

RESEARCH ARTICLE

Design of Integrated Aircraft Fuel Ordering Based on Blockchain Technology at An International Airport

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Abstract

This study focuses on DPPU SHIPS. DPPU SHIPS is a subsidiary of PT Pertamina, which is a subsidiary of Pertamina that plays a role in the distribution and sale of aircraft fuel at Soekarno Hatta International Airport. Since 2020, Pertamina has been committed to digitizing all lines of business for efficiency. Therefore, the Digital Ground Operation (DGO) system was implemented, which combines the main business processes into one digital platform. In its implementation, weaknesses were found due to the absence of an integrated ordering system without intermediaries between airlines and Pertamina, resulting in a line of work that was prone to human error. This research aims to recommend an integrated service model for aircraft fuel distribution using blockchain technology. The booking system model is designed to ensure transparency of booking data and secure and valid receipt between airlines and Pertamina. Blockchain technology was chosen because it can guarantee transparency of orders, traceability, and the capacity to share information about the aircraft fuel distribution process. Thus, the aviation fuel supply chain can be more reliable. Furthermore, this technology can reduce human error in every transaction. The application of blockchain can revolutionize the way the supply chain works. This research consists of three stages: identifying the business processes of aviation fuel sales, identifying the data needed and used in each process along with the actors involved, and then formulating a model or design. The results of this research describe the model design of how the aircraft fuel ordering system is integrated by applying blockchain technology.

Keywords: Aircraft Fuel; Blockchain Technology; Booking Integration; Supply Chain Management

1. Introduction

Aircraft fuel ordering is critical in the aviation industry. It involves efficient fuel procurement and management to keep airline operations running smoothly while reducing operating costs. A careful ordering process helps airlines optimize resource usage and efficient route planning. (IATA, 2015).

Soekarno-Hatta International Airport (CKG) is recognized as the busiest airport in Southeast Asia according to the Airport Council International (ACI) with 39.6 million passenger movements throughout 2022. This achievement outperforms 2600 other airports. As part of daily operations, Pertamina recorded an average fuel sale of 5620KL at CKG, which operates 24 hours every day. DPPU Soekarno-Hatta Into Plane Service (SHIPS) has a key role in the Marketing Operation Region (MOR) III structure, acting as a BBMP sales point in the West Java (JBB) aviation area. SHIPS emphasizes reliability, efficiency, and performance in accordance with global safety and quality standards in providing services in the aviation industry (Airport Service, 2023).

In 2021, Pertamina introduced the Digital Ground Operation (DGO) innovation in aircraft fuel refueling activities. The main objective of this innovation is to facilitate information and fuel sales transactions by utilizing information technology. DGO integrates several processes that were previously carried out manually, reducing the potential for operational errors caused by human error (Pertamina One Solution, 2021). The processes that were

successfully integrated include filling scheduling, fuel volume allocation, refueling, transaction ticket creation, direct transaction data, and billing and reporting.

Based on the results of field observations, indications of problems were found in the aircraft fuel ordering process. These problems come from two main processes, namely problems originating from the fuel ordering process and the validation process of transaction collections on each shift which are still done manually. This can certainly be improved and improvised so that waste in each process in the company can be minimized for continuous improvement.

In its implementation, this system is operated using Ebits Global Refueling Solutions software, a leading provider of aviation refueling services in the world. This system has been used at 400 airports worldwide and is responsible for more than 100 billion liters of fuel annually (Ebits, 2023).

This system has shortcomings because it cannot handle direct bookings between airlines and Pertamina. Bookings are made through a third party (JAS/GAPURA) and forwarded to Pertamina through a personal chat application, causing potential errors such as aircraft registration input and booking delays. Total fuel order and aircraft registration errors can cause airlines to reject payment bills, requiring resolution between the two parties. Booking delays also have an impact on the allocation of CRO (Certified Refueling Operator) tasks. The intensity of these errors reaches around seven to ten cases

