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IMPROVING SUPPLY CHAIN MANAGEMENT TRACEABILITY USING BLOCKCHAIN TECHNOLOGY THROUGH HYPERLEDGER COMPOSER

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Abstract

The management of supply chain (SCM) is of paramount importance in guaranteeing the effective and dependable transportation of commodities. Notwithstanding, impediments such as erroneous data and data tampering present noteworthy hindrance to attaining traceability and transparency in the supply chain management (SCM) process at Angkasa Pura Logistic (APLog). The objective of this investigation is to tackle the aforementioned concerns by examining the capabilities of blockchain technology, with a particular focus on the implementation of Hyperledger Composer. The author employed focus group discussions to obtain current operational data as well as data spanning a period of three years in order to analyze the percentage of factors contributing to issues. Through the utilization of Hyperledger and smart contracts, an author has the ability to provide recommendations and propose novel concepts for the application of this technology in their respective solutions.

Keywords: Blockchain, Supply Chain, Hyperledger Composer, Improvement, Traceability

INTODUCTION

Supply chain management (SCM) is an important component of corporate operations since it includes the coordination and integration of many activities involved in the production, procurement, and distribution of goods and services. (Christopher, 2016). Traditional supply chain systems, on the other hand, frequently confront hurdles in terms of transparency, traceability, and security, which can result in inefficiencies, fraud, counterfeiting, and other operational issues. Traceability is especially important in supply chain management since it allows for the tracking and tracing of products, components, or ingredients along the whole supply chain, assuring visibility and responsibility (Santos et al., 2020). Traditional traceability

solutions, however, frequently rely on centralized databases and paper-based records, which are prone to errors, manipulation, and a lack of transparency (Thoben et al., 2017).

To address these issues, blockchain technology has emerged as a game-changing option with the ability to revolutionise supply chain management. Blockchain is a decentralized and irreversible digital ledger that records transactions across several computers or nodes, assuring transparency, security, and trust in the absence of intermediaries. Blockchain facilitates the construction of a tamper-proof, auditable, and transparent record of transactions by applying cryptographic methods and consensus procedures. Blockchain has various interesting uses in supply chain management, including greater traceability, higher transparency, increased efficiency, and cost reduction (Iansiti and Lakhani, 2017).

Organizations can create an indelible and transparent audit trail by using blockchain-based technologies, allowing stakeholders to check the validity, quality, and movement of commodities in real time. Furthermore, blockchain enables the secure and efficient exchange of information among supply chain partners, removing the need for intermediaries and lowering administrative costs.

In the current economic climate, where businesses operate in more intricate and worldwide markets, supply chain management (SCM) is essential. Organizations may streamline their processes, make the best use of their resources, and improve customer satisfaction with effective supply chain management. To ensure the efficient flow of goods and services from suppliers to end customers, it entails the coordination and integration of numerous operations, including procurement, production, transportation, warehousing, and distribution (Chopra & Meindl, 2016).

Technology improvements in recent years have completely changed supply chain management procedures, giving organizations a competitive edge in the market. The way supply chains function has changed as a result of technologies like artificial intelligence, big data analytics, blockchain, Internet of Things (IoT), and cloud computing, which enable real-time visibility, increased efficiency, and improved decision-making (Monczka et al., 2015).

The southeast Asian nation of Indonesia, which is quickly developing, has adopted technological improvements to update its supply chain management procedures. With a middle class that is expanding and a population that exceeds 270 million, Indonesia presents an enormous market opportunity for both domestic and foreign firms. Indonesian businesses have been implementing cutting-edge technologies to improve their supply chain operations in order to take advantage of this chance and get over the obstacles presented by its geographical complexity and infrastructure restrictions.

The use of IoT devices is one major technological development in Indonesia's supply chain management. These gadgets can gather and send real-time information on client demand, production processes, inventory levels, and transportation circumstances. Indonesian businesses can receive insightful information on their supply chain operations, improve inventory management, reduce waste, and guarantee on-time delivery by utilizing IoT technology.

Utilizing blockchain technology is another important technological development in Indonesia's supply chain management. Blockchain makes it possible to trace items securely and effectively along the whole supply chain due to its decentralized and transparent nature. Blockchain can be used by Indonesian

businesses to speed customs procedures, identify product origins, check supplier credentials, and stop the entry of fake goods onto the market. This technology fosters more stakeholder engagement by improving supply chain transparency, trust, and traceability.

Furthermore, big data analytics has been a game-changer for supply chain management in Indonesia. Companies can find patterns, trends, and insights to help them make decisions by analysing the large volumes of data generated from many sources, such as customer transactions, social media, and sensors. Big data analytics can be used by Indonesian businesses to improve demand forecasting, inventory management, production planning, and customer experiences.

Blockchain technology has revolutionized conventional business procedures and improved transparency, security, and efficiency across a variety of global businesses. A fast developing nation in Southeast Asia, Indonesia has seen a major uptick in the adoption of blockchain technology, which is presenting exciting possibilities for innovation and change in a variety of industries (Tanjung et al., 2019).

