ISSN 2347 - 3983
Volume 8. No. 2, February 2020
International Journal of Emerging Trends in Engineering Research
Available Online at http://www.warse.org/IJETER/static/pdf/file/ijeter01822020.pdf
https://doi.org/10.30534/ijeter/2020/01822020

Applying Smart Contract in E-logistics for Monitoring and Control

Adrian[1], Fandi Anugerah Husain[2], Willyanto[3], Gunawan Wang[4], Sfenrianto[5]
Information System Management Department, BINUS Graduate Program-Master of Information System, Bina Nusantara University, Jakarta, Indonesia, 11480. e-mail: [1]adrian003@binus.ac.id, [2]fandi.anugerah@binus.ac.id, [3]willyanto@binus.ac.id, [4]gwang@binus.edu, [5]sfenrianto@binus.edu

ABSTRACT

As the development of the global economy grows fast, there is also a growing need of logistics, how to get the proper products to the right customers, accurately in time to the right place, the need for e-logistics has been increasing as companies need to both minimize the uncertainty of the status of packages, as well as errors that might appear when the shipment is delivered. In order to improve the quality of logistics, business companies need to adopt e-logistics services to provide a more accurate, faster, and precise delivery. In this paper, a new model of smart contract is proposed, with the implementation to the e-logistics in the healthcare sector, by using the technology of IoT together with smart contract to enable users to get the information of their goods in real-time accurately.

Key words : Blockchain, e-logistics, healthcare, logistics, smart contract

1. INTRODUCTION

The development of technology in the world at this time has been developing in various fields. One of them is in the industrial field. businesses can utilize a variety of the latest technologies to help day-to-day business processes to provide a competitive advantage. The development of this technology enables information to be disseminated quickly and more accurately. It uses a courier service to send goods from the sender to the destination [1].
Logistics has a variety of important components, such as inventory management, warehousing, payment, and others [2]. Delivery of products must be done with a fast time so that consumers can feel satisfied and will make transactions again. At present, logistics is a very important factor related to the transportation of products from and to certain parties. In this sector, there are risks related to delays of order processing, especially at a larger scale. In addition, large companies require many workers to be able to meet all the needs or transactions made by the store. This can cause delays in processing orders and increase the likelihood of order loss [3]. To reduce uncertainty in managing production, monitoring raw material stock, shipping delays and others, e-logistics strategies need to be used [4].

2. LITERATURE REVIEW

E-logistics is the application of IoT technology to traditional logistics, to change the common logistics business process to be more centered to the customers, sharing information and data through all stakeholders, including supply chain partners. Synchronization of various task is made possible with the help of e-logistics, as well as assisting in decision making. E-logistics aims to distribute the right goods at the right quantity, place, and customer.

E-logistics uses technology of internet along with other technologies, to provide detailed information for the participants of supply chain and provide a considerable level of clarity across the whole supply chain. The constantly growing e-logistics companies take advantage of the opportunity to handle logistical issues, including order fulfillment, order visibility, inventory management, prices, asset utilization, and supplier selection. Startup companies and various logistic service providers carry products and services that aims to solve the enormous logistical inefficiencies and burden the current supply chain [6] [7].

2.1. Usage of e-logistics in the healthcare industry

In the healthcare department, the same problem persists, where transports may be delayed, errors on goods delivery, and other errors. This may lead to losing orders, and thus the healthcare industry needs e-logistics to solve this problem. According to Roberto Casado-Vara *et al*, the security of the data of companies in the logistics sector, specifically in the blockchain area is paramount to solving the problem [7].

The following model is proposed by Roberto Casado-Vara *et al.*, which visualizes the process of blockchain that stores all data related to transactions. In this model, smart contract acts as the manager for commercial transactions between different parties. Each business operator/actor holds and operates smart devices that monitors the situation and status of each actor. There are three actors shown in the model, the seller (receiver), the producer (sender), as well as shipping companies. In the following case, the sellers possess sensors that monitors the details of the inventory of stored drugs, including the available stock and the amount of drugs that are being produced. The shipping companies will also have

sensors on their transport trucks, to track and check the status of the shipment, including the position of the cargo. Sensors will be monitoring the status of each actors. Each action the actors take will involve smart contracts, which will automate all the transactions created between all actors [7].

