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Study on the construction of public information platform for international multimodal transport: a case study of Shanghai

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STUDY ON THE CONSTRUCTION OF PUBLIC INFORMATION PLATFORM FOR INTERNATIONAL MULTIMODAL TRANSPORT

--- A CASE STUDY OF SHANGHAI

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Declaration

I certify that all the material in this dissertation that is not my own work has been identified, and that no material is included for which a degree has previously been conferred on me.

The contents of this dissertation reflect my own personal views, and are not necessarily endorsed by the University.

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Abstract

Title of dissertation: **International multimodal transportation information platform development --- taking Shanghai as a case**

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Multimodal transportation is a transportation organization mode characterized with features of good transportation quality, high efficiency and sustainability (Feng et al, 2023), conforming to the green and efficiency transportation in the future. With such background, multimodal transportation has become one of the hottest topics since the twenty-first century in China, where the Chinese government establishes lots of policies on boosting multimodal transportation.

However, there exist many multimodal transportation developing problems in China, such as lack of effective and efficient information exchange, insufficient market subject development and undeveloped management system (Zhao, 2022). Among the problems, this dissertation focuses on the problem of information exchange, where a multimodal transportation information platform is designed.

To be specific, the research will first summarize the developing problems and main reasons in China. Then, depending on the actual multimodal transportation development in China, implications on how the nation should improve its multimodal transportation performance will be given by comparing the multimodal transportation network in China and other countries where multimodal transportation systems are relatively advanced.

Among the implications, how to build the multimodal transportation information platform in Shanghai and how to put the platform into practice will be discussed in

detail. In the chapter of information platform development plan, the basic elements such as administrator, user permissions are discussed, using the PEST-SWOT and RBAC model. In the chapter of platform implication, an example of multimodal schedule is made, how the platform is designed to work in general is presented by in workflow diagram and the platform interfaces for different roles are designed and explained in detail.

In conclusion, the dissertation emphasizes on the multimodal transportation information platform development, which is designed to base in Shanghai to boost and manage the international multimodal transportation in China. In the final conclusion, limitation of the essay and further study recommendation is pointed out as well.

KEYWORDS: Multimodal transportation, information platform, PEST-SWOT, RBAC, interface

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MTO	-Multimodal Transportation Operator

1 Introduction

1.1 Background and problem statement

There is an inseparable relationship between international trade and transportation. From one hand, international trade requires transportation to complete the physical displacement of goods. From the other hand, good-quality transportation could empower and prompt the international trade. Therefore, transportation, as the derived demand from trade which should support the trade fulfillments, is under constant self- innovated, which results in effective and efficient transportation modes development (MORASH.2001), more customized transportation solution design (Zhao et al,.2010), digital transport innovation (Tsvetkov et al,.2020) and so on.

Traditional transportation organization, which is characterized by incoherent connection, high emission, low efficiency and etc., is no longer the mainstream transportation mode. Instead, high-end transportation equipment and modern transportation modes have become the main developing directions (Liu, 2020). For instance, carriers are investing in ships using clean energy or with higher energy efficiency, customers become more willing to purchase from eco-friendly companies, and companies are transforming into transportation solution providers (Liu et al, 2021; Fu & He, 2014).

In China, among these developing directions, multimodal transportation, as an advanced transport organizing modality, has become the key developing field, which is stated in critical government documents with guiding significance, such as the Fourteenth Five-Year Plan for Comprehensive Transportation Services (Xia,2021). It is a reflection that the Chinese government has realized how multimodal transport could reduce logistics cost and improve transportation efficiency (Bi,2022). In the guiding documents, Shanghai is further regarded as an important hub to practice multimodal transportation (Shanghai Municipal Peoples Government,2022). Therefore, how could Shanghai bring its superiority into full play is worth studying.

However, even though the Chinese government has shown great ambition in development of multimodal transportation in recent decades, multimodal transportation still takes very little proportion, namely less than 3%, of cargo transportation in China (Yi,2022). At the same time, the transportation efficiency in Shanghai has reached a bottleneck, where many problems remain to be solved (Tian, 2021). Regarding Shanghai as one of key nodes to develop multimodal transport and multimodal transport as an advanced transport mode, a scientific management, namely a multimodal transportation platform, could be applied to improve the transportation performance in Shanghai. But there are insufficient studies investigating the application on multimodal platform in Shanghai, making this research useful for Shanghai multimodal transport development in the future.

1.2 Aim and objective

The research aims to analyze how multimodal transportation platform, which enables information to be exchanged freely, should be designed to empower the international multimodal transportation in China.

As for the objectives are stated as follows:

- To describe the background of multimodal information platform development in China, and further give implications to China by comparing the multimodal networks around the world;
- To inspect how to design the multimodal transportation platform from perspectives of users' authority, administrator and internal and external business analysis'
- To present how the multimodal transportation information platform could be put into practice.

1.3 Scope and limitation of the research

The scope of this research will only focus on the multimodal transportation information platform development in Shanghai, and will not discuss legislation development and other aspects in detail.

When designing how the information platform should be presented, this research will only discuss the platform functions, show its operation logic and exhibit the interface sketches, but not emphasizing on how computer algorithm would support the website.

With the development of the information platform, Shanghai will be able to organize the multimodal transportation in a more effective and efficient way. There could exist hundreds of multimodal transport routes and different possibility of administrating entities. This research would only give one example showing the basic implementation in detail based on a hypothesis, rather than covering all possibilities.

1.4 Structure of the research / Method

This research will be consisted of one chapter of literature review, three chapters of information platform-related discussion and one chapter of conclusion and prospect.

In literature review, existing literature will be collected and organized in a logic way. In the discussion chapters, Chapter Three will generally describe the background of Shanghai's multimodal information platform construction, covering main problems Shanghai currently facing, the main reasons causing them, similarity and difference of Shanghai and other multimodal transportation nodes, and further imply what are the implications Shanghai should apply. Chapter Four will discuss the development of the platform, which would inspect users' roles and authority limits using RBAC model, discuss who should take charge of the platform, further analyze how are the internal and external environments using SWOT-PEST model and describe the function of the platform. Chapter Five will show the implementation of the platform where how the

multimodal transport network would work would be presented in a diagram. At the same time, a logic tree model would be used to classify the demand of different entities and further design the platform interfaces. At last, a conclusion would be drawn in Chapter Six, where recommendations for future research would also be given.