Blockchain is a distributed, unchangeable digital ledger that keeps track of transactions and data across numerous computers, or "nodes." It makes it possible to store and transmit data in a safe, transparent, and impenetrable manner, doing away with the need for middlemen and offering a solid foundation for cooperation and confidence (Swan, 2015).

Finance, supply chain management, healthcare, and government services have all seen substantial advancements as a result of the adoption of blockchain technology in Indonesia. The motivating forces behind these efforts have been the government's desire for digital transformation and the recognition that blockchain technology has the potential to address substantial problems in areas like financial inclusion, transparency, and data security (Putra et al., 2018).

Blockchain technology has shown several significant improvements and uses in Indonesia's intricate and varied supply chain environment. Making sure that products are real and preventing the sale of counterfeit goods is one of the main areas where blockchain has had a substantial impact. Stakeholders can create an immutable audit trail by recording and validating each transaction and movement of items on the blockchain. This improves traceability and lowers the risks of products being sold as counterfeit (Wiriaatmadja et al., 2021).

The improvement of inventory management and logistics procedures using blockchain technology is another development in Indonesia's supply chain management. Companies may increase coordination, visibility, and coordination among supply chain partners by utilizing the real-time, transparent nature of blockchains, which leads to improved inventory management, effective order fulfilment, and shortened lead times (Prayoga et al., 2019).

Furthermore, blockchain technology has the ability to resolve issues with Indonesian supply chain funding. Companies can simplify and secure trade finance operations by putting smart contracts into use on the blockchain. This enables quicker payments, lowers transaction costs, and improves liquidity for suppliers and purchasers (Mangombar et al., 2020).

PT Angkasa Pura Logistik is confronted with multiple operational issues. In this paper, the author will address the issues associated with one of its services, namely the cargo service. This service is offered in 17 locations throughout

Indonesia, and two recurring issues are negligence and misrouting. Due to ambiguous instructions from field personnel and the system, these issues frequently result in delivery delays. There is a need for data transparency between APLog and the airlines with which it collaborates to transport cargo. However, data transparency cannot always be accomplished due to the technological limitations of APLog, which continues to rely on its internal application system dubbed "sitek reborn".

The author suggests implementing blockchain technology to resolve the extant issues at APLog, particularly in terms of data transparency, centralized data management, and traceability. The author suggests that APLog employ blockchain technology to assist in resolving these issues, as it is not currently implemented.

As a result, there is an urgent need for a dependable and secure traceability solution that can considerably improve transparency, provide real-time visibility into the movement of items, and assure the authenticity and quality of products at every level of the supply chain.

Table 1 APLog Issue Factor Over the Years

Company	Factor	Percentage over the years		
		2020	2021	2022
PT Angkasa Pura Logistics	Mishandling	8%	5%	2%
	Misroute	7,8%	6%	3,2%

In this study author try to solve the problem and improve their supply chain management using blockchain technology through Hyperledger composer because the utilization of blockchain is one of the considerations that APLog employees have already contemplated to enhance their performance. However, they currently lack sufficient time and resources to develop this aspect. As mentioned by Mr. Terry during the focus discussion group, the company must create or possess a new system that allows real-time and user-friendly data access for both airlines and customers. To reduce their challenge over the past year.

Table 2 Total APLog Cargo from 2020 – 2022

Company	Type	Total Cargo over the years		
		2020	2021	2022
PT Angkasa Pura Logistics	Total (KOLI)	44567	37855	34921
	Weight (Ton)	3890	3154	2790

Based on the table 1.2 , APLog decreasing their total cargo over the years from 2020-2022 because the pandemic, it also reduced the percentage of misroute and mishandling issue. It can be said that the decrease in percentage was caused by a decrease in the number of cargo shipments made by APLog.

Table 1 KPI Comparison Over the Years from 2020 – 2022

Subject	Years		
	2020	2021	2022
KPI	100%	100%	100%
KPI Achieved (Mishandling)	92%	95%	98%
KPI Achieved (Misroute)	93,2%	94%	97,8%
Total (Koli)	44567	37855	34921
Weight (Ton)	3890	3154	2790

To properly solve this complicated business challenge, blockchain technology deployment appears as a disruptive answer. Businesses may construct an unalterable and transparent audit trail by using the decentralized and immutable characteristics of blockchain, allowing stakeholders to easily verify the origin, travel, and handling of items. The addition of Hyperledger Composer, an open-source framework for constructing blockchain applications, enhances supply chain management traceability. Businesses can tailor and deploy blockchain-based solutions using Hyperledger Composer, leveraging its tools, libraries, and APIs to create a proof of concept that demonstrates the feasibility and effectiveness of blockchain technology in revolutionizing traceability systems.

The company use their internal application called "Sitek Reborn" from 2022, and before that the company use application called "Sitek" from 2020. In this study author will use one of the blockchain technology categories, it's called private blockchain or permissioned. In a permissioned blockchain, participants are known and trusted entities granted to the network. So, the combine between Hyperledger and smart contracts will offer transparency, traceability, efficiency, and etc.