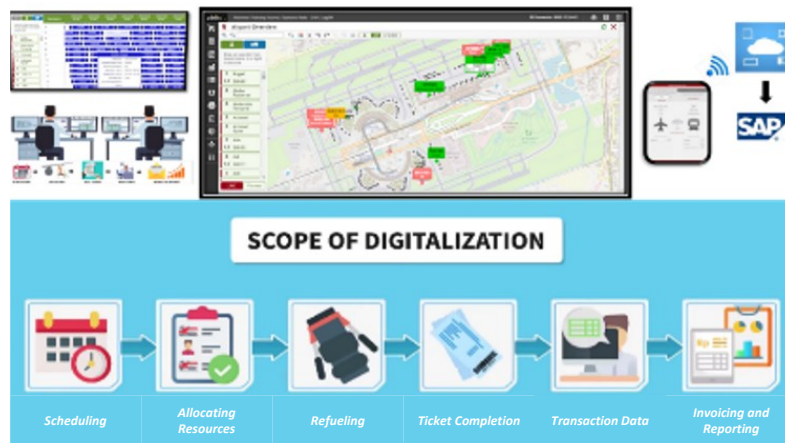


Fig 1. Implementation of Digital Ground Operation (DGO), Pertamina SHIPS. Sourced from Company Internal Data (2024)

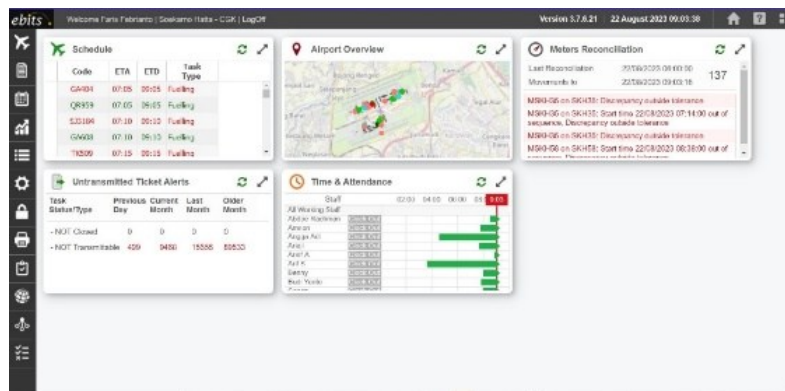


Fig 2. Ebits Global Refueling Solutions Software. Sourced from Company Internal Data (2024)

per week based on company records (Gapura Angkasa, 2023).

To integrate the booking service comprehensively, the implementation of Blockchain technology is a potential solution (Vincent et al., 2020). This technology allows solving problems through the implementation of a decentralized protocol, which automatically integrates booking data, inventory, delivery, and payment of aviation fuel, with accurate recording. All information related to flight requests and schedules is recorded in chronologically connected blocks, reducing the risk of human error, increasing security, and strengthening the trust of all parties involved. Therefore, this study aims to design a transparency model in integrating the aviation fuel booking system using Blockchain technology.

2. Theoretical Basis

The data used in this study are primary and secondary data. To obtain primary data in Pertamina SHIPS, observations and interviews were conducted regarding the Digital Ground Operation (DGO) system and operational activities. While secondary data was obtained by conducting a literature review (Creswell, 2014).

To ensure the validity of the data obtained from the Pertamina SHIPS business process, validation was carried out with authorized workers in the process. The observation data was converted into a Business Process to obtain a deeper picture of the SHIPS business model and identify key problems. The next step is to formulate a blockchain model or design that can be applied to solve company problems related to the research topic.

Blockchain is a distributed and decentralized database that uses independent nodes to store and retrieve data (Zhang et al., 2020; Zhu et al., 2019). Introduced by Satoshi Nakamoto in 2008, the technology was originally used to create more transparent and trustworthy supply chains. The first use of blockchain was related to cryptocurrencies, specifically Bitcoin, which eliminated intermediaries and provided an efficient way to record transactions (Radziwill, 2018). Blockchain has changed the paradigm in various industries, such as healthcare, insurance, government, supply chain management, and the Internet of Things (Rcapodiec, 2023). Today, blockchain has the ability to record transactions and track the movement of assets in a variety of contexts (Tumpal et al., 2022).

3. Result And Discussion

The general business process of Pertamina SHIPS is to distribute aircraft fuel to airlines. This activity is carried out every day for 24 hours. This data is used to trace factual problems from work in the field.

