The Impact of Blockchain Technology on the Smart City Industry

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ABSTRACT

In recent decades, the Smart City Industry has been actively developing around the world due to the economic benefits of the globalization of product design and development. Information exchange is an important characteristic of the global activities of the Smart City Industry. The Internet of Things (IoT) enhances information sharing for the Smart City manufacturing industry. Despite this success, the adoption of IoT applications to automate business processes faces many challenges due to security concerns. IoT technology helps collect real-time information about the Smart City Industry using tags and radio frequency identification (RFID) sensors. Blockchain technology with IoT can enable broader categories of business applications to improve integration and improve the efficiency of business transactions. This article provides an overview of blockchain integration with IoT technology, highlighting the advantages and disadvantages of integration. This article provides a classification of security threat models that are taken into account by blockchain protocols in IoT networks.

CCS CONCEPTS

• **Social and professional topics** → Professional topics.

KEYWORDS

Blockchain Technology, Internet of Things, Radio Frequency Identification, Privacy and Security

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1 INTRODUCTION

Blockchain technology is a distributed network for orchestrating transactions, value, and assets between peers without intermediaries' assistance. Blockchain technology helps record transactions or any digital interaction designed to be secure, transparent, highly resistant to outages, auditable, and efficient. These characteristics provide impetus to blockchain-based IoT architecture for secure data processing in a distributed environment. In order words, IoT-based information systems to improve their IoT networked infrastructure to blockchain complimented technology. It is a distributed ledger managed by a peer-to-peer (P2P) network to provide internode communication and verify new blocks. A convergence of IoT and blockchain technologies can lead to a verifiable, secure, and robust mechanism of storing and managing data processed by smart connected devices. This network of connected devices will interact with their environment and make decisions without any human intervention. However, integrating blockchain technology in IoT-based information systems will enhance the security, data privacy, and reliability of IoT devices, it creates a new set of challenges.

This article presents how smart city businesses can leverage IoT applications in combination with blockchain technology to streamline their supply chains business information. When combined, these enabling technologies will help global textile and clothing companies to overcome difficulties related to data collection d integrity, address security challenges, and reduce information asymmetry. This article will demonstrate areas of disadvantages towards safety and privacy in blockchain technology.

2 MATERIALS AND METHODS

Blockchain technology won many individuals' and corporations' interest due to its technological capabilities and scalability for various use cases. This led to the disruption of traditional internet/intranet business models alongside services such as conducting business transactions and managing information ineffective and secure ways. These use cases clearly communicate a message for systems and experience designers to get equipped with relevant skills and to keep polishing them as the technology grows. Following the evolution of this rapid introduction, blockchain technology nowadays consists of three types: the 'public,' 'private,' and 'federated / consorted.' In a nutshell, these blockchains share similar functionalities. In terms of differences, they rely on the use cases, permission levels, and privacy. Within the business context, the blockchain brings several advantages: time-saving over work processes, minimizing costs,

risk reduction, and an increase in trust. By learning these values and benefits, web designers will have the ability to foresee how this technology can reshape our clients' businesses, notwithstanding the knowledge and confidence we need to guide and proposing the right solutions fitting their needs. However, for that to happen, the business must have a network of some kind to ensure a solid foundation of a good blockchain use case. It is often said that 'with great power comes great responsibility.' This statement is heavily applicable when it comes to this technology. The blockchain restores control and ownership of information to its rightful owner, thus eliminating central authorities and third parties' dependencies.

3 INTERNET OF THINGS AND ITS APPLICATIONS IN SMART CITY INDUSTRY

IoT technology has used in smart cityl industries for different business process automation purpose. This area of computing has recently focused on enterprise automation, and there is a handful of evidence of the successful use of this technology in supply chain operations. IoT based information system aims to improve organisational communication and collaboration activities. In recent decades, World Wide Web technologies are getting prominence for business use, and the numbers of Internet-based IoT services are increasing rapidly for supply chain communities. The main form of communication is human-to-human. IoT attempts to not only have humans communicating through the Internet but also have objects or devices. These things are to exchange information by themselves over the Internet, and new forms of Internet communication would form human-to-things and things-to-things [4].

The IoT technology characterised by three types of visions:

1. Things Oriented Vision: This vision supported by the fact that this technology can track anything using sensors. The advancement and convergence of microelectronic systems technology, wireless communications and digital electronics have resulted in the development of miniature devices having the ability to sense, compute and communicate wirelessly in an effective way. The basic philosophy is uniquely identifying an object using specifications of Electronic Product Code (EPC) [4]. It is worth considering that the future of 'Things Oriented Vision' will depend upon sensor technology evolution for accurate sensing (without any error) and its capabilities to fulfil the "thing" oriented other issues.

2. Internet Oriented Vision: This vision realises upon the need to make smart objects which are connected.

3. Semantic Oriented Vision: This vision is power because the number of sensors used in the smart city industry is vast. The data that these IoT infrastructures collect is massive. Thus, the industry needs to process this data in a meaningful way to form value-added services using semantic technologies (e.g., ontology, knowledge-based reasoning), efficient, secure, scalable, and market-oriented computing.