RESEARCH METHODS

The purpose of this research is to get an understanding of the potential applications of blockchain technology in supply chain management, particularly with regard to traceability, as well as the degree to which blockchain has been successful when applied to supply chain management. As a foundation for the research, the author is making use of the already-existing operational data of supply chain Angkasa Pura logistic. After the problem statement has been formulated, the research will employ an approach known as business issue exploration to investigate the fundamental reasons for the potential solutions derived from the problem statement. This investigation will make use of a cause-effect diagram.

After that, the investigation will continue with an internal analysis that makes use of value chain analysis, process mapping, risk assessment, and technology assessment. In addition, an external analysis that makes use of SWOT analysis and PESTEL analysis will be carried out. The thesis will conduct a SWOT analysis in order to determine the benefits, drawbacks, opportunities, and dangers connected to the supply chain management that Angkasa Pura logistic has put into place.

The thesis will proceed with blockchain Hyperledger composer based in the results of the value chain analysis, SWOT analysis, and root cause analysis after the business issue has been recognized and evaluated. This will be done after the business issue has been identified and analyzed. The thesis will offer a proof of concept that blockchain technology may improve supply chain management, as well as the traceability to meet the problem statement. Additionally, the thesis will propose a solution. The conclusion of the thesis will consist of a proposal and a concept for the implementation of the recommendation for Angkasa Pura logistic to improve their level of traceability in their supply chain management system.

The thesis utilized a wide variety of data collecting approaches, all of which were essential in acquiring accurate and reliable data for the value chain analysis that was proposed for the purpose of reaching the competitive advantage, cost efficiency, and process optimization. These methodologies were developed with the intention of providing a glimpse into the experience and performance of the operational supply

chain that was already in place, in addition to existing literature and a SWOT analysis.

A structured focus group discussion was carried out with the supply chain manager, the supply chain staff, the logistics or operation manager, and the logistics or operation staff. This strategy ensured that the data obtained was from experienced people and gained insight on the utilization of blockchain in supply chain, with an emphasis on examining the errors data, data manipulation, and traceability data. In addition, this strategy allowed for the gathering of information regarding the utilization of blockchain in supply chain. The FGD would contribute to the process of identifying the most optimal concept for utilizing blockchain in supply chain operations.

In addition, secondary data collecting methods were applied, such as a thorough examination of the available literature on blockchain in supply chain and a SWOT analysis. Both of these methods were utilized. A backdrop and background information were provided by the literature research, and the SWOT analysis made it possible to identify the supply chain's strengths, weaknesses, opportunities, and threats in Indonesia.

In order for the thesis to accomplish its goal, it will use a methodical strategy that consists of several important steps, including the identification of the problem, a study of the relevant literature, data collecting, and data analysis.

Problem identification is the first stage of the research process. This stage entails establishing the research problem, the research question, and the objectives of the thesis. In this thesis, the research problem is the traceability in supply chain that has not been optimal, and the research question aims to identify the factors contributing to this problem and develop effective traceability in supply chain to increase quality control and assurance, transparency and visibility, and risk management and mitigation. In other words, the research problem is that the traceability in supply chain has not been optimal.

The literature review is the second step in the research process. This step entails conducting an in-depth investigation of previous research on blockchain supply chain in Indonesia that has been published. The purpose of the literature review is to lay a foundation of information and understanding on the subject at hand, as well as to identify any gaps in the current body of research and to assist in the formulation of research questions and hypotheses. The review of the relevant literature will focus on a wide variety of sources, such as scholarly journals, books, reports, and other pertinent publications.

The third step in the research process is the gathering of data, which entails identifying appropriate techniques for data collection, constructing data collection devices, and carrying out activities related to data collection. For the purposes of this thesis, the key methods for collecting data consist of focus group talks and Angkasa Pura logistic management. The FGD will give participants an understanding of the challenges that are currently faced in the supply chain's day-to-day operations. The activities of data collecting will be carried out in an organized manner in order to guarantee the consistency and reliability of the data that is obtained.

The last stage of the research process is called data analysis, and it consists of examining the data that was obtained through the use of the suitable methods for data analysis. For the purpose of this thesis, several different approaches to data analysis will be utilized. These approaches include descriptive statistics, value chain

analysis, risk assessment and technology evaluation, and SWOT analysis. The descriptive statistics will be used to summarize and present the acquired data in relevant ways, while the content analysis will be used to categorize and analyze qualitative data utilizing focus group talks. Both of these analyses will be conducted after the data has been collected. The comparative analysis will be used to detect similarities between various sets of data, whereas the SWOT analysis will be used to identify the strengths, weaknesses, opportunities, and threats connected with existing supply chain strategies, and a recommendation for improvement will be created based on the findings of both analyses

RESULT AND DISCUSSION

Network Architecture

Under the proposed network architecture, each organization in the supply chain would be a part of a single channel. Hyperledger Fabric networks are structured such that each channel is linked to a singular ledger, and only peers within the same channel have access to the ledger. Consequently, each organization has access to a copy of the same ledger, which contains all supply chain-related data. The properties of DLT ensure data integrity because the entire database is modeled after a ledger; data on the ledger is immutable and tamper-proof. Each organization has multiple counterparts for data redundancy purposes. Within an organizational system, all colleagues are able to communicate with one another.