An integrated fuel terminal operational model is a physical fuel handling activity that is seamlessly connected to a digital information system. This process begins at the planning and scheduling stage, where fuel availability, tank allocation, and loading schedules are determined to ensure that terminal operations run efficiently and in line with demand.

Following the planning phase, fuel is received at the terminal and stored in designated tanks. During this inbound and storage stage, key operational controls such as quantity verification, quality inspection, and inventory

recording are carried out. These activities ensure that the physical stock in the tanks accurately reflects operational requirements and safety standards.

Once storage is confirmed, the process continues to the loading stage. Fuel is transferred from storage tanks to multiple tanker trucks in parallel, indicating high-throughput operations designed to minimize waiting time and maximize terminal utilization. At this stage, precise volume measurement, authorization checks, and safety procedures are critical to ensure that each delivery complies with operational and regulatory requirements.

After loading, the fuel is dispatched for outbound distribution. This marks the completion of the physical operational flow within the terminal. However, alongside these physical activities, a continuous digital process operates in parallel. Data generated from field operations, such as volumes, timing, and equipment status, is captured in real time through automation systems and operator inputs.

This operational data is processed by local terminal systems, which serve as an intermediary layer between field operations and enterprise-level platforms. The data is then integrated, validated, and standardized to ensure consistency between physical fuel movements and digital records. Finally, all verified information is transmitted to the enterprise system (SAP), where it supports inventory accounting, financial reporting, billing, compliance, and managerial decision-making.

Overall, the figure conveys an end-to-end digitalized fuel terminal operation in which planning, storage, loading, and distribution activities are fully synchronized with enterprise information systems. This integration enhances operational efficiency, improves data accuracy, and strengthens transparency and governance across the fuel supply chain.

In the business process, each step includes the sequence of ordering aircraft fuel, starting from ordering, filling, reporting, summarizing, to payment. After understanding the ordering flow and transaction collection, the description of the blockchain design model requires an explanation of the business actors and their data needs in carrying out their tasks. To find out the data needs per process (Table 1).

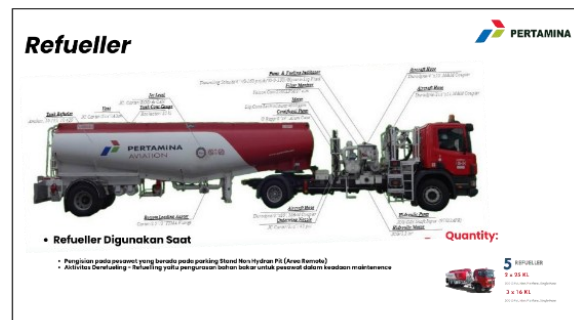
At Soekarno Hatta International Airport, aircraft fuel distribution is carried out through underground pipelines connected to the DPPU SHAFTHI (Soekarno Hatta Fuel Terminal & Hydrant Installation) depot. Most areas in Terminal 1, Terminal 2, and Terminal 3 have been equipped with fuel pipe holes (hydrant pits). Pertamina uses vehicles as connecting dispensers between hydrant pits and aircraft tanks during refueling, as well as filling tanks that carry aviation fuel for aircraft in certain circumstances. Based on the guidelines from the book, there are two types of vehicles used in these distribution activities, including Hydrant Dispenser Trucks and Refueller Trucks (Figure 3).

Table 1. Data Requirement Per Process

Actor	Business Process Flow	Information
CRS (Customer Relation Support)	CRS provides FIDS (Flight Information Display) flight data to Dispatch per shift	FIDS (Flight Information Display) or flight information display
The Airlines	The airline is at the Parking Stand	No. Parking Stand
	Airline Request to JAS/Gapura	Filling Amount (Lpt), Avtur Type, Airline Name, Aircraft Reg. From/To, Day/Date
JAS/Gapura	JAS/Gapura Forwards Request to Pertamina Ships	No. Parking Stand, Number of Fillings (Lt), Avtur Type, Airline Name, Aircraft Reg. From/To, Day/Date
Dispatch	Accepting Requests	No. Parking Stand, Number of Fillings (Lt), Avtur Type, Airline Name, Aircraft Reg. From/To, Day/Date
	CRO and Hydrant Dispenser Assignment	CRO Stand By, Hydrant Dispenser/Refueller
CRO (Certified Refueller Unit)	Accepting Assignments	My Task, Hydrant Dispenser/Refueller Code, Parking Stand No., Filling Amount (Lt), Avtur Type, Airline Name, Aircraft Reg. From/To, Day/Date, Airline fuel order
Adm. Officer	Receive Filling Results	End Transaction EBITS, Pertamina fuel order, Airline fuel order
	Shifting Recap	Report data Shift (SAP)
Adm. SHIPS	Daily Recap	Report data daily (SAP)



