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Article Title: **Quality Data Sharing Platform for Aviation Suppliers Using Blockchain Process**

Quality Data Sharing Platform for Aviation Suppliers Using Blockchain Process

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ABSTRACT

The aviation industry is characterized by complex supply chains, which can pose challenges for ensuring quality processes across all participants. To address this issue, a blockchain-based process quality data sharing platform has been proposed to improve the traceability and transparency of quality-related information among aviation suppliers. This platform allows suppliers to securely share process quality data, such as inspection results and certifications, with their partners in the supply chain. The platform utilizes a permissioned blockchain network, ensuring that only authorized parties have access to the shared data. Smart contracts are used to automate the validation and verification of data, reducing the need for manual intervention and streamlining the quality assurance process. The platform also incorporates a user-friendly interface to enhance ease of use and accessibility. Overall, the proposed platform has the potential to increase efficiency and trust in aviation supply chains by improving the sharing and verification of process quality data.

Keywords: Blockchain, Hashing, Supply Chain, Data Sharing, data information management, Smart Contracts, Permissioned Blockchain.

1 Introduction

Aviation supplier process quality data refers to the characteristic values collected by suppliers during the manufacturing process, which are used to obtain the quality indicators of aviation products [1]. This data encompasses a wide range of topics, including manufacturing process planning, production batches, usage, and return maintenance. The timely and reliable collection of quality characteristic data, high-speed safe transmission, and stable traceability storage are essential for ensuring the comprehensive performance and service life of aviation goods. However, due to the involvement of aviation enterprises in a variety of product types, a large number of suppliers, and deep levels of the supply chain in the actual manufacturing process, the credibility sharing and security interoperability of quality data in the manufacturing process have always been a challenge in supplier quality management and control. This has also been a bottleneck for aviation enterprises seeking to improve their level of supplier quality management. A secure and reliable supply chain system is becoming a new need for both manufacturers and users [2]. Exploration of a new paradigm of deep integration of next-generation information technology and the aircraft manufacturing business is critical [3], [4].

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The introduction of new data services and technologies, such as blockchain, has had a significant influence on the processing market and supply chain, generating new ideas for the study of aviation supplier intelligent governance [5], [6]. As a result, the blockchain-based process quality data-sharing platform for aviation suppliers is implemented in the paper.

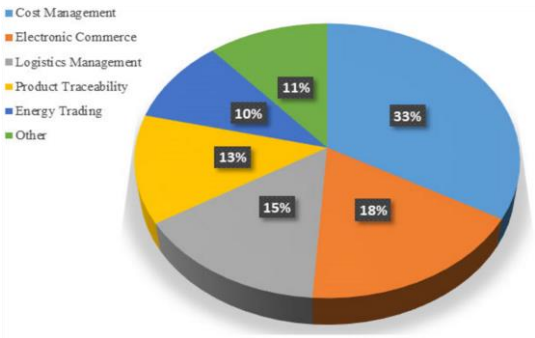

Figure 1: *The proportion of document types is based on keywords*

The blockchain is based on Bitcoin technology, and its decentralization, high-volume fault and security, and trustworthiness have piqued the interest of industrial manufacturing countries. According to the National Science and Technology Council's 2018 ''U.S. Leadership Strategy in Advanced Manufacturing,'' it is employed as soon as possible to create or revise blockchain standards and guidelines in information and data security in the field of advanced manufacturing. In September 2019, the German government unveiled a blockchain policy to support industrial digital transformation. The Chinese government included blockchain technology in its ''Fourteenth Five-Year Plan,'' which intends to improve technology integration and layout.

2 Related Works

Blockchain technology in supply chain management for sustainable performance: Evidence from the airport industry Assunta Di Vaio-2019. This paper investigates the major implications of blockchain technology for operations management (OM) with a focus on the decision-making processes in supply chain management (SCM) from the perspective of sustainable performance. The links between blockchain technology, OM, and sustainability issues within SCM are analysed. This two-step research study includes a broad review of the main contributions in the literature that have focused on blockchain technology and OM in SCM. It covers the airport industry from the perspective of sustainable performance and data analysis by reading and processing financial statements, non-financial reports, and the website of one strategic airport infrastructure in southern Italy. The Italian airport infrastructure investigated successfully adopted the Airport Collaborative Decision Making (A-CDM) platform. This is one of the main blockchain technology applications in the airport industry. It promotes cooperation between the main players in the aviation industry and the air traffic controllers (ATCs) to reduce fragmentation, inefficiency, and uncoordinated operations. It also

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allows information and data sharing, but it is still not possible to observe a high level of sustainable performance. Although the adoption of blockchain technology presents numerous benefits, especially in improving OM, these new technological solutions do not guarantee the achievement of the best performance in terms of effectiveness, efficiency, and sustainability issues. Managers and policy makers need to work together to create a real forum within their collaborative network in which there is a common culture and mutual trust. This article adds an interesting reading of blockchain technology to the existing research with concerns about OM and sustainability issues within the airport setting in Italy.