To facilitate communication between organizations, a single peer from each organization is designated as the anchor peer, which can exchange information directly via the channel. A non-anchor peer communicates with other organizations through the anchor peer. This failsafe mechanism ensures that communication between organizations is never disrupted, even in the event that the anchor peer becomes unavailable. Each proposed network organization is comprised of two peers. The network proposed uses the raft consensus protocol.

This protocol stipulates that the server cluster has leaders, candidates, and adherents. The cluster members vote for a cluster leader. A cluster can only contain one cluster. When a client sends a command to the server, the leader nodes issue an AppendEntry RPC (Remote Procedure Call) to instruct the followers to update and synchronize their logs to match the new entry in the leader's logs. When the preponderance of servers commits the new change, it is deemed committed. The leader then conducts the new entry and returns the result to the client once this is complete. Hyperledger Fabric's consensus algorithm is exclusively Raft.

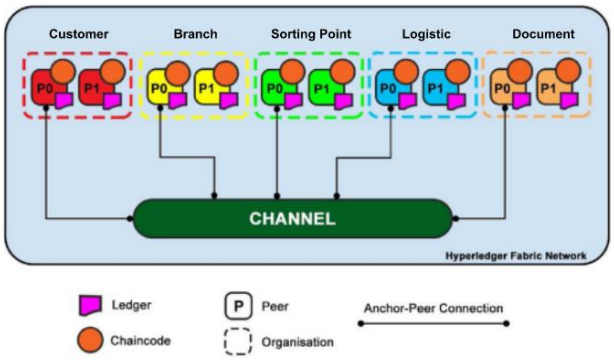

Figure 1 Network Architecture

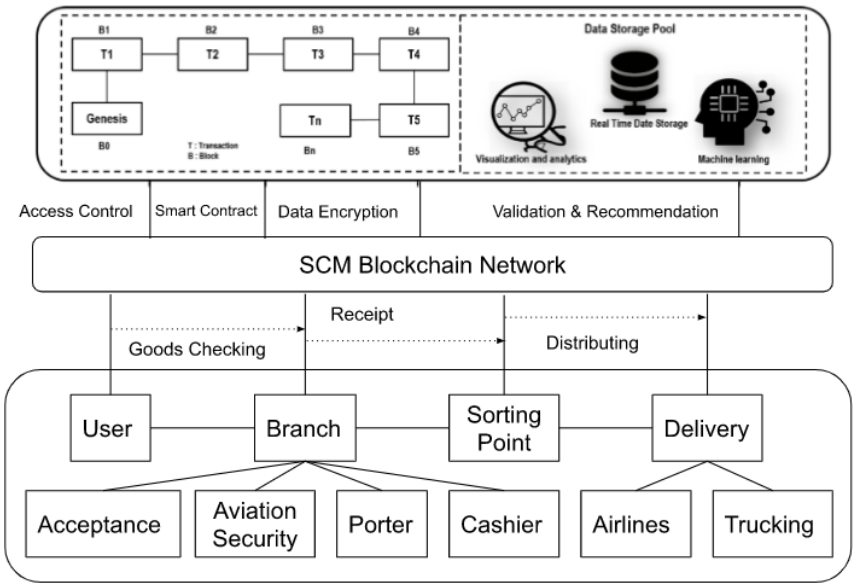

Figure 2 SCM Blockchain Network Proposed

Goods Management

The APLog internal application "sitek reborn" has only internal participant in their existing application, in this proposed author give how the goods management network can be applicable to APLog. In Figure it show all the participants in APLog environment that should be added to their network, including airlines or logistic partner, so they can collaborate and easily exchange data, so there's no more paper based data, exclude for reporting. As author describe, all the participants can open the internal data with they own roles, and than connect to every possible API form airline, branch, or partner, after that it create a block of data in the blockchain network., so every data can safely store and easy to track. Inside the blockchain network, there's a Hyperledger composer that analyze the data dan also testing the data based on cargo recommendation or their regulation.