In this way, the IoT application builds on three pillars, related to the ability of smart objects to (i) be identifiable (anything identifies itself), (ii) to communicate (anything communicates), and (iii) to interact (anything interacts) – either among themselves, building networks of interconnected objects, or with end-users or other entities in the network [4]. Cloud computing and fog computing provide computing resources and scalability to connect, store and analyse IoT data (often labelled as big data).

4 BLOCKCHAIN TECHNOLOGY IN SMART CITY BUSINESS

Since the innovation of Bitcoin, a digital cryptocurrency, blockchain technology has positioned itself as the focal point of interest among a diverse range of researchers and practitioners. Blockchain is a decentralised ledger that stores all transactions that have made on top of a peer-to-peer (P2P) network in a secure, verifiable, and transparent way. The significant advantage of blockchain over the existing technologies is that it enables the two parties to make transactions over the Internet securely without any intermediary party's interference. The omission of the intermediate party can reduce the processing cost while improving the security and efficiency of transactions. Due to the benefits that blockchain can bring in information processing, this technology expands its applicability to new territories such as supply chain management and logistics management. Today, blockchain also stands as a gatekeeper in the emerging "trust economy", in which the global smart city businesses supply chain operates to serve its suppliers and customers. The efficiency of a global smart city buisnesses supply chain relies on trust between the different stakeholders. The integration of blockchain and IoT technologies can increase the traceability and reliability of information and the business network. The IoT technology should integrate with enterprise resource planning (ERP) and point of sales (POS) systems of smart city business to share and monitor real-time information at each stage. Blockchain technology offers a mechanism to record transactions or any digital interaction designed to secure, transparent, highly resistant to outages, auditable, and efficient. In other words, blockchain technology has introduced an effective solution to IoT based information systems security. A blockchain enhances IoT devices to send inclusion data in a shared transaction repository with the tamper-resistant record. It improves business partners to access and supply IoT data without central control and management, which creates a digital fusion.

In a blockchain-based infrastructure, every node of the chain maintains a local copy of transaction information. The copy is identical to the original copy and updated in the global information sheet as it distributed within the database with well-built constancy support. Once data entered within the blockchain ledger in this database, no one can change this data in the future. However, this mechanism is known as *tamperproof*, a systematic effort required for building a *reliable* blockchain-based information infrastructure. The main features of these systematic efforts are as follows: (i) Blockchain Protocols for Commitment: The *protocol of commitment* makes sure that valid transaction from smart city industry business processes are committed and stored in the blockchain information storage with appropriate *validation mechanism* and within a *stipulated time*; (ii) Consensus: Consensus consists of two things: First, it permits blockchain to be updated while making sure that every block in the network is valid as well as keeping participants incentivised and second, it safeguards any single entity from controlling or crashing the whole blockchain system. The consensus aims to create a distributed network without central authorities with participants who do not necessarily need to trust each other [3]. The

consensus is an essential part of blockchain technology. Each node runs a programmed mechanism called a consensus. The consensus is how nodes agree on how to update the blockchain because of a set of transactions. Achieving consensus ensures that most network nodes have validated the same set of transactions; (iii) Security: Safety is an essential aspect of the blockchain-based transaction processes. All the data within the blockchain ecosystem needs to be secured and tamperproof. Ensures that there are no malicious nodes within the blockchain-based enterprise ecosystem. (iv) Privacy and Authenticity**:** Privacy in blockchain enables the client/user to perform transactions without leaking its identification information in the network; and (v) Smart Contracts.

5 BLOCKCHAIN APPLICATIONS FOR THE IOT

5.1 Applications in Supply Chain

Academics and practitioners identified industrial business processes, mainly supply chain and logistics management, essential for deploying IoT based information system applications. IoT-based industrial information systems can enhance enterprise competitiveness through more effective tracking of raw materials' flow, leading to improved business processes' effectiveness and efficiencies. In the context of globalised business practice, with multiple collaborating-partners based supply chains, IoT-based applications enhance the sharing of more accurate and timely information relevant to production, quality control, distribution, and logistics. However, researchers expressed their concern regarding standalone IoT-based applications and global supply chain management. The main concerns raised on the issues of standalone IoT systems security and privacy. The research community has proposed different hybrid information system architectures (e.g., IoT with blockchain, cloud based IoT and blockchain technology). A blockchain enhances IoT-based applications tamper-resistant characteristics. In recent years, different blockchain-based information management systems have reported by researchers. For example, IBM has developed a new blockchain-based service designed to track high-value items through complex supply chains in a secure cloud-based application system. In recent decades, due to globalisation, manufacturing supply chain networks are going through an evolutionary change through their business practices' continued digitisation. These global manufacturing chains evolve into value-creating networks where the value chain becomes an essential competitive advantage source. Simultaneously, developments are in progress to integrate blockchain technology with other technologies solutions (e.g., IoT-based applications, cloud-based solutions, and fog computing-based automation): modern manufacturing supply chains and holistic collaboration mechanisms value-enhancing applications for the global business.