2 Literature review

2.1 Introduction

The literature review is conducted to organize the multimodal transportation-related researches in a logic way, which will follow the order of the developing timeline of a multimodal transportation solution, namely network design, evaluation and improvement. Also, as the paper focuses on multimodal transportation platform development in Shanghai, relevant researches would be reviewed.

2.2 Multimodal transportation network design

In a general way, multimodal transportation network connects the nodes together to better carry out transportation missions under unified coordination and overall planning, which should be supported by physical transportation network, global logistics channel and well-developed transport nodes (Li,2022).

During the network design, the first step is to choose the nodes. Studies have been carried out to identify critical nodes in multimodal network using k-shell model to ensure overall network reliability (Wang et al,.2021). Naumov et al. (2015) further discussed how to develop efficient transport nodes to achieve capacity maximization taking the randomness of material and information flows into consideration.

When the network needs to be expanded, two-stage genetic algorithm could be

applied to optimize location selection (Li et al.,2022). At the same time, the positive impact inland ports have on multimodal transport network efficiency improvement has been discovered (Rickard & Jason, 2021). But there is also evidence showing additional capacity into the network does not necessarily lead to better efficiency but congestion and increase in cost (Lucija et al., 2021; Li & Sun,2022). Therefore, building a multimodal transport network could be very challenging.

When designing networks, there could be different objectives. In business content, the three main objectives are lowest cost, shortest transport time and better customer service. As the impact of climate change intensifies, low carbon emission has become another mainstream goal of multimodal network combined with the three traditional objectives. For example, networks are developed around the world with goals of high efficiency, low cost and carbon emission reduction, considering both the economic outcomes and the negative impact on environment and human health (Li & Yin,2022; Mostert et al., 2018; Guo et al.,2022). In the sub-sector of container transport, low emission is also key research field. Liu and Zhao (2022) used a Dijkstra-GA hybrid algorithm to propose a green and highly efficient transport model, while Li and Sun (2022) considered emission trade and constructed a robust stochastic optimization model to reduce container transport cost. In society content, there are also networks designed to ensure safety of people, involving advanced industry and transport technologies (Anatolii et al, 2017).

2.3 Evaluation of multimodal transportation network

Before adopting the multimodal network into practice, there could be evaluation on the reliance of the network, which could be done by reliability fault tree and Bayesian network (Wu et al.,2022). By such measurement, management subjects could do adjustments according to different objectives. On another aspect, there exists method to evaluate whether the design meets the balance of land use and multimodal

network efficiency when building the connection between different level cities (Akun et al.,2023), helping government and business entities to achieve both social benefits and economic benefits.

After finishing the multimodal transport network design or during operation of the network, there should be constant monitor on whether the network is working efficiently as well. Evaluation system including capacity, service level and developing environment is regarded as basic evaluation classifications (Yu & Cao,2020). To further evaluate different transport modes respectively, there could be different systems and indicators. In railway multimodal transport, key performance indicators could consist measures on quality, quantity and development (Dai et al.,2022). When assessing shipping and highway transport, indicators such as facilities, equipment and legal environment could be adopted (Wu et al.,2022). But under fast development and repaid revolution, all evaluation systems and key performance indicators should be constantly renewed according to the real market situation (Yu & Cao,2020).

2.4 Improvement of multimodal transportation network

There are many different methods to improve the multimodal transport network performance. For example, improvement of the whole network could be done through improvement of individual transport nodes. In real practice, when boosting the positive effect of ports in the network to enhance the connection with other countries, ports could give incentives to shippers or carriers to increase their market status and to further gather more cargos (Qu et al.,2021).

Also, government policies and activities, such as adjustment on carbon tax rate, are able to push business entities to change from traditional multimodal transport routes to more environment-friendly ones (Liu et al.,2021), namely transform into a greener network to achieve better environment outcomes.

At last, decisions made by business entities could make a difference as well.

Multi-objective robust optimization method is proven to be effective in better transport decision making in volatile transport market (Zhao et al.,2022; Zhang et al.,2022), making business entities able to improve the overall network efficiency. Similarly, Mostert et al. (2017) helped government and business entities on investment decisions by studying about strategies on balance achievement among multimodal network efficiency, economic benefits and environment outcome. With the strategy, reasonable investing plans could be developed.

2.5 Multimodal transportation in China and Shanghai

There is a gap between multimodal transportation in China and the world advanced level (Tan, 2016). In the first decade of the twenty-first century, there still exists serious problems in China, such as mixed transport of passenger and cargo on same transport route, restrictions on double-layer containers on some railway routes, insufficient railway capacity and etc. (Wang, 2012), namely there is no enough attention on multimodal transport development. But such situation has been changed since the Chinese government put forward the “The Belt and Road Initiative” and announced the goal of “carbon peak” and “carbon neutral”. Thereafter, development of multimodal transportation as one of the priority areas has been emphasized.

However, even with strong ambition, problems in China were not well-solved. Li and Zhang (2022) broke the Yangtze River into several parts and studied the multimodal transportation situation and main problems in each part, concluding that not well-connected routes in the lower reached of Yangtze River makes the multimodal transport there unable to display even with dense transport network. At the same time, there exist problems such as insufficient upgraded infrastructure construction (Liu et al.,2021), high coordination cost, low flexibility of railway and waterway, poor market subject development (Yi, 2022; Zhang et al., 2022) and so on, debilitating the positive effect of multimodal transport.

Other researchers dug deeper in the internal reasons of poor multimodal transportation development. From the perspective of the whole nation, Bi (2022) compared multimodal transportation developing history in China and other countries, stating that one of the reasons why multimodal transport is not advanced in China is that the nation does not have a gradual development from bulk cargo transport to container intermodal transportation but skipping containerized transport and container transport in between. At the same time, unhealthy competition among different transport modes and insufficient link between different physical infrastructures makes railways difficult to fulfill its role (Yu,2021; Liu et al.,2021), weakening the whole multimodal transport network's effectiveness and efficiency.

In the future, there needs a multimodal transportation revolution in China from the perspective of management, cooperation, information exchange, upgraded vehicles (Zhang & Wang,2022) and so on, which is exactly why China should make full use of Shanghai's advantage, solving the problems of blocked information exchange (Tan,2016) and build an information platform to encourage international multimodal transportation development. After the platform is put into practical application, Shanghai could act as a comprehensive hub for international shipping in Northeast Asia, boosting both transport efficiency within the nation and transport amount among Asian countries (Li,2021).