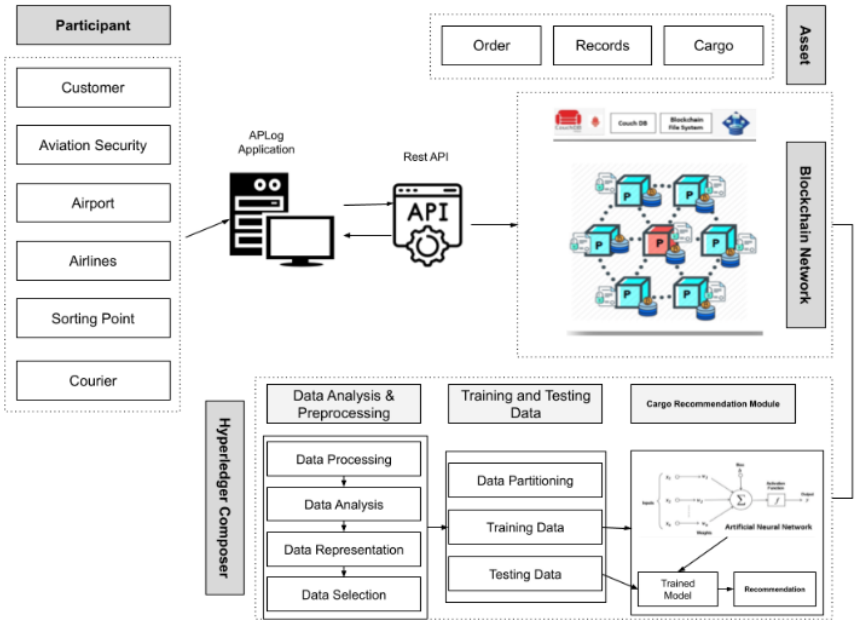

Figure 3 Proposed Goods Management Network

API Layer

The chaincode is called using the Fabric SDK. At this tier, all transaction requests to store or query are run right away. But it is a good idea to hide this process behind a layer of communication in between. In the suggested work, a REST API layer is used to separate the different parts. This layer shows the user basic endpoints, such as GET and POST, that can be used to call chaincode.

This makes it easier for end users to use the blockchain network while hiding the complexity of the chaincode business logic.To make a REST API layer that works with the blockchain, all of the users' names must be stored in a wallet along with their certificates and keys. These certificates and keys are made when the network is created using the cryptogen tool. The Hyperledger Fabric SDK is used to check the keys and sign up people for the wallet. This makes sure that only people who have the right passwords can connect to the network and run chaincode. If the new certificates are given to a user in the future, that user won't be able to use the network until the new certificates are used to record their name in the wallet.

Each REST route is put into action in four steps. First, the SDK connects to the Fabric gateway by using a name in the wallet that is important. Second, the SDK connects to the network path where the tasks need to be done. Then, the contract containing the chaincode that needs to be run is called. If any of these steps fail because the network is down, the passwords are wrong, or for some other reason, the API won't send the transaction to the network. If all three steps are done correctly, the input arguments are used to prepare a transaction that is then sent to the Fabric layer. When the chaincode is called and gives the answer to the REST layer, the same response is sent back to the user.

Figure illustrates the communication signals exchanged during Create Batch between the cultivator and the Hyperledger Fabric layer via the REST API layer. The farmer only needs to ask the Hyperledger Fabric's REST API Layer for Create Batch and send the necessary data. The REST API layer is in charge of everything else that needs to be done to run CreateBatch. The REST API Layer and the Hyperledger Fabric Layer talk to each other in the following ways:

1. The Hyperledger Fabric layer is asked to join by the REST API layer.
2. If the link works, Hyperledger sends back a confirmation. The channel is asked for by the REST API layer.
3. When Hyperledger is asked, send the channel name that goes with it.

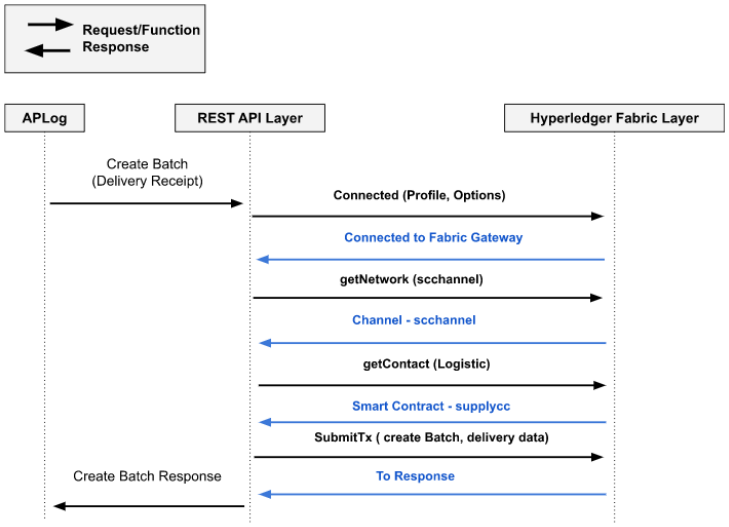

Figure 4 Hyperledger Sequence Diagram

Membership and Access Control

With gratitude to Hyperledger Fabric, the blockchain network is now private, allowing only designated stakeholders to engage in the system. Therefore, the security of the system is maintained. This is due to the unique access mechanism and channel configurations. Hence, a blend of the following factors facilitates the attainment of privacy and security in Hyperledger Fabric:

a. MSP stands for "Membership Service Provider." Provides and controls the members' names and authentication. In particular, an MSP hides the encryption methods and protocols that are used to authenticate users, issue certificates, and check certificates. An MSP can also come up with its own idea of identity and the rules for how that identity is verified (by making and checking signatures) and controlled (by validating identity). Every node must have a local Access Control
b. List (ACL) that is set by the MSP: This is an extra layer of permission for user identities, and it also limits the rights for different network activities. For example, it might let one user do one thing (like "invoke chaincode") but not let another user do something else (like "deploy new chaincode").