Hydrant Dispenser Truck



Refueller Truck

Fig 3. Distribution Vehicle

Two main problems were addressed through interviews with Mr. Aji Suprayoga (Refueling Supervisor) Pertamina SHIPS and Mr. Bagus Setiawan (DGO Officer) Elnusa Group. The interviews involved validation of findings and mentoring sessions with agency mentors. The decision on the focus of the research was taken after academic and practical discussions, indicating that the problems mainly stemmed from the aircraft fuel ordering process. Although Digital Ground Operation (DGO) has not fully supported every process, Pertamina noted the implementation of the EBITS device system as the main service provider since 2021. During the field survey, EBITS admitted that they were still in the system development stage to meet user satisfaction. The results of the interviews in general are as follows:

1. The Digital Ground Operation (DGO) system with EBITS software does not yet support direct airline bookings to Pertamina; current bookings involve third-party intermediaries (JAS/GAPURA).
2. Air fuel bookings from JAS/GAPURA are made via a personal chat application that has the potential for miscommunication in receiving orders.
3. Differences in Aircraft Registration or Flight Numbers on proof of transactions between airlines and Pertamina SHIPS cause disputes in billing and payments.
4. Additional bookings often arrive at Pertamina late and coincide with shift change times. This happens because the booking process is not integrated.

From the results of field observations, interviews, and literature studies, a solution using Consortium Blockchain technology was chosen. The reason for this selection is because this type of blockchain can only be accessed by parties such as airlines and Pertamina. Each party can participate in ordering, transacting, monitoring, and validating transactions in an integrated manner. Authorization is given to all parties involved, ensuring the security, confidentiality, and suitability of transactions. The detailed reasons for selecting this type of blockchain are as follows:

Decentralization. Blockchain allows interaction without intermediaries or known as Peer to peer. all nodes act as the center of all data (Helo and Hao, 2019; Hyperledger, 2023).

Transparency. With the Consortium Blockchain model, transparency is possible between authorized parties. Parties have visibility into transactions and changes that occur in real time. This transparency can prevent potential abuse and errors while still prioritizing the confidentiality of limited information Farouk, A., Alahmadi, A., Ghose, S., & Mashatan, A. (2020).

Privacy and Security. This is because in the aviation fuel industry there is highly confidential data that is not accessible to many people, such as order data and inventory data (Helo and Hao, 2019).

Shared Authority and Control. Consortium Blockchain allows stakeholders to control the network, especially in the sale of aircraft fuel. In cooperation between Pertamina, airlines, and other entities, this concept simplifies and optimizes the process in a mutually beneficial way. Suitable for industries with many stakeholders who have different interests (Hyperledger, 2023).

Cost Reduction and Efficiency. By cutting out the middleman, the use of blockchain in the ordering system can reduce administrative and operational costs. In the Consortium Blockchain, transactions and changes can be done automatically, thus reducing the impact of manual processes that contain human error and have the potential to affect the results (Liu, Yan and Wang, 2022; Vikaliana et al., 2024).

Track Record and Audibility. Blockchain provides irreversible transaction reports for each transaction, which supports audits and quick resolution of problems or irregularities in the ordering to payment system (Nanayakkara et al., 2021). This transparent evidence accelerates effective dispute resolution (Zhu dan Wang, 2019).

The blockchain structure implementation model shows the relationship of actors with network management decisions and transaction validation shared between a group of entities (Helo and Hao, 2019). The blockchain consortium (Figure 4) provides equal access to its members, ensuring democratic decisions. Pertamina, airlines, and Pertamina Patra Niaga management can use this technology to create a platform that integrates information and transactions. This platform ensures transparency, security, and validity of data, facilitating the airline booking process (Pertamina Patra Niaga, 2023).