3 Background of multimodal information platform construction in Shanghai

3.1 Multimodal transport problems and reasons in China

3.1.1 Multimodal transportation problems in China

Multimodal transportation has been one of the hottest topics in China since the

establishment of "Several Opinions on Accelerating the Development of Modern Logistics" in 1998, which has been put much attention since the "Opinions on Promoting the High-Quality Development of the Transportation and Logistics Industry" was issued in 2019 (Wang & Zheng, 2022).

However, there still exist many bottlenecks of multimodal transportation in China. Insufficient flexibility. Multimodal transportation in China relies on ports as transshipment point heavily (Li & Luo, 2019), lacking diversified multimodal transportation choices and not being able to provide tailor-made transportation solutions.

Immature service. Within China, the volume of multimodal transportation only accounts for less than 10% of transportation volume of the whole society, while in America 40%. Additionally, multimodal in China does not realize the seamless and smooth connection between different transportation nodes, where cargos need to be transshipped many times (Bi,2022).

Lack of efficient information exchange. Even though there exist many information platforms in transportation market in China, the ranges always only restricted to several provinces or several cooperative enterprises, rather than platform could cover larger ranges and bigger service scopes.

Lack of healthy market format. Up to 2023, there still does not exist specific international legislation on multimodal transportation operator (MTO), making traders worry about responsibility division and related legal risks (Yu & Li,2023). Also, there commonly has difference between market subjects in Chinese multimodal transportation market and the ones in developed countries, reflecting in technologies, informationization level and so on (Dong, 2021).

3.1.2 Reasons causing the multimodal transportation problems in China

Reasons that causing the problems could be generally divided into two parts, namely congenital market formation issues and development afterwards.

About multimodal transportation market formation in China, which is later than America and other developed countries, skips the gradual process from traditional transportation, to containerized transportation to multimodal transportation (Bi,2022), making both physical equipment and system formation difficult to adopt the advanced multimodal transportation level.

About development afterwards, the severe competition among different transportation modes makes it difficult for them to cooperate and bring their own superiority into full play. Competitions exist among similar transportation providers as well (Zhao,2022), making the multimodal transportation market very hard to survive. Also, with insufficient legislations and loose connections among different transportation modes, MTOs can hardly provider high quality multimodal transportation, easily causing customers' dissatisfaction.

3.1.3 Current situation in Shanghai

Shanghai shares common problems with the nation, such as insufficient connection between different transportation modes, immature multimodal market objects development. But Shanghai as the economy center and transportation in China, has indisputable advantages in multimodal transportation (Li et al,. 2022).

For instance, from the perspective of economy, Shanghai is the relatively developed province in China, where real economy and financial business are both developed (Chen,2022). Technologically, Shanghai as the science and technology innovation center put much effort on both high-end technology development and technological system building (Qian et al,.2022), having good atmosphere in embracing and managing interactive information technologies. Geographically, Port of Shanghai, which is world leading port from the perspective of cargo throughput, could largely empower the multimodal transportation through gathering cargo around the world and further distributing the cargoes to inland market (Zhang,2021). Similarly, the port could act as a transshipment point to ship the cargo to the rest of the world,

guaranteeing sufficient cargo volume for multimodal transportation. Additionally, with municipal policies on multimodal transportation being issued, market subjects start to put emphasis on multimodal transportation and even establishing new companies in the multimodal market, such as SIPG Group Yangtze River Delta Multimodal Transport (Shanghai) Co., Ltd (Gangkouquan, 2023).

To sum up, the development status of the multimodal transportation market in Shanghai is relatively good, with multiple advantages such as policies, technology, geography, services, and enterprises promoting the development of the market. With the support of the government and the continuous development of major logistics enterprises, it is believed that the Shanghai multimodal transportation market will play a greater role in the future, promoting the rapid and stable development of the national multimodal transportation market.

3.2 Comparison of multimodal transport network

3.2.1 Multimodal transportation network in Europe

Multimodal transport in Europe could be traced back to the nineteenth century due to higher requirement of transporting industrial materials during industrial revolution, where different transportation means been connected together. With decades' improvement, freight transport network has become more efficient with larger scope covering most European countries (Elbert et al, 2020).

According to the report of Eurostat, the multimodal cargo transport volume and the trade volume within EU countries accounts for a very high proportion of the trade volume of European countries and actions were taken to boost multimodal transportation (Eurostat, 2020), indicating that most European countries use multimodal transport to transport goods in order to improve the efficiency and sustainability of transport.

Multimodal transport enterprises in Europe consist of transportation companies

with actual transportation physical assets with strong resources and financial strength and companies that simply provide agency service (Saeedi et al., 2017). All these business entities are supported by European intermodal transport law, which sets up a single system to promote the sharing and processing of information, making it possible to handle all relevant formalities of goods, including transportation agreement, transportation plan and expense settlement.

3.2.2 Multimodal transportation network in North America

There are several main forces promoting the multimodal transport in America, which are enormous trading entities, private transport companies and legislations. As one of the largest economies in the world, the United States has a huge number of economic and commercial activities where the flow of goods needs the cooperation of various transportation modes, creating huge demand for multimodal transport. Therefore, since the 1980s, more and more private transport companies have entered into the American multimodal transport market, which provided financial and equipment support to multimodal system and promoted the quality and efficiency of transport services(Tan & Tang,2021). With relatively sufficient built infrastructures and service system, the nation coordinates these resources with legislations, such as Intermodal Surface Transportation Efficiency Act and Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users, which established a unified information sharing platform and promoted e-commerce to improve transport efficiency and service quality.

An outstanding multimodal example is the multimodal transportation network in Chicago, where large amounts of cargos from the Port of Chicago would go through and be further distributed through railways. Different types of well-developed multimodal transportation stations are designed to meet different customers' transportation demand(Yang, 2007). America railway company BNSF also acts as an important coordinator in the nation, who builds twenty eight multimodal transportation

stations connecting to the ports with inland transportation modes using efficient and intelligent methods and managing the multimodal network in a centralized and professional way (Yu,2023).

3.2.3 Shanghai-center Multimodal transportation network in China

3.2.3.1 Comparison of multimodal transportation network

The United State and main European countries, all as main international economies, all have great transportation demand, which provide good foundation for multimodal transport network development. Also, all three networks are supported by related legislations, well-developed infrastructure and logistics service network, which are further empowered by information platform.