Figure shows how the MSP is set up between companies in the setting of this paper's coffee supply chain. Even though all the groups should be in the real building,

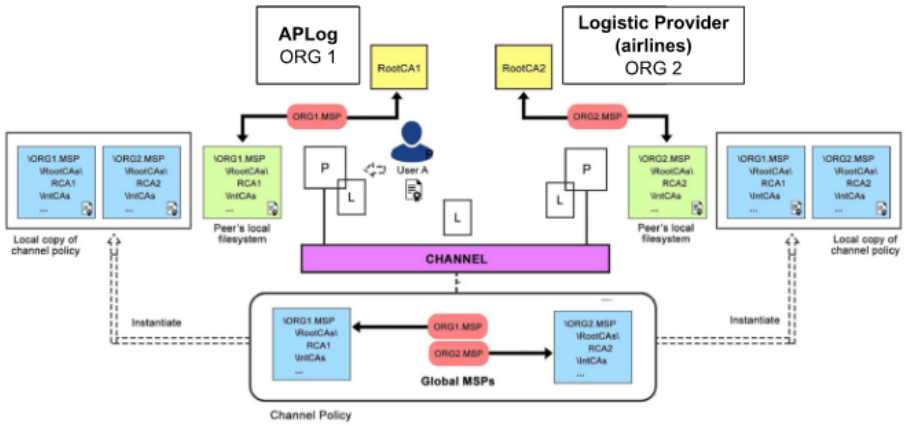

Figure 5 Membership and Access Control Architecture

Public Key Infrastructure (PKI)

Fabric SDK is utilized to invoke chaincode. All storage and query transaction proposals are implemented directly at this stratum. However, it is advisable to hide this process behind an intermediate communication layer. In the proposed work, abstraction is accomplished via a REST API layer. This layer provides the user with fundamental endpoints, such as GET and POST, for chaincode invocations. This facilitates the use of the blockchain network for end-users by concealing and abstracting the chaincode business logic's complexities.

To successfully establish a REST API layer that interacts with the blockchain, the identities of all users must be stored in a wallet with the corresponding certificates and keys, which are generated using the cryptogen utility at the time of network creation. The Hyperledger Fabric SDK is utilized to validate certificates and register wallet users. This ensures that only authorized users are able to access the network and execute chaincode. If in the future new certificates are assigned to a specific user, that user will be unable to access the network until their identity has been registered in the wallet using the new certificates.

Each REST endpoint execution consists of four stages. Initially, the SDK establishes a connection with the Fabric gateway by using a pertinent financial identity. The SDK then gains access to the network channel on which the operations must be executed. The subsequent step involves invoking the contract containing the chaincode to be executed. The API will not submit a transaction to the network if any of these stages fail due to a network outage, invalid credentials, or any other reason. If all three stages are executed satisfactorily, an input-argument-based transaction is prepared and submitted to the Fabric layer. When the chaincode is invoked and the response is sent to the REST layer, the user receives the same response.

Notion of Privacy

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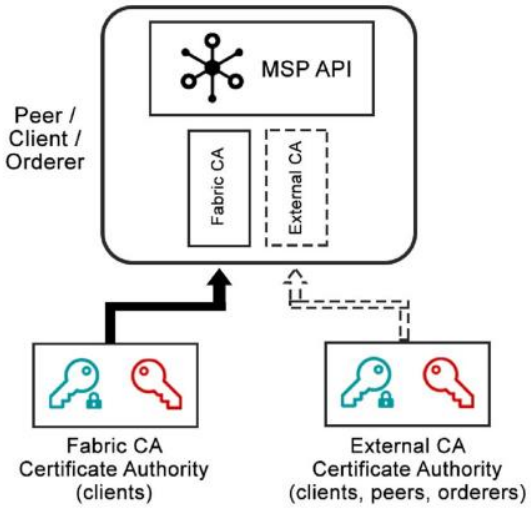

Figure 6 Fabric Key Authorization

Identify Mixer

Table 7 shows in a few words how the identity mixer works at a high level. The real thing would just be a bigger form of the design shown in Fig. 14. The blockchain user needs to get a certificate from a CA. An MSP works with the CA to give out certificates, and there is also an ECert. When a customer calls for a smart contract transaction, the ECert has already signed the transaction. Instead, the identity blender lets the user make certificates that only work for a single transaction. These certificates can be used for each transaction. The same can be done with encryption keys. One-time-use encryption keys can be made. So, the person can show that everything