Each actor in this model is bound by a smart contract, regulating their respective roles (Nanayakkara et al., 2021). Pertamina SHIPS, airlines, and Pertamina Patra Niaga management play a role in the smart contract that regulates the provision of fuel. Airlines can order and use fuel, while Pertamina acts as a regulator and provider. Accessibility is regulated for all parties involved, ensuring mutual protection. Transaction data is stored securely with blockchain technology, which ensures security, integrity, and cannot be changed unilaterally. Transparency and data security are guaranteed through network consensus and encryption.

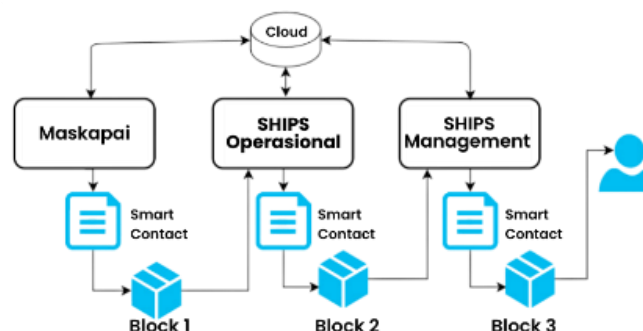


Fig 4. Implementation of Blockchain Consortium Model. Sourced from Company Internal Data (2024)

Based on this study, it can be concluded that the use of Consortium Blockchain can increase the efficiency of transparency and continuity in ordering aircraft fuel (Androulaki et.al, 2018). Integration of secure and efficient ordering services through blockchain technology can be a solution to weaknesses in Digital Ground Operation (DGO) using the current EBITS software that does not support integrated ordering between airlines and Pertamina, increasing the risk of human error. Human errors, such as miscommunication and data errors, can have a negative impact on efficiency, accuracy, customer satisfaction, and overall business performance. The use of this technology is expected to optimize the performance of Pertamina's Digital Ground Operation by combining existing technology with the application of Consortium Blockchain.

Pertamina can minimize risks and ensure successful implementation by working with leading blockchain technology companies or expert consultants. Implementation can be started gradually through small projects or prototypes to understand the impact of the technology before being widely implemented. Although it requires a large investment, Pertamina's management must consider long-term benefits such as operational efficiency, cost reduction, and improved reputation. A thorough feasibility study can be conducted to assess the potential Return on Investment (ROI) of implementing blockchain technology in aircraft fuel ordering services. Collaboration with blockchain experts and industry players can help determine risks and design effective strategies in the implementation plan.

4. Conclusion And Recommendations

Based on the results of this study, it was found that the business process in the aircraft fuel distribution process at DPPU SHIPS has complexity due to the high density of flights at this airport.

The process has been assisted by the implementation of Digital Ground Operation (DGO) since early 2021 using EBITS software which has made the process 75% more efficient than before. This system has succeeded in cutting down several previous manual activities to be more effective with the help of information technology.

Increasing efficiency through the implementation of Digital Ground Operation (DGO) still has weaknesses, especially in the fuel ordering section which has not been integrated. The current system can accommodate everything from the worker assignment process to payment. Of course, there are still gaps in ordering through third parties, which means still using intermediaries and the use of personal chat applications that are vulnerable to human error.

So, a solution is needed to the problem using blockchain technology. This implementation is first carried out by describing the design model of how transparency and traceability in the aircraft fuel ordering system are carried out using blockchain technology. The recommended blockchain type is the Consortium Blockchain type. This type ensures data security with only authorized parties with consensus being able to access with blockchain technology codes or tokens. Transaction conformity is also regulated in a smart contract.

References

Abdirad, M. and Krishnan, K. (2020) 'Industry 4.0 in logistics and supply chain management: A systematic literature review', *Engineering Management Journal*, pp. 1–15. doi:10.1080/10429247.2020.1783935.