5.2 Applications on the Internet of Things Devices Management

In IoT, devices management relates to security solutions for the physical devices, embedded software, and residing data on the devices. Internet of Things (IoT) comprises of "Things" (or IoT devices) that have remote sensing and data collecting capabalities and can exchange data with other connected devices and applications (directly or indirectly). IoT devices can collect data and process the data either locally or send them to centralised servers or cloud-based application back-ends for processing. A recent on-demand model of manufacturing that is leveraging IoT technologies is called Cloud-Based Manufacturing (CBM). It enables ubiquitous, convenient, on-demand network access to a shared pool of configurable manufacturing business processes information collection and use it service provision.

5.3 Applications on the Internet of Things Access Management

Access control is a mechanism in computer security that regulates access to information system. The access control systems face many problems, such as third-party, inefficiency, and lack of privacy. These problems can be address by blockchain, the technology that received significant attention in recent years, and much potential. As there is a third party with access to the data, the risk of privacy leakage exists. Also, a major party is in charge to control the access, so the risk of a single point of failure also exists. This study presents an access control mechanism with a temporal dimension to solve these problems and adapts a blockchain-based solution for verifying access permissions. The attribute-based Encryption method also has some problems, such as privacy leakage from the private key generator (PKG) and a single point of failure as mentioned before. Wang and colleagues introduce a framework for data sharing and access control to address this problem by implementing decentralised storage. Blockchain can be classified either as private (permission) or public (permissionless). Both classes are decentralising and provide a certain level of immunity against faulty or malicious users for blockchain technology [2]. The significant differences between private and public blockchains lie in the consensus protocol's execution, the ledger's maintenance, and the authorisation mechanism to join the distributed network. Recently, there has been a tremendous investment from the industries and significant interest from academia to solve significant research challenges in blockchain technologies. For example, consensus protocols are the primary building blocks of blockchain-based technologies. Therefore, the threats targeting the consensus protocols become a significant research issue in the blockchain.

6 CONCLUSION

Today's smart city industry supply chain face significant volatility, uncertainty and complexity imposed by a dynamic business environment. Changes in customer buying pattern – the demand for a lower price, higher service levels, mobile commerce and so on – necessitate customer intelligence and varying fulfilment models. These have introduced significant stress on smart city industry supply chain networks, compelling clothing businesses to revisit their supply chain design strategies. It includes the deployment of appropriate information systems that enhance supply chain execution. In such scenarios, enterprise information systems architecture plays a significant role.

This article explains and summarises some of the main issues of the smart city industry supply chain management system. IoT is a smart worldwide network of interconnected objects, which

through unique address schemes can cooperate with each other and interact with their neighbours to reach common goals. The data obtained from the IoT applications along smart city industry business processes can make operational decision-making much more comfortable. However, standalone IoT application systems face security and privacy-related problems. With the rapid growth in the number of connected IoT devices, many obstacles arise that may slow down the IoT's adoption across different smart city business processes automation. Firstly, the market for IoT devices and platforms is fragmented, with many standards and many vendors. Secondly, interoperability concerns, as the solution implemented often tends to create new data silos. IoT device data often stored in the cloud securely, but they are not protected against compromised integrity devices or tampering at the source. In contrast, the blockchain is an evolving technology that can help with IoT systems resiliency [3]. The blockchain provides trust between IoT devices and reducing the risk of tampering with cryptographic techniques. Security and business organisational issues tend to enhance the need to build an smart city buisnesses manufacturing supply chain management system leveraging blockchain ledger technology. Regardless of the particularities of the specific textile manufacturing supply chain-related application, blockchain can offer a wide range of advantages. By registering and documenting a product's (e.g., cotton, fibre, textile cloths) lifecycle across the manufacturing supply chain nodes increases the transparency and the trust of the participating business partners. Finally, the article tries to emphasise the security and privacy-related issues of blockchain-based technology deployment. The article concludes by presenting five different types of threat models, namely - identity-based attacks, manipulation-based attacks, cryptanalytic attacks, reputation-based attacks, and service-based attacks in the context of blockchain technology. The idea of a permissioned blockchain presents many hopeful solutions to the development and integration of smart smart city businesses supply chain operations. In practice, however, many more efforts need to be conducted to secure permissioned blockchains before realistic implementation. In the future, the current research moves on to a more in-depth approach to permissioned blockchain security, whether an analytical or experimental analysis. The membership service provider (MSP) needs to be analysed comparatively, and rigorous proofs need to be built to quantify the threats that accompany permissioned blockchain numerically. Further work is encouraged in a comparative analysis of key management systems to find the best fit system for permissioned blockchain. On 25 May 2018, the GDPR became enforceable in the European Union (EU) region. This has a paradoxical effect on blockchain data in general and should be strongly considered when implementing any blockchain identity solution within the EU region. In this way, enforcing data privacy and protecting user data is no longer optional in Europe. However, it should be noted that the text of the GDPR documentation is void of both technical and non-technical implementation details necessary to achieve GDPR compliance [1]. This constitutes a significant research gap that this research aims to fill in the future.

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