**[P1]**

Hello everyone, My name is Hangdong Chen. My research topic is “Using Blockchain for improving communication efficiency and cooperation: the case of port logistics”

**[P2]**

I will describe my work in five steps

First, let me briefly introduce my research background.

**[P3]**

With the rapid development of the logistics industry, port logistics is playing an increasingly important role in global logistics.

Over 85% of the cargo has traveled at least once on board. And the advantages of shipping makes it always occupy an important position in logistics.

With the development of technology, many place have begun to develop automated ports.

**[P4]**

But,

Automated ports require significant costs to purchase intelligent equipment and infrastructure reforms, so for economically developed areas and large ports such as Rotterdam and Shanghai, they have enough resources to develop it.

But for small ports, they often need to cooperate with multiple third-party companies, such as transportation companies, which means there are more challenges when cooperate and communication.

Between these companies, information did not shared, different companies use different systems with different information, all these problems reduce the efficiency of small ports and limit their development.

**[P5]**

We have found that even though port communication system has been developed for more than 30 years, when small ports cooperate with third-party companies, they still use inefficient way to exchange information.

For example, They use files to send information, and communication with phone and email.

This type is not only inefficient, but it takes a long time to review if anything lost or incorrect.

**[P6]**

When cooperating, there may be a problem of repeated waiting. Such a similar situation occurs in the communication between the various roles of the logistics chain.

Therefore, we hope to improve the efficiency of multi-company cooperation.

**[P7]**

When considering some reasons that may cause this situation, we are thinking using blockchain to improve it.

**[P8]**

Because of the blockchain has the characteristics of Transparency, Traceability, Security, Built-in-trust and Real-time accessibility, it may be able to improve the communication efficiency of small ports cooperation

**[P9]**

Therefore, we mainly focused on the problem of low communication efficiency in the cooperation process between small ports and multiple companies and explored whether we can use blockchain to improve it.

**[P10]**

In this research, we mainly use the simulation method to simulate traditional systems and blockchain-based system, and compare the performance differences of the models.

**[P11]**

So, we proposed two research questions, First determine how to simulate and then perform a system analysis

**[P12]**

For research question 1, we need to determine roles and functions, to understand how to simulate. In order to compare system differences, we also need to determine comparison indicators

**[P13]**

According to Dr. Henesey's research and the Global Logistics Institute's analysis of PCS roles, we roughly divide the roles into 6 categories. In this research, it is unrealistic to simulate a complete port communicate system. There are very complex information interactions between different categories and within the categories, so we mainly simulate the communication and physical processes between port and inland transportation companies

**[P14]**

In Dr. Henesey's research, he list the information interactions between stakeholders and the port system. Because of the timing factor of information exchange is the physical process, it is necessary to consider the physical process together in the simulation. Combining Digital Container Shipping Association industry blue print, we screened out physical processes and information exchange between ports and inland transportation companies, which are necessary functions in the simulation system.

**[P15]**

To compare the system differences, we chose four performance indicators. Overall time of cargo in port, vehicle utilization rate, access speed to information and port throughput.

**[P16]**

In simulation method, we will design two systems

**[P17]**

Traditional system will use bilateral communication,

**[P18]**

In traditional system, port manager will ask transport company one by one until the order was accepted.

Based on the previously identified functions and roles, we designed the system process

**[P19]**

For a Blockchain-based system, we need to design four additional parts: block, consensus mechanism, reward mechanism and anti-tampering mechanism.

**[P20]**

We use the blockchain network to enable port management to send requests to multiple companies at the same time,

If the transportation company has free resources, it is allowed to participate in mining. The first company to complete the mining task obtains the shipping qualification of this container，then broadcasts the information to the network. only one company can get this order. And the commission will give as reward.

**[P21]**

Based on the design, we can have the flow chart.

**[P22]**

After implement the simulation model, we collected the results of KPIs. Next, I will analyze the results in details.