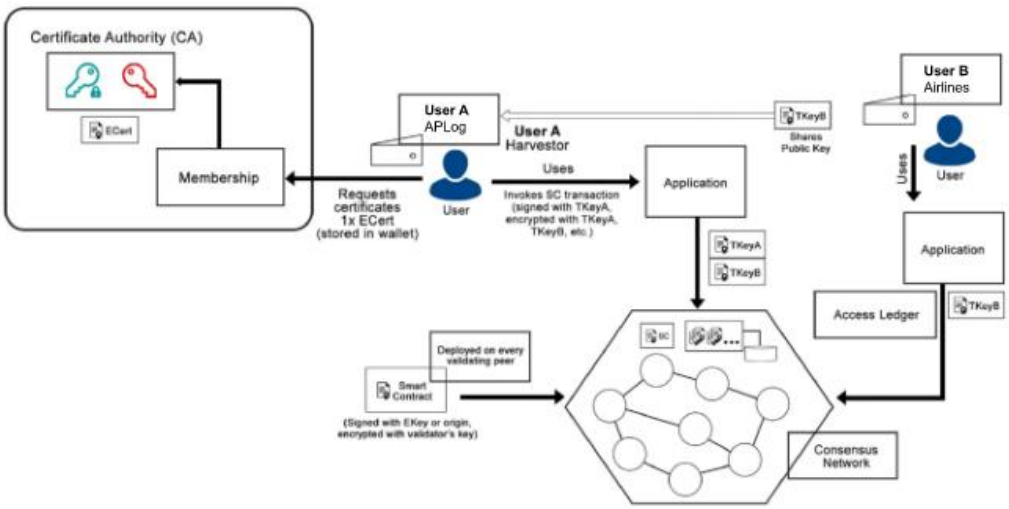

Figure 6 APLog and Airline Identify Mixer

These keys were derived from the ECert, which provided the unique capability where the user can generate multiple keys from the original ECert, and the user can also prove that they were generated by the same ECert. This means that all

transactions were performed by a particular user, which can be proved to an auditor in the network if necessary, but no other entity in the system would know that all the transactions were performed by the particular user.

Proposed New Flow with Hyperledger

This proposed system provides an overview of the transit cargo section, where numerous misrouting and mishandlings are caused by non-airline-related documents. Previously, APLog relied on conventional methods and their internal system for updates. With Hyperledger, it provides APLog and airlines with rapid data retrieval and data accessibility.

Transit Cargo and Post

In table, it shown how transit flow chart can be more efficient with the use of Hyperledger, many changes have occurred, with reduced posts that must be passed, to reduce misroute and mishandling during cargo transit.

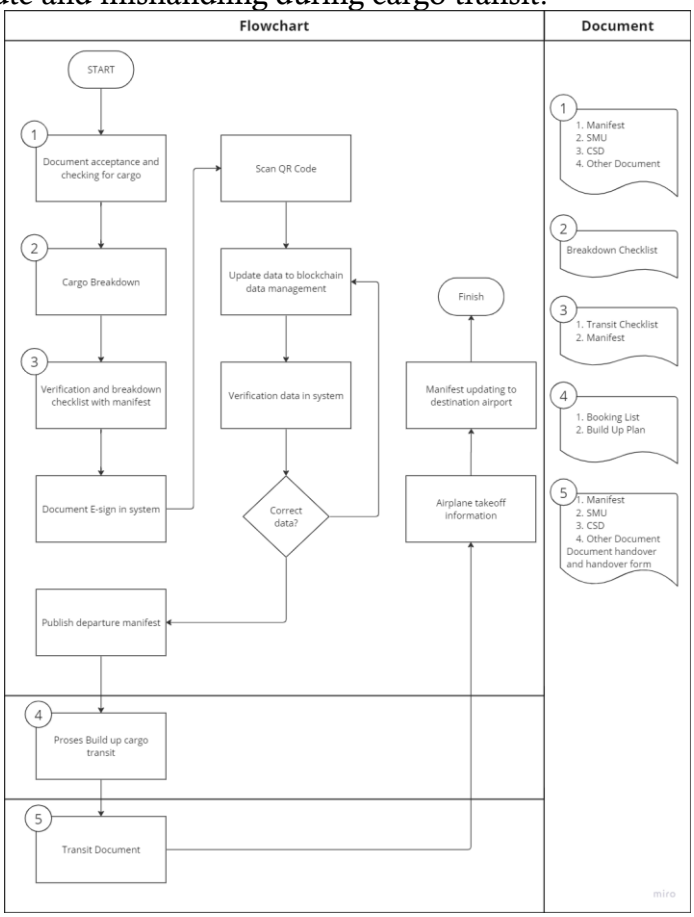

Figure 7 Transit Cargo and Post Flowchart

Comparison Between the Proposed Solution and Existing Methods**.** In the APLog cargo service, there are a few flows that are based on the findings of existing procedures. These flows include receiving products, picking up goods, sorting goods, managing incoming and outgoing items, shipping, invoicing, and tracking.

