (2021, March 17). *The grocery industry on BlockchainblockchainBlockchainblockchain*. Ibm.com. https://www.ibm.com/blockchain/resources/food-trust/grocery

Institute of Customer Service. (2024). *UK Customer Satisfaction Index (UKCSI) ⋆ Institute of Customer Service*. Institute of Customer Service. https://www.instituteofcustomerservice.com/research-insight/ukcsi/

Javaid, M., Haleem, A., Singh, R. P., Suman, R., & Khan, S. (2022). A review of Blockchain Technology applications for financial services. BenchCouncil Transactions on Benchmarks, Standards and Evaluations, 2(3), 100073. https://doi.org/10.1016/j.tbench.2022.100073

Kamath, R. (2018). Food traceability on BlockchainblockchainBlockchainblockchain: Walmart's pork and mango pilots with IBM. The JBBA, 1(1), 1–12. https://doi.org/10.31585/jbba-1-1-(10)2018

Kayani, U., & Hasan, F. (2024). Unveiling cryptocurrency impact on financial markets and traditional banking systems: Lessons for sustainable BlockchainblockchainBlockchainblockchain and interdisciplinary collaborations. Journal of Risk and Financial Management, 17(2), 58. https://doi.org/10.3390/jrfm17020058

Kitsantas, T. (2022). Exploring Blockchain Technology and Enterprise Resource Planning System: Business and Technical Aspects, Current Problems, and Future Perspectives. *Sustainability*, *14*(13), 7633. https://doi.org/10.3390/su14137633

Lewis, B. (2018, March 5). UK firm pilots using BlockchainblockchainBlockchainblockchain to help BMW source ethical cobalt. *Reuters*. https://www.reuters.com/article/technology/uk-firm-pilots-using-blockchain-to-help-bmw-source-ethical-cobalt-idUSKBN1GH2UJ/

Negi, S. (2020). Supply chain efficiency framework to improve business performance in a competitive era. Management Research Review, 44(3), 477–508. https://doi.org/10.1108/mrr-05-2020-0272

Nestlé. (2019). *Nestlé and Carrefour give consumers access to blockchain platform for Mousline purée*. Nestlé Global. https://www.nestle.com/media/news/carrefour-consumers-blockchain-mousline-puree-france

Notomoro. (2023, October 15). *Blockchain Cost Analysis: Calculating Expenses for Your Next Blockchain Implementation*. Webisoft. https://webisoft.com/articles/blockchain-cost/

Nur Hasanah. (2024). TRANSACTION COSTS: A LEGENDARY THEORY OF THE FIRM. *JOURNAL of BUSINESS STUDIES and MANGEMENT REVIEW*, *7*(2), 79–95. https://doi.org/10.22437/jbsmr.v7i2.33755

OECD. (2023). *Trade in Counterfeit Products and the UK Economy FaKE Goods, REal lossEs*. https://www.oecd.org/content/dam/oecd/en/publications/reports/2017/09/trade-in-counterfeit-products-and-the-uk-economy_g1g7dbdb/9789264279063-en.pdf

Orji, I., Kusi-Sarpong, S., Huang, S., & Vazquez-Brust, D. (2020). *Evaluating the factors that influence blockchain adoption in the freight logistics industry Evaluating the factors that influence blockchain adoption in the freight logistics industry*. https://researchportal.port.ac.uk/files/21793255/HUANGs_2020_cright_Evaluating_the_factors_that_influence_blockchain_adoption_in_the_freight_logistics_industry.pdf

Oriekhoe, O. I., Ashiwaju, B. I., Ihemereze, K. C., Ikwue, U., & Udeh, C. A. (2024). Blockchain technology in Supply Chain Management: A comprehensive review. International Journal of Management & Entrepreneurship Research, 6(1), 150–166. https://doi.org/10.51594/ijmer.v6i1.714

Payandeh, R., Delbari, A., Fardad, F., Helmzadeh, J., Shafiee, S., & Ghatari, A. R. (2024). Unraveling the potential of blockchain technology in enhancing supply chain traceability: A systematic literature review and modeling with ISM. Blockchain: Research and Applications, 100240, 100240. https://doi.org/10.1016/j.bcra.2024.100240

Pinnington, B., Benstead, A., & Meehan, J. (2023). Transparency in supply chains (TISC): Assessing and improving the quality of modern slavery statements. Journal of Business Ethics, 182(3), 619–636. https://doi.org/10.1007/s10551-022-05037-w