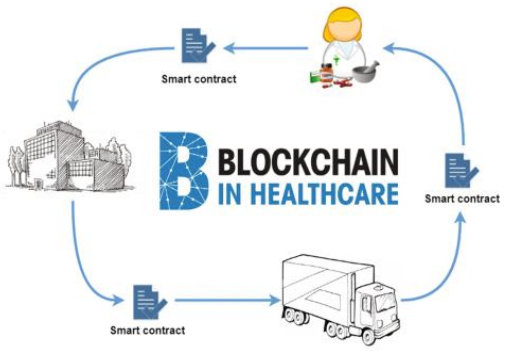

Figure 1: Implementation of Smart Contract in the Healthcare Sector

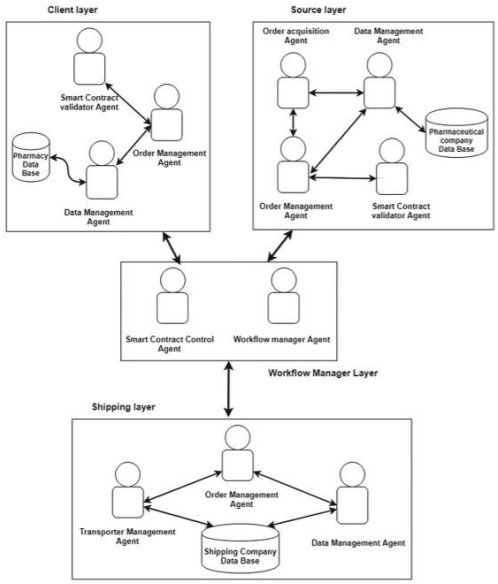

Figure 2: Multi-Agent Architecture

The multi-agent architecture shown in the model consists of four layers, including client layer, source layer, agent layer, and workflow management layer. (1) The client layer consists of pharmacies responsible for the process. The pharmacies include pharmacy that handles the control stock agent, which verifies the smart contracts and responsible for the order placing. (2) There are two agents that construct the source layer. One of the layers is tasked to receive orders from receivers (pharmacists), and the other layer is tasked to control the stock inventory and production levels. (3) The third layer is where the agent works on the verification of the obligations of smart contract. (4) The final layer is the workflow management layer, which has several agents, including a smart control agent and the workflow management agent, which is tasked to create new smart contracts, while keeping money from the creation of transactions and the application of penalties in the event of the dereliction of the smart contracts.

And so, every one agent in each of every layer will check when the requirements of the smart contracts are fulfilled. In example, in the event where a pharmacy and a pharmaceutical company is involved in a purchase of a medicine utilizing a smart contract, a smart contract will at first be signed by both companies. Then, the pharmacy will progress onto the payment of the to-be-shipped drugs, then a control entity will keep the money in the blockchain, in which the agent will then verify the smart contract. Upon receival of the drugs ordered by the pharmacy, the agent of the control entity will then confirm the fulfillment of the smart contract conditions, then the agreed amount of money will automatically be sent to the pharmacist [7].

3. METHODOLOGY

This paper proposes a state-of-the-art model which utilizes the information gathered from the sensors from IoT the (Internet of Things)-enabled containers, concerted with smart contract. The smart contract plays a role in triggering notifications on each actor and sending them to smart devices should any alerts occur. IoT-enabled containers with sensors applied are continuously tracked and monitored throughout the shipping process from the sender of goods to the receiver. The containers are equipped with temperature IoT-sensors that is tasked with the function to monitor temperature inside the container, a GPS receiver to track the exact position of the container, a pressure sensor to recognize difference in pressure to detect the opening and closing of the container, and an accelerator that detects the sudden movements of the container in the case of sudden drop or fall, that is connected to Message Queue Telemetry Transport (MQTT) server so that every information is stored in the server, ready to be distributed through IoT devices [8]. All information will be notified to all the parties through their PC or smartphone so they can easily find out the latest news about their package.