Digital Transformation in Aeronautics through the ICARUS Aviation Data and Intelligence Marketplace Fenareti Lampathaki-2019. Today, digital transformation has drifted all industries with its proven capacity to improve operations and boost revenues while building a value chain ecosystem. The aeronautics ecosystem is almost unanimously invested in some way into a digital transformation strategy in which data typically plays an instrumental role. However, despite the vast quantity of data across myriad parameters that never stop flowing across the aircraft passengers-luggage-cargo journeys, the aviation-related stakeholders are still at a relative disadvantage in terms of data gathering and sharing, especially since the eternal questions of "who owns the aircraft" and "who owns the passenger" remain open. In this contact, the present paper focuses on the design and delivery of the ICARUS data and intelligence platform that aims to enable trusted and fair data sharing and insightful data analytics in an end-to-end secure manner. The methodology followed during the implementation of the ICARUS platform is defined, the aviation data value chain is elaborated, the ICARUS Minimum Viable Product is outlined and the theoretical foundations of the ICARUS data management and value enrichment methods are introduced, giving way to a brief reference to the ICARUS unique selling points and platform implementation.

Blockchain and Supply Chain Management: Aircrafts' Parts' Business Case Yash Madhwal-2020. To serve target customers better than their competitors, supply chain management (SCM) teams today look into new technologies such as Big Data, Internet of Things (IoT) and Blockchain. These new technologies allow managers to develop and provide complex supply chain services and products faster with improved reliabilities. With these technologies, SCM teams can build complex models of a supply chain or systems of supply chains using a data-driven approach. With the growth of aviation domain across the world, there has been increasing demand in aircraft for airlines and other customers. In this domain, SCM teams deal with complex networked supply chains for aircraft's spare part purchase and delivery for aircraft's maintenance and repair. Aircraft's spare parts are shipped to single assembly hubs, located globally. All parts come with certain life expectancy, specific requirements and maintenance attributes. With thousands of spare parts, hundreds of parameters, and number of manufactures distributed globally, SCM team need to deal with very large amount of data. In this paper, it use an industrial scenario of aviation industry SCM to demonstrate the necessity of having decentralized system based on distributed data-driven

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application technologies such as Blockchain, not only to assist in maintaining inventory of the aircraft's parts but also to monitor the performance, usage, etc. This will help to achieve a transparent network of supply chain for aircraft's parts and reduce the risk of availability of aircraft's parts in black market. These new data-driven technologies when embedded into SCM scenarios will help the SCM managers to analyse the supply, demands, source of availability of spare parts and provide methods to procure them from the right sources.

Product lifecycle management in aviation maintenance, repair and overhaul S.G. Lee-2019. This publication discusses the evolution of CAD, CAM, and CAE tools through product data management systems into today's product lifecycle management (PLM), followed by a review of the characteristics and benefits of PLM. Current practices and potential applications of PLM in aviation maintenance, repair and overhaul (MRO) are discussed through case studies, two of which were from the authors' experience.

The Value of Information Sharing in a Two-Level Supply Chain Hau L. Lee-2020. Many companies have embarked on initiatives that enable more demand information sharing between retailers and their upstream suppliers. While the literature on such initiatives in the business press is proliferating, it is not clear how one can quantify the benefits of these initiatives and how one can identify the drivers of the magnitudes of these benefits. Using analytical models, this paper aims at addressing these questions for a simple two-level supply chain with non-stationary end demands. Our analysis suggests that the value of demand information sharing can be quite high, especially when demands are significantly correlated over time.

3 Proposed Work

The proposed system is a blockchain-based platform that enables aviation suppliers to securely share process quality data with their partners in the supply chain. The platform utilizes a permissioned blockchain network, which ensures that only authorized parties have access to the shared data. Smart contracts are used to automate the validation and verification of data, reducing the need for manual intervention and streamlining the quality assurance process. The platform also incorporates a user-friendly interface to enhance ease of use and accessibility.