But there exist many differences as well. For instance, multimodal transport in Europe takes the advantages of highly-developed highway system, while north America makes full use of high-density rail system.

From the perspective of means of implementation, European governments are more inclined to enforce multimodal transport through legislative means, such as the “Grenelle policy” of France and the “Kombi-Verkehr policy” of Germany. On the opposite, the United States government has adopted more incentive policies to encourage intermodal transport.

Differences in management organizations also exist. Multimodal transport in Europe is mainly supervised and managed by the European Union or the transport departments of various countries, while the United States is jointly managed by the Federal Aviation Administration and other departments as well as state government agencies.

3.2.3.2 Implications for China

China, as one of the biggest economies in the world, has much amount of trading and transportation demand. But he development of multimodal transport in China started relatively late compared to European countries and America(Bi,2022). So to

develop to the same level as the top multimodal transport, multimodal transport development In China requires faster and more efficient plan.

From the comparisons above, China should learn from the successful experience of advanced countries, namely making full use of high-density railway and highway networks, building necessary multimodal stations according to real situations and putting all the multimodal market under unified management and monitor.Moreover, there should be more effort put into legislation development, market entities development, infrastructure development and etc, among which the building of multimodal transport information platform could be a breakthrough point. Because the information platform could first prompt the development of unified multimodal transport standard, which is the foundation of smooth information exchange. As long as the platform could further provide business ease for carriers and traders, market entities would act actively to reform the method of information exchange and storage meeting the unified standard. With easily exchangeable information, there is possibility to realize high efficiency multimodal transport.

Shanghai, as the economic center and transportation center of China, is a good starting point to boost the development of multimodal transport where information technology is well-developed with physical infrastructure networks meeting together. Moreover, Shanghai municipal government has actively responded to national multimodal-related policies and promoted relevant ones, providing policy support for the development of multimodal transport platforms. Therefore, it is feasible to take Shanghai as the center of China's multimodal transport information platform managing both national and international multimodal transport business.

4 Multimodal information platform development plan in Shanghai

4.1 Administrator of the multimodal information platform

4.1.1 Existing administrator of multimodal information platform

4.1.1.1 Company

Shipbob is an American company which provides multimodal transportation service with a multimodal information platform. The company mainly focuses on e-commerce logistics, where their customers are provided with point-to-point transportation service empowered the company's fulfillment network, fulfill stores and etc. (Shipbob,2023). Instead of owning large amount of physical assets, the company acts as a third-party logistics service provider, cooperating with existing carriers to ship their customers' cargo to the world.

Similarly, cargomatic, which is a private company, offers customers with multimodal transportation service with an information platform, where traders could release their transportation demand and transportation service providers could serve the service. With such operation methodology, the company does not have physical asset, but offering parties with an information platform connecting them together (Cargomatic, 2023). But as the company size is rather small, it mainly focuses on multimodal transportation within America. There are many other companies acting as administrator of the multimodal information platform, such as GT Nexus. However, being limited to company size and characters, they do not necessarily own physical assets, but center on providing service through coordination.

There are several advantages of company managing the information platform. For example, a market where companies compete with one another can always offer customers better quality transportation service with reasonable price, because every company is trying to seek something as their core competence. Even it is not about offering the lowest price, every company can have comparative advantages. But with no official entities monitoring the information platform operation, there exists

possibility of credit default.

4.1.1.2 Company with government monitoring

There exists a multimodal transport information platform called “Yangtze River Economic Belt Multimodal Transport Public Information and Transaction Platform” operated by Jiangsu Wurun Shiplink Network Co., Ltd under the joint guidance of multiple government entities, and the supervision of the Transportation Administration Bureau of the local government (Yangtze River Economic Belt Multimodal Transport Public Information and Trading Platform, 2023), which emphasizes on the multimodal transport within the nation. It provides different service including freight forwarding, multimodal transport transaction service, multimodal transport information service and etc.

Instead of arranging the whole transportation and making deal with separate carriers themselves, traders could simply propose the place of dispatch, destination, cargo type, cargo intent and LAYDAY. With their demand on the platform, multimodal service provider could initiate order appointment and discuss the further freight rates. With the information platform, traders are provided with additional multimodal options other than segmented transportation. Even with same transportation costs, more comprehensive transportation service is offered to the traders, making one of the advantages of the multimodal transport.

Under such combines governance, there are several advantages as followed: There could be cooperation between government with sufficient fund and policy support and companies with professional operating skills and experience, making more reasonable allocation and efficient operation of resources and providing more efficient transporting service. Additionally, under governmental governance, transparent and fair operations could be ensured, where all participants do not need to worry about the information security or illegal operations.

4.1.2 Hypothesis on administrator of Shanghai-centered multimodal transportation network

When considering the administrator of the multimodal information platform, there should be some basic principles to adhere to. Above all, due to the reason that there involves many confidential business information in the multimodal transport information, the administrator should be an entity that could be easily supervised by public or the government, avoiding the risk of sensitive information breaches. Moreover, it could be better if the administrator is qualified with relevant business capabilities or business advantages. With such information security assurance and multimodal transportation coordination ability, there are advantages for the administrator to operate the platform properly.

Take the account of the fact that the platform is designed to boost the multimodal transportation in China, the Chinese government could be a good supervisor of the administrator and the platform, guiding and governing the multimodal transport format. Then, among the enterprises meeting the conditions, railway companies are those both directly hold transportation capacities and have rather good transportation managing systems. Further choosing the administrator among the railway companies, China Railway Shanghai Group Co. Ltd., whose main jurisdiction extent covers regions with relatively developed domestic and foreign trade, such as Shanghai, Jiangsu, Zhejiang, Anhui provinces, is a company within direct management range of China State Railway Group Co. Ltd., holding the same vision and mission with the Chinese government in the matter of multimodal transportation development.

Therefore, the essay would make a hypothesis that the administrator of the multimodal information platform is China Railway Shanghai Group Co. Ltd.

4.2 Multimodal transport information platform under PEST-SWOT analysis

When analyzing how the information platform to develop and operate, there

should be analysis on what superiority and weaknesses the platform holds, on how the administrator could use its advantages and improve its disadvantages and on how the multimodal business format would affect the multimodal information platform. Therefore, this part will put the platform under PEST-SWOT model to explore how should the platform to develop in the multimodal transportation market.

4.2.1 PEST-SWOT model introduction

PEST-SWOT model is a combination of PEST and SWOT, which integrates the advantages of both models.