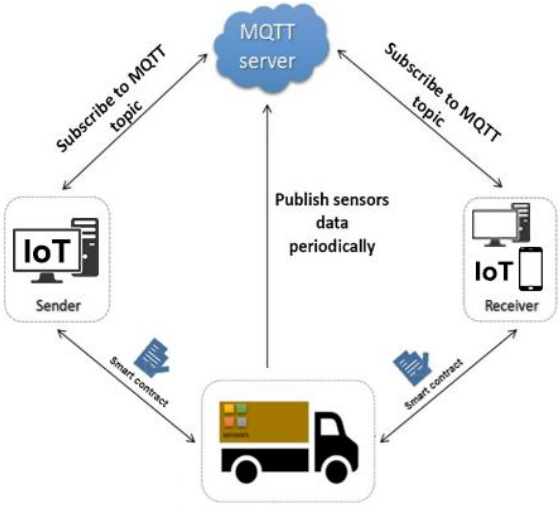

Figure 3: System overview

Figure 3 illustrates the illustration of the proposed system. As stated in the proposed system, the major components of the system are the shipment senders, the shipment receivers, sensors-equipped IoT-enabled containers, and an MQTT server to store, amass, and broadcast all data generated by sensors installed in the cargo. The sender and receiver utilize the smart contract by joining the supply chain entities together after the IoT-enabled containers to identify whether the receiver would pay before or after the shipment is complete [8]. When the shipment is abruptly aborted, refund is automatically issued to the receiver. Smart contract acts as the manager for commercial transactions between different parties. Each business operator/actor possess smart devices has the ability to monitor the status of each actor. Every smart contract for each party has their own multi-agent architecture to automate the transaction.

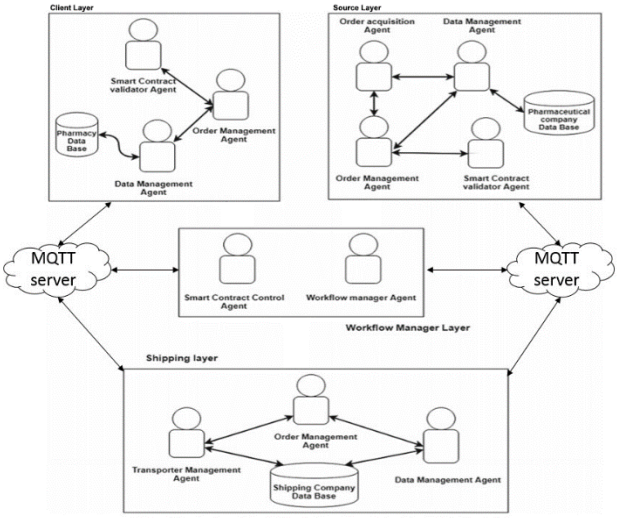

Figure 4: Proposed multi-agent architecture of logistics smart contract

Figure 4 illustrates the detailed multi-agent architecture to Figure 3. In this theory, the multi-agent system controls the whole process, from client layer and source layer to shipping layer, with the help of MQTT server. In the proposed model, the technology of cloud-hosted MQTT server enables for various layers to access MQTT server's subscription services. In this model, MQTT server will share all the published data and topics to the subscribers, mainly for the sender and the receiver. Figure 4 shows the interactions between layers, utilizing MQTT server in between transactions for processing and communication purposes among IoT enabled devices and IoT enabled cargo, with the help of smart contract to automate various processes.

The client layer is responsible for inventory control, which will send packets related to the updates of inventory and shipments to MQTT server, which will then be received by IoT-enabled cargo subscribed to the MQTT server, where the rest of the shipment process will be managed by the smart contract automatically. The source layer controls the placing of orders and order taking. When orders are received in the source layer, the source layer will process and automatically send the updates to the MQTT server, which then enables the shipping layer subscribed to the server to receive the order, and process the order. For the order placing process of the source layer, packets related to the details of the orders are sent into the MQTT layer, and then will be received by MQTT server-subscribed client layer to proceed with the order process. Shipping layer will be the IoT-enabled cargo, which will process the updates of shipped goods, from taking in the ordered goods to delivering them completely. Every process done will be recorded to the MQTT server and shared to every other layer, including the position of the cargo. Workflow manager will work as the creators of the smart contracts, and as a smart contract agent, they will act with every layer, which will help automate the whole process of the transaction.