3.1 Supply Chain Quality Management

Supply chain quality management is the process of ensuring that products or services meet required quality standards throughout the supply chain, requiring coordinated efforts between manufacturers, suppliers, distributors and retailers. This process includes supplier selection and evaluation, quality control measures, continuous improvement and risk management to ensure that any product or service meets quality requirements and customers are satisfied with their purchases. Effective quality management in the supply chain is crucial for the success of companies and customer satisfaction.

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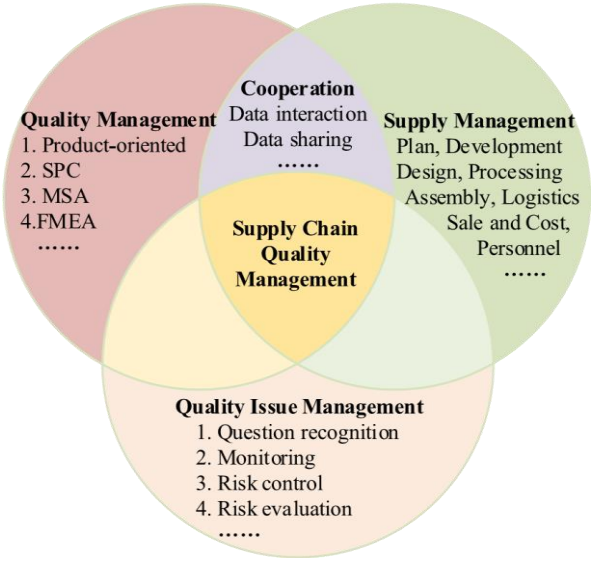

Figure 2: *Supply chain quality management definition.*

Permissioned Blockchain: The platform utilizes a permissioned blockchain network, which ensures that only authorized parties have access to the shared data. A permissioned blockchain network is a type of blockchain network that only allows authorized parties to participate in the network and view or modify data. This type of network is well suited for business applications such as the aviation industry, where data security and privacy are critical.

Smart Contracts: Smart contracts are used to automate the validation and verification of data, reducing the need for manual intervention and streamlining the quality assurance process. Smart contracts are self-executing contracts where the terms of the agreement between buyer and seller are written directly in lines of code. In the context of the proposed platform, smart contracts can be used to automate the validation and verification of data shared by air carriers. For example, a smart contract can be designed to automatically validate an inspection report against pre-defined quality control procedures and flag any deviations.

User-friendly Interface: The platform incorporates a user-friendly interface to enhance ease of use and accessibility. A user-friendly interface is important to ensure suppliers can easily use the platform to share data with their supply chain partners. The user interface can be designed to be intuitive and easy to navigate, with features such as drag-and-drop file uploads and clear labeling of data fields.

Traceability and Transparency: The platform enables traceability and transparency of quality-related information among aviation suppliers. Traceability and transparency are crucial aspects of any supply chain, including the aviation industry. A blockchain-based platform can provide an effective solution to improve traceability and transparency in the aviation supply chain. In the aviation industry, traceability is critical to ensure safety and regulatory compliance. A blockchain-based platform can help improve traceability by recording every transaction in the

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supply chain in an immutable ledger. The origin and history of a product or component can thus be traced more precisely and transparently.

Increased Efficiency and Trust: The proposed system has the potential to increase efficiency and trust in aviation supply chains by improving the sharing and verification of process quality data. A blockchain-based platform can revolutionize the aviation supply chain by improving traceability and transparency, increasing efficiency and building trust between stakeholders. Using an approved blockchain network and smart contracts, aerospace suppliers can securely share process quality data, automate data validation and verification, and reduce the need for manual intervention. The platform can also provide a user-friendly interface, ensure privacy and security, and improve regulatory compliance. By streamlining the supply chain, reducing intermediaries, and improving data accuracy, a blockchain-based platform can improve decision-making and reduce the risk of disputes and breaches.

