

# An Efficient, Traceable, and Transparent Maritime Logistic System Based on Blockchain

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**Abstract**—In today’s era of global trade, efficient marine logistics are pivotal for international trading. However, conventional logistic frameworks have significant difficulties in traceability, transparency, and conflict resolution, which have become more prominent due to increased globalization. This study introduces an innovative method that uses blockchain technology to enhance marine logistics by incorporating smart contract. In the proposed framework, exporters, logistics providers, and customs authorities use the blockchain to transport goods consistently through an automatic series of steps. The performance of the proposed framework highlights its advantages, specifically the automation of transportation activities, enhanced security through decentralization, and improved traceability. The empirical findings illustrate that efficient logistics operations can lead to fewer disputes and increased efficiency, potentially transforming international trade procedures.

**Index Terms**—Maritime logistics, blockchain, smart contract.

## I. INTRODUCTION

Efficient maritime logistics are crucial for international trade, transporting 90% of global goods and 70% of world commerce [1]. The US shipping industry faces significant losses due to counterfeit cargo, with an annual \$50 billion loss and numerous theft incidents reported [1]. Centralized systems have inefficiencies like cumbersome documentation, lack of real-time visibility, and distrust among stakeholders, increasing costs and slowing supply chains [2]. Blockchain technology offers a solution by enhancing transparency, security, and efficiency [3]. A decentralized system improves container management, reduces delays and costs, and builds trust among stakeholders [4]. Blockchain’s resilience against single points of failure ensures robust operations. Every transaction is recorded in an immutable ledger, fostering trust and collaboration [5]. Smart contract automate processes, reducing costs and paperwork, creating a transparent, traceable, and secure logistics system. Existing logistics procedures face challenges like participant distrust, excessive paperwork, and data tampering, which are worsened in complex settings with multiple transit modes. Traditional methods relying on paper-based records are slow, error-prone, and lack security against fraud and theft [6]. An overhaul using blockchain technology enhances shipping operations’ transparency, reliability, and verifiability. This study proposes a blockchain-based system to modernize maritime logistics. Current applications like TradeLens and CargoX address parts of the process but do not cover the entire logistics chain [7]. The proposed framework uses blockchain and smart contract to ensure traceability,

transparency, reliability, and verifiability, creating a secure, efficient, and transparent logistics system.

## II. PROPOSED METHODOLOGY

This blockchain-based maritime logistics system tracks cargo from registration to delivery, ensuring transparency and security. As illustrated in Fig. 1, the framework begins with stakeholders like sellers and buyers registering, listing products, and initiating purchases. Smart contract automate transactions, storing all data on a tamper-proof ledger. Digital payments and secure data storage (using IPFS) streamline operations. Each phase, from product listing to final delivery, is managed efficiently, enhancing the reliability and security of maritime logistics.

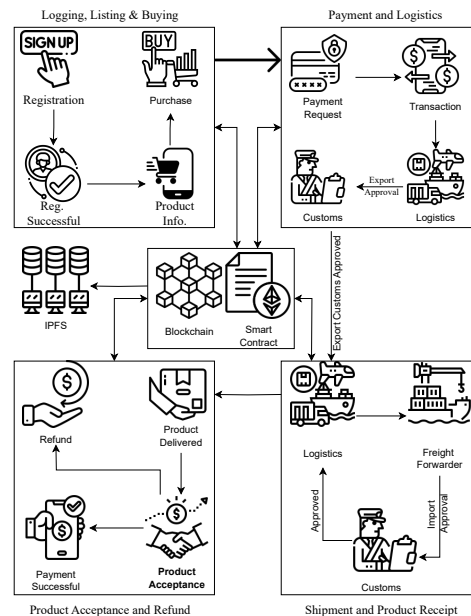


Fig. 1: Blockchain-based maritime logistic system

Stakeholders register and verify on the blockchain, gaining access to a list of items for orders. Product details are hashed for secure tracking, with metadata stored on IPFS. Upon buyer confirmation, the smart contract triggers payments and coordinates export logistics, documenting all steps on the blockchain for real-time progress tracking. Delivery acknowledgment triggers payment processing and refund management if needed, with automatic payment completion if no feedback