4. CONCLUSION

In this paper, we propose a new solution to blockchain and IoT solution to monitoring and control the shipment using smart containers that monitored and controlled by multi-agent architecture. The novelty of this paper is combining the blockchain smart contract, IoT, MQTT, and the multi-agent architecture that makes the information more accurate and precise. IoT makes all the parties knows not only about the position of container, but it can also inform about the temperature of the container, pressure of the container, and detect if container fall or drop from their devices such as PC or smartphone. With this proposed model, the information provided should be more precise and can be accessed through all smart devices in real-time.

REFERENCES

1. Turban, E., King, D., Lee, J., Liang, T.-P., & Turban, D. ***Electronic Commerce 2012: Managerial and Social Networks Perspectives,*** 7th ed. Pearson, 2012.
2. Safitri, T., **Penerapan E-Logistik dalam E-commerce**. Retrieved January 14, 2020, from https://supplychainindonesia.com/new/penerapan-e-logistik-dalam-e-commerce/, June 2019
3. Li, T., Sun, S., Bolić, M., & Corchado, J. M. **Algorithm design for parallel implementation of the SMC-PHD filter**, *Signal Processing 119*, pp. 115–127, 2016 https://doi.org/10.1016/j.sigpro.2015.07.013
4. Chamoso, P., Rivas, A., Martín-Limorti, J. J., & Rodríguez, S. **A Hash Based Image Matching Algorithm for Social Networks**, *Advances in Intelligent Systems and Computing Trends in Cyber-Physical Multi-Agent Systems. The PAAMS Collection - 15th International Conference, PAAMS 2017*, pp. 183–190. July 2017.
5. Lima, A. C. E., Castro, L. N. D., & Corchado, J. M. **A polarity analysis framework for Twitter messages**, *Applied Mathematics and Computation*, vol. 270, pp. 756-767, November 2015. https://doi.org/10.1016/j.amc.2015.08.059
6. Wang, J., Yang, D., Guo, Q., & Huo, Y. **Taking Advantage of E-Logistics to Strengthen the**

Competitive Advantage of Enterprises in China, *The Fourth International Conference on Electronic Business – Shaping Business Strategy in a Networked World*, pp. 185–189, January 2004.

7. Casado-Vara, R., González-Briones, A., Prieto, J., & Corchado, J. M. **Smart Contract for Monitoring and Control of Logistics Activities: Pharmaceutical Utilities Case Study**, *Advances in Intelligent Systems and Computing International Joint Conference SOCO'18-CISIS'18-ICEUTE'18*, pp. 509–517, June 2019.
8. Hasan, H., Alhadhrami, E., Aldhaheri, A., Salah, K., & Jayaraman, R. **Smart contract-based approach for efficient shipment management**, *Computers & Industrial Engineering*, vol. 136, pp. 149–159, October 2019 https://doi.org/10.1016/j.cie.2019.07.022
9. Basa, J. J. A., Cu, P. L. G., Malabag, N. N., Naag, L. A. V., Abacco, D. F. P., Siquihod, M. J. M., Tolentino, L. K. **Smart Inventory Management System for Photovoltaic-Powered Freezer Using Wireless Sensor Network**. *International Journal of Emerging Trends in Engineering Research*, vol. 7, no. 10, pp. 393–397, October 2019.
10. Hussein, W. N., Kamarudin, L. M., Hamzah, M. R., Husain, H. N., Jadaa, K. J. **A Methodology for Big Data Analytics and IoT-Oriented Transportation System for future implementation**, *International Journal of Emerging Trends in Engineering Research*, vol. 7, no. 11, pp. 449–459, November 2019. https://doi.org/10.30534/ijeter/2019/087112019
11. Raghavarapu, D. S. N., & Meier, K.-J. **Methodology for Supply Chain Management**, *International Journal of Emerging Technologies in Engineering Research*, vol. 4, no. 10, pp. 29–41, October 2016.