3.2 Blockchain Technology

Blockchain is an overlay distributed ledger that packages important data into a chain structure using cryptography and consensus mechanisms. It is also decentralized, immutable, traceable, and maintained by numerous parties' distributed databases. The basic technology consists of encryption, hash algorithms, binomial structures, and a peer-to-peer network. Blockchain may be classified into three types based on the varying authority of nodes in the consensus mechanism: public chain, alliance chain, and private chain. And the difference between the three chain structures is the degree of de-naturalization. Buterin. V pointed out that the public chain is a permission less blockchain, which means that anyone can read and send transactions, participate in the consensus process, and maintain data on the chain [16]. The blockchain, in theory, has none at the core, and the degree of de-neutralization is the greatest. Bitcoin and Ethereum apps symbolize it. A consortium chain means that when a node participates in a pre-selected blockchain, it needs to be authorized to join. It is suitable for a certain type of user group or secret-related enterprises with specific purposes, represented by R3 Blockchain Alliance and BigchainDB applications. The private chain is a blockchain deployment paradigm with a single centre, and all activities need to be approved by the centre and subject to its limits and restrictions. Participating nodes on the chain have only limited rights. For example, node A can only access data, node B can only regulate data rights writing, and so on [20]. At present, blockchain platforms are commonly used in the market. This section summarizes the characteristics of the three types of blockchain and the corresponding applicable scenarios.

3.3 Advantages of Proposed Work

Improved data security: Blockchain is known for its robust security features, which makes it ideal for storing sensitive data like aviation process quality data. A blockchain-based platform can prevent data tampering, hacking, and unauthorized access to data, thereby improving data security. The platform may use encryption and other security features to ensure that data shared

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by suppliers is safe and protected from unauthorized access. The platform can be designed to ensure privacy by giving suppliers control over who has access to their data. For example, suppliers can set permissions to limit access to only authorized parties and revoke access at any time.

Enhanced transparency: A blockchain-based platform can offer increased transparency by providing real-time access to data across multiple stakeholders in the supply chain. This can lead to better coordination, collaboration, and faster decision-making. The platform's blockchain ledger provides transparency by allowing authorized parties to view and track the data shared by suppliers. This can help reduce disputes and ensure compliance with industry standards and regulations.

Increased trust: A blockchain-based platform can help build trust among stakeholders by providing a decentralized and transparent system that ensures data integrity and eliminates the need for intermediaries. Increased trust is a key benefit of a blockchain-based platform for aviation suppliers. The platform can provide a secure and transparent platform for data exchange and increase trust between stakeholders in the aviation supply chain. By using an approved blockchain network, only authorized parties can participate in the network and view or modify data, ensuring data security and privacy. Smart contracts can automate processes like payment and quality assurance, reducing the need for manual intervention and streamlining the quality assurance process. The platform's blockchain ledger provides transparency by allowing authorized parties to view and track the data shared by suppliers, reducing the risk of disputes and breaches. By providing real-time access to data and transaction records, a blockchain-based platform can increase stakeholder trust and lead to more efficient and secure supply chain operations.

4 Digital Ecosystem

A blockchain-based aviation supplier process quality data sharing platform is built using the core notion of blockchain and enterprise and supplier product management system integration, as illustrated in Figure 3. The platform is organized into five sections: the supplier manufacturing data collecting layer, the data collection, the storage layer, the blockchain data layer, the blockchain business layer, and the application layer. Based on aviation production management, transform, optimize, and extend to satisfy the engineering demands of aviation supplier data-gathering activities.

The functions at this level are used by air carriers to visualize and analyse suppliers' process quality data via the platform and to support the procurement of corresponding test reports if required. The integration method adopts the B/S architecture and the process is shown in Figure 3.

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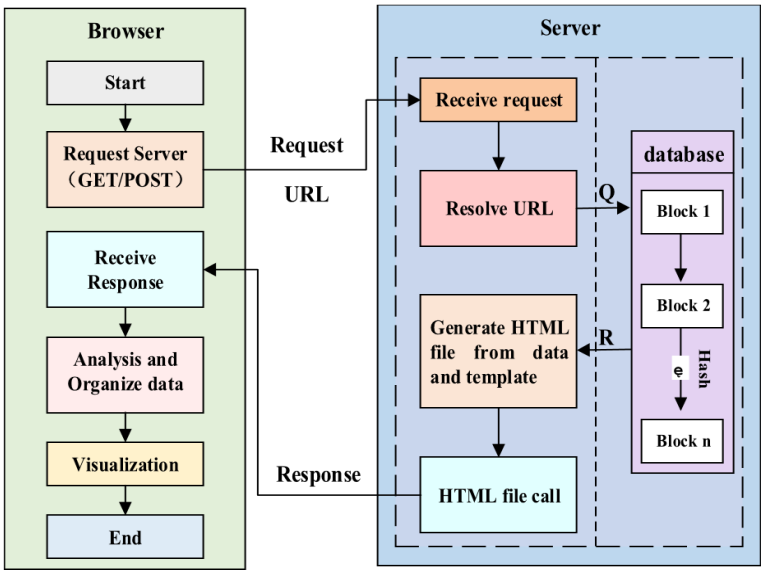