Popoola, O., Rodrigues, M., Marchang, J., Shenfield, A., Ikpehia, A., & Popoola, J. (2023). A critical literature review of security and privacy in smart home healthcare schemes adopting IoT & BlockchainblockchainBlockchainblockchain: Problems, Challenges and Solutions. *Blockchain: Research and Applications*, *5*(2), 100178. https://doi.org/10.1016/j.bcra.2023.100178

Provenance. (2015, September 21). *Blockchain: the solution for transparency in product supply chains | Provenance | provenance*. Www.provenance.org. https://www.provenance.org/news-insights/blockchain-the-solution-for-transparency-in-product-supply-chains

Sharma, M., & Kumar, P. (2021). Adoption of Blockchain Technology: a Case Study of Walmart. *Advances in Marketing, Customer Relationship Management, and E-Services*, 210–225. https://doi.org/10.4018/978-1-7998-8081-3.ch013

Soesanto, D., L, L., & Bambang Prijambodo. (2022). Food Fraud Prevention using a Blockchain-Based System: Case Study Slaughterhouse in Sidoarjo. *Jurnal RESTI (Rekayasa Sistem Dan Teknologi Informasi)*, *6*(2), 295–304. https://doi.org/10.29207/resti.v6i2.3937

Sristy, A. (2021, November 30). *Blockchain in the food supply chain - what does the future look like?* Blockchain in the Food Supply Chain - What Does the Future Look Like? https://tech.walmart.com/content/walmart-global-tech/en_us/blog/post/blockchain-in-the-food-supply-chain.html

Statista. (2023). *Blockchain Technology Market Size Worldwide 2030*. Statista. https://www.statista.com/statistics/1319369/global-blockchain-technology-market-size/

Swazan, I. S., & Youn, S. (2024). Blockchain in Luxury Resale: The Impact of Blockchain Technology Through Regulatory Focus and Uncertainty Reduction Theories. *Journal of Consumer Behaviour*. https://doi.org/10.1002/cb.2433

Tripathi, G., Ahad, M. A., & Casalino, G. (2023). A comprehensive review of blockchain technology: Underlying principles and historical background with future challenges. Decision Analytics Journal, 9(100344), 100344. https://doi.org/10.1016/j.dajour.2023.100344

Upadhyay, A., Mukhuty, S., Kumar, V., & Kazancoglu, Y. (2021). Blockchain technology and the circular economy: Implications for sustainability and social responsibility. Journal of Cleaner Production, 293(126130), 126130. https://doi.org/10.1016/j.jclepro.2021.126130

UK Finance. (2023, May 11). *Over £1.2 billion stolen through fraud in 2022, with nearly 80 per cent of APP fraud cases starting online*. UK Finance. https://www.ukfinance.org.uk/news-and-insight/press-release/over-ps12-billion-stolen-through-fraud-in-2022-nearly-80-cent-app

Vu, N., Ghadge, A., & Bourlakis, M. (2021). Blockchain adoption in food supply chains: a review and implementation framework. *Production Planning & Control*, *34*(6), 1–18. https://doi.org/10.1080/09537287.2021.1939902

Vu, N., Ghadge, A., & Bourlakis, M. (2024). The impact of Blockchain adoption on supply chain performance: evidence from the food industry. *International Journal of Production Research*, 1–26. https://doi.org/10.1080/00207543.2024.2414375

Wang, Z.-J., Chen, Z., Xiao, L., Su, Q., Govindan, K., & Skibniewski, M. J. (2023). Blockchain adoption in sustainable supply chains for Industry 5.0: A multistakeholder perspective.

Journal of Innovation & Knowledge, *8*(4), 100425–100425. https://doi.org/10.1016/j.jik.2023.100425

Xia, J., Li, H., & He, Z. (2023). The Effect of Blockchain Technology on Supply Chain Collaboration: A Case Study of Lenovo. *Systems*, *11*(6), 299. mdpi. https://doi.org/10.3390/systems11060299

Zimuto, J., & Zvarimwa, C. (2022). Valuable, Rare, Inimitable, Non-Substitutable and Exploitable (VRINE) Resources on Competitive Advantage. *EPH - International Journal of Business & Management Science*, *8*(1), 9–21. https://doi.org/10.53555/ephbms.v8i1.1915

Zoughalian, K., Marchang, J., & Ghita, B. (2022). A blockchain secured pharmaceutical distribution system to fight counterfeiting. International Journal of Environmental Research and Public Health, 19(7), 4091. https://doi.org/10.3390/ijerph19074091