Individually, PEST, which stands for political, economic, social and the environment, focuses on the external environment that could affect a business entity, which enables companies to evaluate the potential of the market and to further predict the future development. With the PEST model, an entity could better realize its risks from the extent from policy, economy, technology, environment, legislation and so on. On the contrary, SWOT analyzes the business entity itself from the perspectives of strengths, weakness, opportunities and threats, helping enterprises to find their market positions and to develop their unique development paths.

Jointly, PEST-SWOT could help business entities to analyze their business both under the whole business format and with the uniqueness of every company. With the model, business entities would be able to put its strength, weakness, opportunities and threats under background of politics, economy, society and environment, making it easier to compare with market competitors and to realize differentiated competition.

When using the PEST-SWOT model, the analysis could be carried out with different focuses. For example, using matching strategies to match T in PEST and W in SWOT, namely to understand how to weaken the weakness of the business to deal with external threats. Similarly, by matching S in PEST and S in SWOT, focus is put on how to apply the strength in society to better improve the performance of the company. So, when putting a company under such model, an overall and thorough

analysis on both external and internal advantages and disadvantages could be arranged in a logical way, empowering the company to better bring its superiority into full play and develop its unique strategy.

Therefore, when analyzing the China Railway Shanghai Group Co. Ltd. with PEST-SWOT model, the essay would break the analysis into sixteen dimensions. For better presentation, the following analysis would be first divided into strength, weakness, opportunity and threat, then be further divided into political, economic, social and environment.

Need to mention that there is no perfect administrator for the platform, when putting the hypothetical administrator under the PEST-SWOT, the purpose is to analyze the entity could develop, but not to prove China Railway Shanghai Group Co. Ltd. is the best administrator.

4.2.2 Strength

Strength of the China Railway Shanghai Group Co. Ltd. could be analyzed from the perspectives of policy, economy, society and environment.

From the view of policy, China Railway Shanghai Group Co. Ltd. is a state-owned company under the jurisdiction and monitor of China State Railway Group Co., Ltd., which strictly follows the national policy of multimodal transportation development. Relevant policies such as “The 14th Five Year Plan for Transportation” have boosted the multimodal transportation volume in the nation. Other policies such as “Guiding Opinions of the General Office of the State Council on Accelerating the Development of Railway Multimodal Transport” further encourage the multimodal transportation of railway (Wang, 2019).

As of the end of 2022, the country's railway multimodal transportation business had completed a total of eight million TEU of cargo shipments cooperating with shipping, a year-on-year increase of 16% (The Central People's Government of the People's Republic of China,2023). From the data, it can be seen that with the relevant

policies multimodal transportation has been largely encouraged and improved in the twenty-first century, among the different transportation modes railway is one of the driving forces.

From the perspective of economy, volume of domestic and foreign trade of China has been increased since the 21st century, showing a very positive future of trade. As transportation demand is derived demand from trade, the demand for transportation would have certain possibility to increase. Additionally, Shanghai, as the economy center in China and with the Port of Shanghai as one of the busiest ports in the world, could be guaranteed with sufficient supply of cargo. Therefore, railway which is regarded as the most economic transportation mode could maximize its advantages to get involved into multimodal transportation deeply relying on the good market environment. Under such condition, China Railway Shanghai Group Co. Ltd. could act as an expertise in multimodal transportation and further direct the multimodal transportation information platform. More importantly, as railway is a vital and main transportation mode in multimodal transportation, there is large possibility for China Railway Shanghai Group Co. Ltd. to be one of the railway carriers of a multimodal transportation mission, namely there is large possibility that the company would know about the cargo and transportation information and could offer lower prices. With such entity governing the multimodal transportation information platform, there is accordingly less possibility of information risks and greater advantages in prices.

When analyzing strength of the company from the view of society, it is the integration of government encouragement and the advantage of multimodal transportation that make the company suitable to be the administrator. Shanghai government puts much attention on developing green and sustainable transportation system, consisting all transportation modes (Song,2022). Consequently, multimodal transportation as an effective and efficient transportation mode is put great attention, where many business entities including China Railway Shanghai Group Co. Ltd. strive

to expand their business scope to multimodal transportation. In other words, business entities and the society is willing to develop multimodal transportation. China Railway Shanghai Group Co. Ltd. as one of companies has already got involved in the multimodal business could be the overall manager of the platform.

Also, as technologies, such as Internet of Things, artificial intelligence and big data analysis, have developed rapidly in the twenty-first century, they could offer the platform strong foundations to connect all transportation units and entities together. With the already developed technologies such as block chain, the security of the platform can also be assured.

Additionally, from the perspective of environment, railway is the most efficient inland transportation mode, whose performance in transportation volume and emission level outweighs highway transportation, and could cover more inland area than inland shipping which needs highway or railway to distribute cargos into deeper inland. Therefore, China Railway Shanghai Group Co. Ltd. could act as an exemplary in emission reduction and efficiency improvement.

4.2.3 Weakness

From the view of policy, the biggest weakness of China Railway Shanghai Group Co. Ltd. is derived from its strengths. Namely although the policy advantages provide the company with big political support, the company could be easily affected by changes in government policies. Additionally, as a state-owned company, the conflicts between countries and turbulent world political situation could largely affect the business of a company with political stand. Under such condition, it could be possibility for the platform to be not able to gather enough cargoes. Therefore, administrator of the multimodal transportation information platform should be very alert to policy change and world political situations.

Due to the reason that China Railway Shanghai Group Co. Ltd. could act both as contracting carrier and as actual carrier, the cost of the company could be higher than

companies that simply carry on multimodal transport service and transportation enterprises, which may cause pressure on the company cash flow. Also, with double or triple corporate identities, the company should bear the fluctuation of both multimodal transportation market and railway transportation market, requiring the company to better manage its market risks.

Similar to weakness in economy, when discussing the weakness of China Railway Shanghai Group Co. Ltd. in terms of society. When taking charge of more transportation missions, there are higher possibility for the company to make mistakes. Also, if the company could not reach the expectation of the society in the multimodal transportation information platform management, the influence may backfire on the company's original business and cause social pressure on the company.

As the information technology developed far later than railway transportation, it is common for railway companies using paper documents in China (Liao et al, 2021). Moreover, railway companies prefer investing in physical assets rather than intangible information exchange system (Cai,2021). Since China Railway Shanghai Group Co. Ltd. started revolution in e-documents and online document platform in 2018, primarily turning the paper documents into electronic ones, there still exist many problems such as information security, customer using experience (Tang,2018), making it necessary for the company to speed up in the information technology.