Figure 3: *Brower/Server framework.*

4.1 Modules

Data storage module: This module would be responsible for storing aviation process quality data in a secure and immutable manner on the blockchain.
Smart contract module: This module would enable the automation of contract execution and ensure that all stakeholders comply with the agreed-upon terms.
Identity and access management module: This module would provide secure user authentication and authorization to ensure that only authorized personnel can access the platform.
Audit and compliance module: This module would enable the tracking of all activities on the platform and provide tools to ensure compliance with regulatory requirements.
Analytics module: This module would provide data analytics tools to enable stakeholders to analyze aviation process quality data and identify trends and patterns.
Notification and alert module: This module would enable real-time notifications and alerts to relevant stakeholders in the event of any issues or exceptions in the data.
Supply chain management module: This module would enable end-to-end visibility of the aviation supply chain, including inventory management, logistics, and transportation.
Reporting module: This module would enable stakeholders to generate customizable reports based on aviation process quality data to support decision-making.

4.2 Module Description

The supply chain management system consists of several modules that work together to ensure that the supply chain functions efficiently and effectively. The data storage module is responsible for storing all data related to the supply chain, including supplier, product and

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transaction information. The smart contract module ensures that all parties involved in the supply chain comply with the terms of the contract and automates processes such as payments and deliveries. The identity and access management module is responsible for managing user identities and ensuring that only authorized individuals have access to the system. The audit and compliance module ensures that the supply chain meets all relevant regulations and standards. The analytics module provides insights into supply chain performance, enabling continuous improvement. The notification and alert module sends notifications to users about important events in the supply chain. The supply chain management module is responsible for managing the entire supply chain from procurement to delivery. The reporting module generates reports that provide a detailed overview of supply chain performance. Finally, the payment module manages all payments within the supply chain and ensures that they are processed securely and efficiently.

5 Result and Discussion

Enhanced Data Integrity: By leveraging blockchain technology, the platform ensures data integrity and immutability. Each quality data entry is cryptographically linked to the previous entry, creating a transparent and auditable chain of information. This improves trust and reduces the risk of tampering or unauthorized modifications.

Real-time Data Sharing: The blockchain-based platform facilitates real-time data sharing among aviation suppliers. Quality data, such as manufacturing processes, test results, and compliance information, can be securely shared across the supply chain network. This enables faster decision-making and improves collaboration between suppliers, reducing delays and enhancing overall operational efficiency.

Increased Transparency: The transparency offered by the blockchain platform allows aviation stakeholders to access and verify quality data at any stage of the supply chain. Suppliers, regulators, and customers can gain visibility into the production processes, ensuring compliance with industry standards and regulations. This transparency promotes accountability and helps identify and address any potential quality issues promptly.

Improved Traceability: The immutable nature of blockchain enables traceability of aviation components and materials throughout the supply chain. By recording each transaction and process step on the blockchain, stakeholders can easily trace the origin, manufacturing processes, and quality assurance data of aviation products. This aids in identifying the root causes of quality issues and enables targeted recalls or investigations if necessary.

Efficient Compliance Management: The blockchain platform can streamline compliance management for aviation suppliers. Smart contracts and predefined rules can automate compliance checks and ensure adherence to regulatory requirements. This reduces manual efforts, minimizes errors, and provides a verifiable record of compliance activities, simplifying audits and inspections.

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Trust Building and Risk Mitigation: The implementation of a blockchain-based platform fosters trust among aviation suppliers, customers, and regulators. The decentralized and distributed nature of blockchain eliminates the need for intermediaries and promotes peer-to-peer interactions. This reduces the risk of data manipulation or fraudulent activities, enhancing the overall reliability and integrity of the supply chain ecosystem.

Scalability and Interoperability Challenges: While blockchain technology offers numerous benefits, there are challenges to consider. Scalability remains a concern as blockchain networks need to handle a large volume of data in real-time. Additionally, ensuring interoperability between different stakeholders and legacy systems may require standardization efforts and integration solutions.