**[P23]**

Access speed to information, this indicator shows the time required after the port initiate the request for transport resource, until the transportation company accepts and dispatches the vehicle to the port. This indicator can represent the speed of information reaction between the port and multiple transportation companies in the process.

From the collected results, we can see that in the response time of 5 to 35 unit time, the order completed by the blockchain-based system is much more than the traditional system. In this interval, we observed that the blockchain-based system has the ability to respond quickly.

for over 100 unit time, we observed that only traditional systems have orders completed.

**[P24]**

In 150 time-units, the traditional model processed a total of 123 orders and the blockchain-based system processed 209 orders. By analysis the data, we find the results are very interesting.

From average time spent, blockchain-based systems are slightly faster than traditional systems,

From the perspective of variance, the blockchain system is also slightly more stable than the traditional system.

However, if we only calculate the variance in less than 100 unit time, we find that the variance using traditional models is much lower than blockchain-based system. Which means if the long-delayed container is not considered, the order processing time of the traditional model is more average than blockchain system.

**[P25]**

In terms of information processing, we found:

In 150 simulation time, Blockchain-based system processed more orders.

In terms of fast response, the Blockchain-based system performs better

If we don't consider the orders that are processed for a very long time, the order processing speed of the traditional system is more stable. Which means in traditional system it is easier to predict the time of order processing.

For orders that took a long time to complete in traditional systems, we found that they in special case. During the Bilateral communication process, the port needs to ask the transport company one by one. Suppose that when port asking company C(Charlie) for resource, Company A(Alpha) has idle truck. But port manager does not know that, so he will continue ask company D(Delta). And a worse possibility, when the port manager gets a refuse from company D(Delta), idle truck of company A(Alpha) has dispatched, which makes waiting time even longer.

**[P26]**

Overall time of cargo in port

We can found in 150 simulation time units, blockchain based system process 197 containers and traditional system only process 121. And In terms of time distribution and mean, the Blockchain-based system can make containers move out of the port faster.

**[P27]**

Therefore, using the blockchain system can shorten the waiting time of containers at the port. Moreover, the use of blockchain systems also has a good performance in terms of fast transportation. If urgent orders need to be quickly delivered to customers, the blockchain system can provide better services.

**[P28]**

In the communication process between the port and the transportation company, the vehicle utilization rate can represent whether the port has the ability to know the transportation resources statement. If the utilization rate is high, it means that the port can communicate with the transportation company in time and obtain updated information.

In this part, we will compare the Company vehicle Utilization Rate and Overall Vehicle Utilization Rate for analysis.

**[P29]**

This is the line chart of vehicle Utilization Rate over time for each company in 150-time units.

**[P30]**

By comparing vehicle utilization for each company in the two systems, although the rate fluctuates frequently in Blockchain-based system, the amplitude of the fluctuation is not large. Compared with the traditional system, Blockchain-based system can always maintain a higher and more average vehicle utilization rate.

**[P31]**

This is the Stacked chart for Overall Vehicle Utilization Rate.

**[P32]**

By comparing Overall Utilization Rate in the two systems, at the early stage, companies B(Bravo) & C(Charlie) are idle in the traditional system, while in Blockchain-based system the utilization rate of all three companies are rising quickly, and it can put more resources into use in a short time. For traditional system, the overall rate is not high, which indicates that by using Blockchain-based systems, cooperation between ports and transport companies is more efficient.

**[P33]**

By observing these four graphs, we find that in terms of vehicle utilization, when using the traditional system, the rate fluctuates greatly for company C(Charlie). Although there are still many containers needs to be shipped at the port, the rate still be low for a long time.

In blockchain-based system, the vehicles of all companies are arranged centrally, which can reduce repeated waiting times. And it can quickly call resources in a short time and keep the utilization rate at a high level.

With the consensus mechanism, the blockchain system can replace the manual confirmation process with algorithm, which can reduce the waiting time for a response.