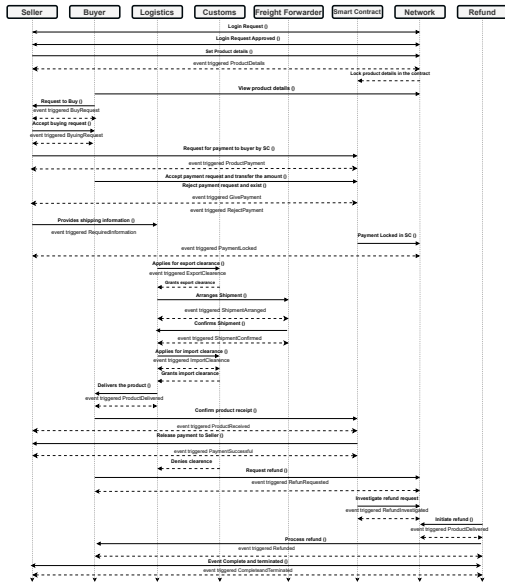


Fig. 2: Sequence diagram of smart contract execution

is given within 24 hours. The refund process, activated for clearance rejection or dissatisfaction, uses smart contract rules for fair dispute resolution. The system’s multi-tiered architecture integrates smart contract, external Oracles, and IPFS for efficient, transparent, and immutable maritime logistics, potentially revolutionizing traditional processes.

### III. IMPLEMENTATION AND VALIDATION

This section details the implementation of a smart contract for secure maritime logistics, thoroughly tested on the blockchain using Remix IDE. As illustrated in Fig 2, the process starts with the seller setting product details, triggering the *ProductDetails* event Fig 3. Buyers can view these details and create purchase requests, initiating the *BuyRequest* event. Upon seller acceptance (*ByuingRequest* event), the smart contract requests payment, and the buyer can accept or reject this request Fig 4. Accepted payments are locked by the *PaymentLocked* event. The logistics provider arranges shipment, obtains export clearance, and confirms shipment status, documented by *ShipmentArranged* and *ShipmentConfirmed* events. Once delivered and the buyer confirms receipt (*ProductReceived* event), the smart contract releases payment to the seller (*PaymentSuccessful* event). Refunds, if needed, follow a process triggering *RefundRequested* and *Refunded* events. The final step concludes the process with the *CompleteandTerminated* event. Each function and event ensures transparency, immutability, and reliability in the maritime logistics process.

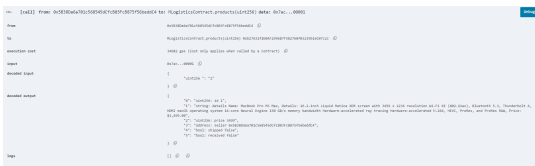


Fig. 3: Buyer can view the listed product



Fig. 4: Seller accepts the purchase request

## IV. CONCLUSION AND FUTURE WORK

This paper proposes an innovative framework to enhance global maritime logistics efficiency and transparency through blockchain and smart contract implementation. The decentralized structure addresses issues of traceability, trustworthiness, and immutability. The study aims to transform global maritime trade by integrating decentralized applications (DApps) for improved operational efficiency and advanced encryption for securing sensitive data. Non-fungible tokens (NFTs) will be used for unique tracking and tamper-proof records, providing a secure, efficient system for the maritime sector.

### ACKNOWLEDGMENT

This work was partly supported by the Innovative Human Resource Development for Local Intellectualization program through the Institute of IITP grant funded by the Korean government (MSIT) (IITP-2024-2020-0-01612, 25%) and by Priority Research Centers Program through the NRF funded by the MEST (2018R1A6A1A03024003, 25%) and This was supported by project for Industry-University-Research Institute platform cooperation R&D funded Korea Ministry of SMEs and Startups in 2022.(S3311338, 25%) and This was supported by (NRF-2022R111A3071844, 25%).

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