4.2.4 Opportunity

Under the background that the whole nation is promoting the development of multimodal transportation, China Railway Shanghai Group Co. Ltd. with the identity of state-owned enterprise could regard itself as the main promoter boosting Chinese multimodal transportation, taking charge of the information platform and making full use of favorable policies. Compare to foreign companies, private companies and other types of companies, China Railway Shanghai Group Co. Ltd. could act as the representative of the nation to development international multimodal transportation

and further connect the Chinese multimodal network with the world.

With the proposal of the Belt and Road Initiative, which is an aspiration of all countries along the road, it could empower the information platform to a large extent. Because, compare to international trade among different continents separated by oceans, the trade along the Belt and Road route could utilize the advantages of the on-land transportation such as railway. Combine the larger cargo volume with advantages of railways, China Railway Shanghai Group Co. Ltd., which is one of the railway companies operating the railways in the most developed area in China, would have a good chance at better multimodal transportation platform development. For the company itself, being the administrator of the information platform could help it expend business scope, developing and transforming into a logistics solution provider.

From the society, China Railway Shanghai Group Co. Ltd. should meet customers' demand of high quality transportation, providing traders with point-to-point transportation solutions. To achieve the goal of offering effective and efficient transportation service, smooth information exchange should be guaranteed, which could be realized through the information platform. Therefore, becoming the administrator of the platform could assure the company better understanding of the platform, consequently bigger business volume and better service quality, which could further result in good society reputation.

When discussing about opportunities from the perspective of technology, the relationship between the administrator and the platform is mutually beneficial. For the administrator, the platform could be seen as a new technology to cooperate with the already existing technologies such as big data to provide better transportation service. On the opposite, the platform needs an entity who is professional in the multimodal transportation area and capable to operate the platform well. Therefore, being the administrator of the information platform itself is an opportunity for China Railway Shanghai Group Co. Ltd..

4.2.5 Threat

As the multimodal transportation would involve traders, carriers and many other entities around the world, threats that affecting the administrator could come from the world political situation, where the administrator should always be sensitive to political changes.

Due to the reason that the transportation market is a perfect competition market (Wang,1995), there exist lots of competitors competing and scrambling for multimodal transportation business. As a result, for China Railway Shanghai Group Co. Ltd., business entities in the same multimodal transportation market could be threats. If administrator is not capable to serve customers with high quality transportation service, the platform will not be able to attract enough customers, causing difficulties to the company's economic situation. Also, when carrying out administrator work, MTO business and carrier missions, investments on the platform, on the physical railways, on useful technologies and so on could be a potential risk to the company's operation, which may end up another threat.

Similarly, due to the characters of international multimodal transportation, there could be risks of social responsibility, security, culture breach and etc. For social responsibility, if the administrator does not operate the platform properly or does not take social responsibility properly, the platform could be under society criticism. Also, there may exist threats on security issues, which is both of transportation mission and of information, only with careful operation could China Railway Shanghai Group Co. Ltd. carry out good transportation missions with high security. For culture breaches, when cultures along the multimodal transportation routes changes, the administrator should pay full attention to respect and adopt the local cultures avoiding unnecessary social problems.

Technology threats come from both inside and outside of the information platform. From inside, if the administrator does not update the platform with

technologies that follow the trend, the platform would face the threat of being replaced by competitors. Also, if the administrator does not make use of the collected information in an ordered way or not be able to operate the platform to offer better transportation service, it would be a limiting factor for the development of the platform. From the outside, with more and more internet hackings and confidential information within the platform, threats of platform security and information security are problems the administrator should put focus on.

4.3 Multimodal information platform design

4.3.1 Design background

Shanghai-centered multimodal information platform is designed to help develop international multimodal transportation in China, which would involve lots of different entities with different roles and functions, mainly traders, MTOs, carriers, transshipment point operators and agents. Among these entities, there largely exists competitors in similar business sectors, making it extremely important to build a platform with clearly distinguished permissions to different business information.

User permission design method

RBAC, which is short for Role-Based Access Control, is a platform design model realizing the access control, consisting contents of role, permission, object and user.

In general, every user of the multimodal transportation information platform would be assigned with a role, which corresponds to a certain permission to certain objects, such as a file and a database. With such management, users of different roles could only get access to limited information and resources, avoiding the resources from being used by unauthorized users.

For entities that only has a single role, permissions are easy to identify. For instance, trading companies, such as “trader1”and “trader 2”, should be assigned with role of “trader”, whose authorities cover transportation demand release, contract

confirmation, multimodal transportation consulting, transportation mission management and overall management for itself. For agency companies, they are assigned with the role of “agent”, whose authority range from agency mission list check to its overall management. Similarly, every user assigned with one single role can only have access to the according permission.

But, when assigning roles to users, one user is allowed to have several roles, namely roles can be inherited. For example, when China Railway Shanghai Group Co. Ltd. signs a contract with a trading company, China Railway Shanghai Group Co. Ltd. first acts as the contracting carrier of the transportation mission, taking charge of the multimodal transport coordination. If the company further carries on the railway transportation itself, China Railway Shanghai Group Co. Ltd. also acts as the actual carrier, being authorized with the role of “carrier”. Additionally, the company always acts as the administrator of the information platform, having access to the resources that under administrator’s permission.

To sum up, the RBAC model divides users into different roles with different permission to certain objects, assigning every role with certain authorities to realize centralized management and control of permissions. Moreover, in the multimodal transportation information platform, when a user acts as different roles in the multimodal transportation mission, it can be assigned with several roles with according resources.

4.3.2 Design process

In the multimodal transport information platform, there involves users of trading companies, multimodal transportation companies, shipping companies, railway operators, highway transportation service providers, port operators, warehouse operators and agency companies. From the other side, roles consists of traders, administrator, MTO, carriers, transshipment point operators and agents.

Firstly, every user with original company nature should be assigned with a basic

role, which is shown in Table 1. For instance, trading companies should be assigned with the role of “trader”, transportation service providers of all transportation modes should be authorized with the role of “carrier” and so on so forth.