- Airport Service, J. (2023) *PT. Jasa Angkasa Semesta – Company profile*. Available at: <https://www.ptjas.co.id/> (Accessed: 27 August 2023).
- Androulaki, E. et al. (2018) 'Hyperledger Fabric: A distributed operating system for permissioned blockchains', *Proceedings of the 13th EuroSys Conference (EuroSys 2018)*. doi:10.1145/3190508.3190538.
- Creswell, J.W. (2014) *Research design: Qualitative, quantitative, and mixed methods approaches*. 4th edn. California: Sage Publications.
- Ebits (2023) *Global aviation refuelling solutions*. Available at: <https://www.ebitssl.com/> (Accessed: 27 August 2023).
- Farouk, A., Alahmadi, A., Ghose, S. and Mashatan, A. (2020) 'Blockchain platform for industrial healthcare: Vision and future opportunities', *Computer Communications*, 154, pp. 223–235. doi:10.1016/j.comcom.2020.02.058.
- Helo, P. and Hao, Y. (2019) 'Blockchains in operations and supply chains: A model and reference implementation', *Computers & Industrial Engineering*, 136, pp. 242–251. doi:10.1016/j.cie.2019.07.023.
- Hyperledger (2023) *What is Hyperledger Fabric?*. Available at: <https://hyperledger-fabric.readthedocs.io/en/latest/whatis.html> (Accessed: 27 August 2023).
- IATA (2015) *IATA guidance material for sustainable aviation fuel management*. 2nd edn. Montreal: International Air Transport Association.
- Indonesia, G. (2023) *Gapura Angkasa – Airport service*. Available at: <https://gapura.id/> (Accessed: 27 August 2023).
- Liu, J., Yan, L. and Wang, D. (2022) 'A hybrid blockchain model for trusted data of supply chain finance', *Wireless Personal Communications*, pp. 919–943. doi:10.1007/s11277-021-08451-x.
- Nanayakkara, S. et al. (2021) 'Blockchain and smart contracts: A solution for payment issues in construction supply chains', *Informatics*, 8(2), p. 36. doi:10.3390/informatics8020036.
- Pertamina One Solution (2021) *Digital ground operation (DGO): Inovasi refueling Pertamina*. Available at: https://onesolution.pertamina.com/Insight/Page/digital_ground_operation_dgo_inovasi_refueling_pertamina (Accessed: 10 December 2021).
- Pertamina Patra Niaga (2023) *Vision and mission*. Available at: <https://pertainapatraniaga.com/visi-misi> (Accessed: 21 August 2023).
- Radziwill, N. (2018) 'Blockchain revolution: How the technology behind Bitcoin is changing money, business, and the world', *Quality Management Journal*, 25(1), pp. 64–65. doi:10.1080/10686967.2018.1404373.
- Rcapodiec (2023) *How peer-to-peer networks can improve supply chain management*. Available at: <https://decbc.com/blog/how-peer-to-peer-network-can-improve-supply-chain-management/> (Accessed: 23 August 2023).
- Tumpal, A., Sianturi, L. and Oklilas, A.F. (2022) 'Penerapan teknologi blockchain pada sistem supply chain management yang terintegrasi dengan sensor RFID (paper review)', *Jurnal Sistem Informasi (JSI)*, 14(1). doi:10.18495/jsi.v14i1.17129.
- Vikaliana, R. et al. (2024) 'Sustainable supply chain in carbon emissions assessment with blockchain

- technology driven: A framework for mining industries', *IOP Conference Series: Earth and Environmental Science*, 1422(1), pp. 1–6. doi:10.1088/1755-1315/1422/1/012029.
- Vincent, N.E., Skjellum, A. and Medury, S. (2020) 'Blockchain architecture: A design that helps CPA firms leverage the technology', *International Journal of Accounting Information Systems*, 38. doi:10.1016/j.accinf.2020.100466.
- Zhang, X. et al. (2020) 'Blockchain-based safety management system for the grain supply chain', *IEEE Access*, 8, pp. 36398–36410. doi:10.1109/ACCESS.2020.2975415.
- Zhu, X. (2019) 'Application of blockchain technology in energy internet market and transaction', *IOP Conference Series: Materials Science and Engineering*, 592(1). doi:10.1088/1757-899X/592/1/012159.
- Zhu, X. and Wang, D. (2019) 'Research on blockchain application for e-commerce, finance and energy', *IOP Conference Series: Earth and Environmental Science*, 252(4). doi:10.1088/1755-1315/252/4/042126.



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