A comparison can be made between the proposed solution, Hyperledger Fabric DLT, and the existing systems, traditional system (non-blockchain) and public blockchain, based on the features and arguments presented thus far. In terms of its practical advantages, Hyperledger Fabric clearly outweighs the other two contemporary solutions, particularly in an enterprise scenario involving supply chain. The traditional system, which lacks a blockchain perspective, and the

subsequent public blockchain are the two contemporary methods that have been used until recently. In most respects, the public blockchain can be viewed as a negative excess of a solution, as it successfully solves the problems of a centralized system, transparency, immutability, authenticity, reliability, etc., but creates new problems such as inflexible privacy and confidentiality, inability to share data privately, lack of modularity, etc. Consequently, a permissioned blockchain, Hyperledger Fabric, enables us to mitigate these new issues by providing a set of features that meet the middle ground between public and private blockchains, as well as several customization options, thereby striking a balance between the two. These features include identity verification of participants prior to their joining a permissioned channel and granting these participants the permissions that allow them to perform only a specific set of duties and access a specific set of data on the network.

In the context of this paper's use-case scenario of a coffee supply chain network, the integration of a blockchain system involves multiple phases and entities. This includes handling all communications with.

	Traditional system (non-blockchain)	Public blockchain	Hyperledger Fabric
Blockchain log	×	✓	✓
Pluggable state database	✓	×	✓
Distributed ledger	×	✓	✓
Flexible transparency	×	×	✓
Immutability	×	✓	✓
Private data sharing	×	×	✓
Confidentiality	×	×	✓
Modularity	×	×	✓
Collision unlikelihood	×	×	✓
Pluggable consensus mechanism	×	×	✓

Figure 8 Comparison Table between Traditional and Hyperledger

Performance Analysis

The proposed system is simulated on a computer with an Intel Core i7 1.820 GHz, 4 processor, 8 GB of memory, and Ubuntu 20.04 as the operating system. Hyperledger Fabric 1.4.7, Docker 19.03.8, Couch-DB v1.4, and the Go programming language are used for development.

For performance analysis, the Caliper instrument is utilized. Caliper is a blockchain benchmarking framework created by Hyperledger. It measures the efficacy of blockchain network implementations and collects the corresponding metrics. Reports from Caliper include performance metrics such as TPS, latency, CPU, and disk utilization, among others. Caliper is used to assess the viability of individual blockchains for a particular use case by analyzing their performance. The intention is not to evaluate various blockchain implementations, as the setups and functionalities may vary to such a degree that the caliper reports cannot provide a sufficient comparison. A Caliper benchmark was used to generate a report for the purposes of this implementation.

Measurements with Varying Number of Transactions.

To understand the impact of the total number of transactions on blockchain, the total number of transactions varied from 50, 100, 150, 200, to 250, and these

transactions were sent to the proposed network at a rate of 25 TPS, to measure the misroute and mishandling.

No.	Number of transactions	Send Rate (TPS)	Max Latency (s)	Min Latency (s)	Avg Latency (s)	Throughput (TPS)
1	50	106.4	1.26	0.11	1.04	34.7
2	100	160.8	2.38	0.28	1.97	35.0
3	150	154.6	4.82	2.75	4.39	27.5
4	200	159.4	5.70	1.93	5.28	30.7
5	250	196.7	6.29	0.07	5.60	34.1

Figure 9 Performance of Blockchain Transaction

Figure 9 shows the performance for transaction through the same metrics. Table x is described through the chart in figure x below. From both charts, it is observed that as the number of transactions increased, the average latency also increased.

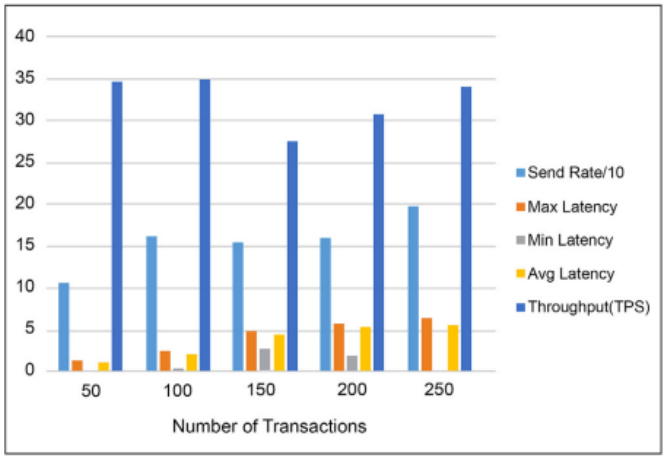

Figure 10 Transaction Latency

CONCLUSION

According to the fishbone and interrelationship diagrams, the writer can conclude, based on the research, that the problem with Angkasa Pura Logistics is technology that has not kept up with the times; in other words, it has fallen behind. By incorporating hyperledger fabric into their operational document flow, APLog will be able to reduce mismanagement and misrouting with the new system and document management facilitated by hyperledger fabric. In addition, APLog and its partner airlines can expose cargo data on a private network, using membership and access control to determine who will use the data and for what purpose.

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