We can also see from the stacking diagram that the performance of the blockchain-based system is better than traditional system

**[P34]**

For all ports, throughput is a very important indicator. Being able to handle more containers in a certain period of time can not only improve port efficiency, bring better economic benefits, but also have more time for allocate and adjust resource usage.

**[P35]**

In this indicator, we find that the processing speed of the blockchain system is greater than traditional system, and in traditional system, there are many times where no container is sent out of the port. In terms of processing speed and overall throughput, blockchain systems perform better than traditional systems

Summary:

Through the analysis of the collected data, we found that compared with traditional systems, using a blockchain-based system can increase the vehicle utilization rate of partner companies, reduce the waiting time of containers at a port, and increase port throughput to a certain extent. In the speed of information access, although there is no major improvement, but blockchain-based system can avoid the situation that the order has not been processed for a long time.

**[P36]**

But during the simulation, we also found some problems using the blockchain-based system:

a.

Blockchain requires a large number of computing resources and storage units, which may be an additional cost for both transportation company and port.

b.

The Blockchain system mainly replaces the manual confirmation step through the consensus mechanism, and then arranges the vehicles. So the choice of consensus mechanism is particularly important. In this system, we chose the proof of work method, and set low workload level. If the workload increases beyond the average time of manual confirmation, the performance of the blockchain system will become very poor. So it is unclear how to choose a consensus mechanism and its impact on different consensus mechanisms.

c.

In the design of this system, one block will be created when an order created, which requires a lot of storage resources. Over time, this data chain will be very large. As a result, the speed of information traceability and inquiry becomes slow. In this regard, although it is possible to try to add a phased storage root node to relieve the storage pressure, this may increase the risk of information lost.

d.

Since the Blockchain system is a distributed information system, in general, the more user nodes, the higher the built-in trust and security. However, in the case of cooperation between multiple companies, any situation that needs to reduce the benefits may cause users to exit the network, such as additional computing resource maintenance costs or reduce revenue. So if we want to promote the Blockchain system in small port, we need to improve the communication efficiency while at least ensuring that the interests of any party are not harmed.

e.

Although the use of the Blockchain system does not need to completely replace the PCS used by the transportation company or the port itself, it still needs to connect to a database and obtain certain information in real time. This is also a place where users who have not used such systems need trust.

**[P37]**

Overall, there are advantages to using Blockchain technology between ports and transportation companies. In the small port logistics system, the information of the port and the transportation company is not shared, so it is very difficult for the port to allocate resources. By using the Blockchain based system, transportation resources can be allocated in a timely manner under the condition of high information security. Under the premise of using an excellent consensus mechanism, such a system can reduce the waiting time, improve the overall vehicle utilization rate, and achieve the purpose of improving port efficiency. The Blockchain based system can communicate with the port in real time without the complete sharing of information,

\*\*if have time\*\*

(For example, when an order is initially created, the port only needs to publish the time information and the type of vehicle required, and after the order is accepted by the transport company, detailed information such as the location of the container could be sent to the corresponding transport company. And also it can write detailed information into smart contracts and publish them to the Blockchain network, allowing this process to be monitored. )

The built-in trust of the Blockchain can allow the cooperation between the port and the transportation company to be supervised by all nodes, which can provide a trust basis for the information exchange between the two parties to a certain extent.

Although there are still many challenges in using blockchain technology in small ports, but in general, there is great potential in using it.

**[P38]**

Due to the characteristics of small ports, there is still have much things need to discuss.

In this research, we discussed the physical processes and information exchange between the port and the inland transportation company, but we still need to perform simulation experiments on how much other roles are affected by the blockchain.

And about the consensus mechanism, we choose proof of work in this research, However, its resource usage is too large, which makes me unable to achieve a larger model simulation, so we need to study how to choose a consensus mechanism in the future.

In addition, the blockchain itself also has value to do more research.