Adoption and Industry Collaboration: The successful implementation of a blockchain-based platform depends on the adoption and collaboration of aviation suppliers, regulatory bodies, and other stakeholders. Education and awareness programs, as well as incentives for participation, may be required to encourage widespread adoption and ensure the platform's effectiveness across the aviation industry.

Continuous Improvement: The blockchain-based platform should be subject to continuous improvement and updates to address evolving industry requirements, technological advancements, and changing regulations.

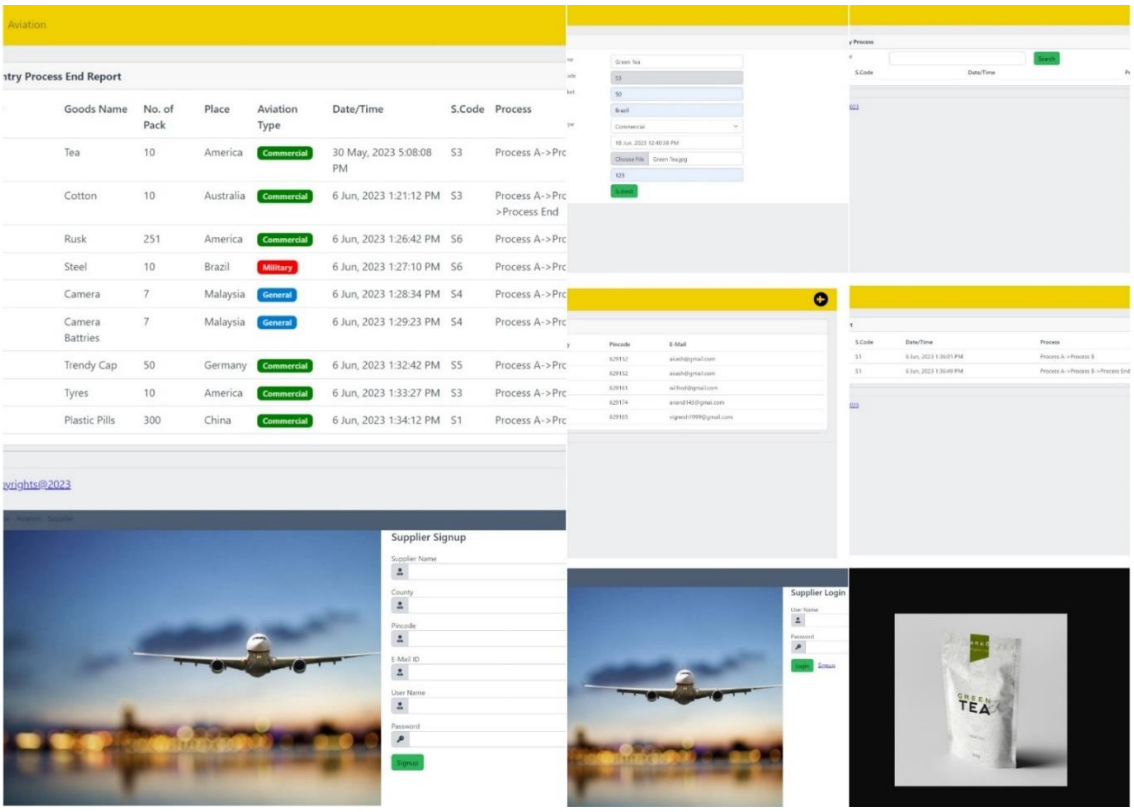

Figure 4: *Result of Application Interface.*

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6 Conclusion

This work focuses on the management and application of aviation supplier product quality data sharing. Committed to using blockchain technology to solve the problems of information opacity and interaction difficulties in the traditional supplier system. Avoid the phenomenon of ‘‘island of information’’ in supplier supervision, and achieve more effective process data information sharing and collaboration between upstream and downstream product supply A quality data-sharing platform that integrates data collection and tracking, storage, up-linking, and visual presentation is proposed. A new data security storage and sharing strategy are proposed, through the data storage method of on-chain and off-chain convergence. A supplier evaluation algorithm based on information sharing is constructed. Build supply-side system process data collection blocks and request-side system block data reception and structured report generation, etc. in conjunction with real-world cases. Further, statistical analysis and visualization display based on supply-side data, etc.

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