Table 1 Relationship between users and basic role

USER	ROLE
Trader 1	Trader
Trader 2	
Trader 3	
Trader 4	
…	
China Railway Shanghai Group Co. Ltd	Administrator
A MTO company	MTO
B MTO company	
…	
China Railway Shanghai Group Co. Ltd	Carrier
China Railway Taiyuan Group Co. Ltd	
China Railway Shenyang Group Co. Ltd	
…	
COSCO	
MEARSK	
…	
Highway carrier	
…	
Port of Shanghai	Transshipment point operator
…	
Waigaoqiao Warehouse	
…	
Agency company	Agent
…	

Moreover, companies, such as COSCO and China Railway Shanghai Group Co. Ltd, strive to expand business scope from original segment transportation service providers to overall transportation solutions providers, they could act as carrier, MTO and even agent. Therefore, there could be thousands of possibilities in the relationship between users and roles. Table 2 shows one possibility, where China Railway Shanghai

Group Co. Ltd are assigned with three roles, namely administrator, MTO and carrier, COSCO and China Railway Taiyuan Group Co. Ltd be assigned with two roles, namely carrier and MTO.

Table 2 Relationship between users and role

USER	ROLE
Trader 1	Trader
Trader 2	
Trader 3	
Trader 4	
…	
China Railway Shanghai Group Co. Ltd	Administrator
China Railway Shanghai Group Co. Ltd	MTO
China Railway Taiyuan Group Co. Ltd	
COSCO	
A MTO company	
China Railway Shanghai Group Co. Ltd	Carrier
China Railway Taiyuan Group Co. Ltd	
China Railway Shenyang Group Co. Ltd	
…	
COSCO	
MEARSK	
…	
highway carrier	
…	
Port of Shanghai	Transshipment point operator
…	
Waigaoqiao Warehouse	
…	
OP company	Agent
…	
Agency company	
…	

However, need to mention that all the assignment of roles should be under strict administration of China Railway Shanghai Group Co. Ltd, namely users should be

certificated by the administrator. Only when passing the authentication can users get assess to corresponding resources.

After determining the relationship between users and roles, it is vital to design the permissions accordingly, which is closely related to customers' demand. Because a well-functioned multimodal transportation information should first understand what users need from the platform to perform better, then the platform could assign different resources to different users. Consequently, demand analysis would be carried out first.

Through the multimodal transportation information platform, all users expected better performance on multimodal transportation, and further ensure themselves bigger business scope or better enterprise transformation. Traders wish to realize the cargo transportation tracking, centralized management and comprehensive logistics support (Liu et al., 2020; Ma, 2022).

MTOs want to manage the whole transportation efficiently, monitor the transportation status constantly and coordinate relevant entities conveniently (Ren,2020).

Carriers of every transportation segment, operators of transshipment points and agency companies are entities whose revenue highly depends on the quantity of goods handled, therefore they desire to gather more market information and cooperate with MTOs to ensure more business (Zhang & Liu, 2006). Moreover, as the capacities are not storable, efficient management of the limited resources are highly valued. Finally, it comes to the permission design after summary of the demand of different entities. Generally, every role has access to their own business and information that are necessary for them to carry on those business, shown in Table 3.

.

Table 3 Relationship of user & role & permission

USER	ROLE	PERMISSION
Trader 1	Trader	Individual released demand
Trader 2		Individual quotation from MTO & Contract information
Trader 3		Requiring ultimodal transport consult
Trader 4		Individual transportation mission information
…		Individual performance data
China Railway Shanghai Group Co. Ltd	Administrator	All multimodal transportation mission information (apart from confidential data)
		Certification information
		Overall platform performance data
China Railway Shanghai Group Co. Ltd	MTO	Multimodal transportation capacity information & Quotations
		Multimodal transportation demand & Contract information
China Railway Taiyuan Group Co. Ltd		Multimodal transportation mission information
		Consulting demand from trader
COSCO		Individual performance data
A MTO company		
China Railway Shanghai Group Co. Ltd	Carrier	Released multimodal transportation demand from MTO
China Railway Taiyuan Group Co. Ltd		
China Railway Shenyang Group Co. Ltd		Individual transportation mission information
…		
COSCO		
MEARSK		Expected transportation mission information
…		
highway carrier		Individual performance data
…		
Port of Shanghai	Transshipment point operator	Released transshipment demand from MTO
…		Individual transshipment mission information
Waigaoqiao Warehouse		Expected transshipment mission information
…		Individual performance information
OP company	Agent	Individual agency mission information & relevant segment transportation information
…		
Agency company		Individual performance data
…		

To be specific, Traders could see the demands that released before to monitor their orders, the quotations from different MTOs to determine which to cooperate with, the information of ongoing and completed multimodal transportation to monitor the transportation process, and their individual performance on the platform. Additionally, they could send consulting requirements to MTOs.

Administrator has access to all multimodal transportation missions on the platform, certification documents from users and the overall transportation mission performance on the platform. But when coming to multimodal transportation contracts, which may involve confidential information, the administrator can only see part of the contract. For example, the administrator could see the information about cargo, multimodal rate, multimodal transportation routes and transportation reliability performance to monitor whether the MTOs are operating well, but has no access to detailed contracts on freight payment, multimodal transportation documents,

technology secrets and so on.

For every MTO, company can reach the demand released by traders and further quote to segment transportation service providers. After determining the carrier, transshipment point and agent of every segment, contract could be signed, where relevant information could be viewed on the platform. Additionally, MTOs could ask their cooperative entities to revert with their transporting or transshipping capacities, help themselves to better arrange and manage multimodal routes.

For carriers, they have access to upstream information of multimodal demand released by MTO, transportation information updated by relevant agents, expected transportation volume summarized by the intelligent platform, and data about individual performance on financial, transportation reliability and other aspects.

For transshipment point operators, who connect different transportation segments together, are authorized to view offers from MTOs, information of two transportation segments updated by agents, transshipment status and individual performance on revenue, efficiency and etc.

For agency companies, whose role is agent, have access to the information of the segments under its agency scope, which consists the transportation carrier, status of the transportation and so on. Also, every agency company would be able to analyze its business performance through the platform.

4.3.3 Platform functions

4.3.3.1 Realization of single-document transportation

Realization of single-document transportation is determined by the basic characteristic of multimodal transport. Under multimodal transport, there will be a single and unique document representing a transportation mission. Within the process, MTO would be responsible for the coordination and scheduling of various logistics missions, including logistics information sharing, goods tracking, dispute management and etc.

From the customers' side, the information platform offers customers more integrated and full-range transportation services, making it no need for customers to worry about transitions among different transport modes or intermediate process. In other words, the platform will be able to provide customers with an overall logistics solution.

