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4.2 INTELLIGENT CARGO SECURITY SYSTEM

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4.2.1 IADA INTELLIGENT CARGO SYSTEM

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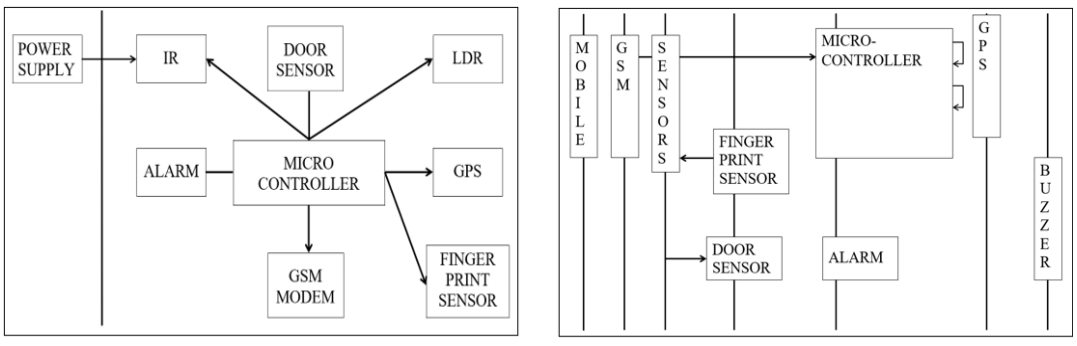

a) System Architecture b) Sequence Diagram

Figure 5. System architecture and sequence diagram of the proposed system (Dinesh, 2017)

4.2.2 BLOCKCHAIN TECHNOLOGY

Blockchain technology, which was initially used in a crypto-currency, Bitcoin, as a decentralized bookkeeping system to prevent double-spending, was leveraged by Xu et al. (2018) to enhance the current cargo security system (Nakamoto, 2009; Xu et al., 2018). By and large, blockchain has three important features; 1) Public Accessibility: All data stored with blockchain is available to the public. 2) Immutability: It is extremely difficult, if not impossible, to modify, alter, or delete information that has been fed to the blockchain when the security assumption is fulfilled. 3) Resilience: Each participant of the system possesses a complete copy of the blockchain and no single point of failure can impinge the availability of the stored data. Simply put, blockchain can provide a unified, immutable, and resilient information management portal for all maritime transportation participants and ultimately improve the transparency of the cargo flow, accelerate the inspection process and minimize fraud (Xu et al., 2018). The proposed scheme developed by Xu et al. (2018) to embed blockchain technology into the maritime cargo management system will be discussed in this subsection.

i. Participants Screening and Digital Identity Generation

The first step to secure the maritime supply chains, particularly for border-crossing cargo flows, is to screen involved participants and generate digital identities for them. An exclusive identity management system is developed to fulfil this objective, which acts as an extended public key infrastructure. A party that is involved in maritime transportation will possess a public/private key pair as its digital identity. If the party is a company, every employee involved in the cargo handling operations should possess his/her own digital identity. Fortunately, several hardware technologies have been developed to improve maritime supply chain transparency, such as smart containers, RFID tags, tracking devices, etc (Carn, 2011; Shi et al., 2011; Talukder, 2007).

ii. Checking Digital Identity

Subsequently, to make certain that a participant can only use his/her own digital identity, the system will execute the following tasks.

- Ensure both public and private keys are matched.
- Ensure the public key is valid and contains all the necessary information.
- Ensure the user is the real owner of the keys.
- Record all the activities and save them in the blockchain.

As discussed above, it is evident that blockchain technologies can be used by shipping companies to further solidify the measures committed by the governments and concomitantly streamline the cargo inspection processes. However, there are several challenges that maritime communities have to solve to fully exploit the expected benefits of blockchain technologies (Munim et al., 2021). These challenges are summarised in Table 2. Fortunately, a growing body of studies have been dedicated to resolving these challenges and all the major resolutions to these challenges are reviewed in detail by Munim et al. (2021).

Table 2. Challenges in the implementation of blockchain technologies

Challenges	Source
Lack of authority for standardization	Jovic et al. (2020), Segers et al. (2019)
Interoperability and lack of scale	Allen et al. (2019), Irannezhad (2020), Pranav et al. (2020), Shi & Wang (2018), Todd (2019)
Antitrust law and commercial privacy	Jovic et al. (2019), Todd (2019)
Environmental concern	Jovic et al. (2020)
Dispute resolution	Perkusic et al. (2019), Todd (2019)
Data tampering and hacking	Dutta et al. (2020), Kermani et al. (2020), Pranav et al. (2020), Nyugen et al. (2020), Greiman (2019)

5.0 CONCLUSION

Covid-19 has left shipping companies with no other options but to leverage recent technologies to endure the impacts subjected by the pandemic. In this paper, several advancements contributed by the scientific community over the last two decades have been discussed to assist shipping companies to minimize their cargo loss and simultaneously maximise their profits. Cargo loss can occur due to several factors such as inefficient cargo loading and unloading operations, substandard security systems, and poor goods monitoring systems, just to name but a few.

For LNG vessels, STS operations can be improved by implementing the guidelines outlined by Wood and Kulitsa (2017). For LPG vessels carrying ethylene, shipping companies can exploit the guidelines provided by Wieczorek (2020) to optimize the gassing-up operations. Moreover, crude oil tankers can reduce cargo loss by adopting closed-loop control systems to minimize VOC emissions. Furthermore, shipping companies can utilize IADA systems and blockchain technologies, as respectively proposed by Dinesh et al. (2017) and Xu et al. (2018) to improve their cargo security systems. Also, for container ships carrying perishable goods, a monitoring system proposed by Emenike et al. (2016) can be adopted to reduce cargo damage. Finally, shipping companies can exploit their logistics data, as recommended by Wu et al. (2017), to determine the factors that cause cargo loss and subsequently develop specific strategies and allocate necessary resources to prevent cargo loss.

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