From the carriers' side, the information platform would be able to integrate demand information and distribute transportation missions accordingly, where carriers are secured with less risks when soliciting goods in the market themselves with limited information.

From MTOs' side, with more information and orders gathered by the information platform, it will be more bargain power for MTOs against carriers and agents. With such bargaining power, MTOs would have lower cost compared to simply and individually connecting different transportation sections, which further obtain a price advantage against other segment transportation service provider.

For actual logistics service providers, namely carriers, operators of transshipment points and agents, the platform enables them to have more market information. If signing cooperation contracts with MTOs, cooperating business volumes can be discussed, where better business volume prediction can be achieved.

To sum up, embracing multimodal information platform with one single transportation document could have positive impact on all entities along the transportation chain.

4.3.3.2 Transportation security

Transportation security refers to security for both the transportation itself and for information on the platform.

Security for the transportation is determined by every transportation segment and transshipment point. Compare to traditional transportation, seamless connection between different transportation modes can be realized through multimodal

transportation, skipping multiple cargo inspection and custom declaration along the transportation, which can largely reduce the possibility of cargo damage during cargo inspection and improve the transportation efficiency.

Security for the information on the platform is both a requirement for the platform and an advantage that the platform could offer the users. During the process of multimodal transportation realization, technologies such as sensors are inevitably injected with equipment to realize constant monitor of the transportation. However, the gathered information could be a backfire against the platform if being abused. Once confidential information leaks, there could be huge negative impact on business entities, where the reputation of the platform could be damaged.

Therefore, the gathering of data and processing of data should be valued equally to provide customers with a safe international multimodal transportation platform.

4.3.3.3 Seamless connection between different transportation modes

From the perspective of physical cargo transportation, one unified multimodal transportation number represents the overall transportation mission. Instead of signing contract with carriers of different transportation segments and submitting transportation materials respectively, under a multimodal contract, all entities are under MTO's coordination, namely it is close to cooperation among different entities where seamless connection can be realized.

From the perspective of intangible information, with multimodal information platform, relevant information can be shared and exchanged by related entities before the cargo actually reaching the point, enabling the cargo to be transported and taken over smoothly among different transportation modes. Once the efficiency during transition is improved, multimodal transportation could have huge advantage over traditional segmented transportation. Moreover, not only the time duration of transportation mission could be shortened, the efficiency of every transportation node could be improved.

4.3.3.4 Cargo flow track & better customer service

With MTO monitoring the overall multimodal transportation mission, technologies empowering the platform, multiple entities cooperating together, the status of transportation could be monitored by at least two entities. Therefore, the cargo flow could be easier to track and become more accurate under double or triple checks.

Besides the advantage of easier cargo flow track, customers could enjoy more effortless transportation by applying multimodal transportation. All traders need to do is to communicate with MTO, ranging from cargo tracking, freight settlement to dispute settlement. There is no longer need for them to communicate with multiple entities and settle dispute separately.

Moreover, with MTO managing the overall transportation route, transportation resources are managed and arranged from a broader view, namely the transportation capacities are under unified allocation to realize the optimal transportation outcome.

5 Multimodal information platform implementation

5.1 Multimodal information platform workflow diagram

Figure 1 shows the workflow diagram of the multimodal transportation information platform.

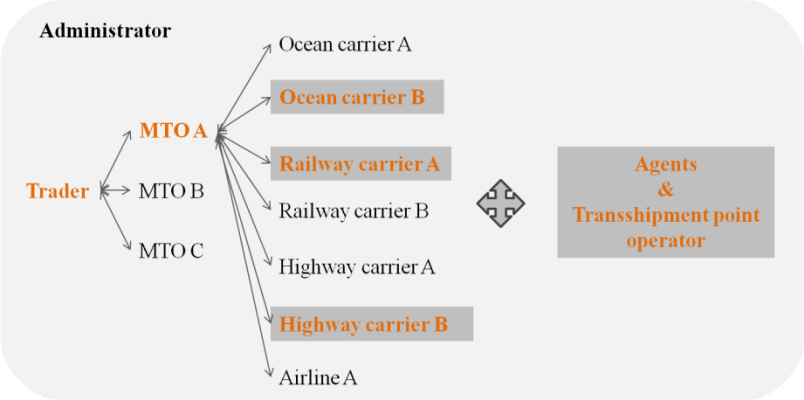


Figure 1 Multimodal transportation information platform workflow diagram

First, it is the negotiation that between trader and MTOs, where trader releases its demand and requirements onto the platform waiting for MTOs' bids. Once an agreement on the transportation is reached, a multimodal contract can be signed between them. In the example, MTO A successfully signed a multimodal contract with the trader.

Then, with the multimodal transportation contract, MTO A can choose its cooperative carriers to carry on the transportation segments or ask carriers on the market to bid through the information platform. After receiving enough information, MTO A will be able to decide an optimal transportation solution which can both meet trader's demand and gain reasonable profits.

In the process, MTO A also considers about the transshipment point conditions. If the port charge is too high or the port equipment can not meet the loading or discharging requirements, the transportation solution would be largely affected. Once a multimodal transportation solution is shaped, MTO A appoints agency companies accordingly to help it carry on the multimodal transportation mission.

All the processes are under administrator's monitor. Any breaches on good faith or serious failure in business performance can be noted. The administrator can take actions to disqualify users' role if necessary.

5.2 Multimodal transport schedule development

From the platform, traders could release their transportation demand themselves. But for every MTO, it could release multimodal transport schedule for traders' reference, offering traders basic ideas of transportation schedules and diversified multimodal transportation choices. Therefore, in this part, the essay would design a multimodal schedule that could be released by MTO to traders.

5.2.1 Hypothesis

Due to the reason that multimodal transportation needs to inspect the cargo with unified standard and to seal the cargo with anti-counterfeiting multimodal sign, multimodal transportation always starts at a specific area such as free trade area, rather than doors of traders' warehouses. When coming to places without setting of free trade zones, ports or other transshipment points that already have the ability and experience on cargo inspection and cargo receipt could act as multimodal transportation nodes. But every MTO could choose whether to offer service between the actual origin to the free trade zone or ports, depending on its own business strategy.

To be more specific in the choice of transshipment points, as the assumed administrator of the international multimodal transportation information platform is a state-owned enterprise in China, countries that have free trade agreements with China could choose the container ports to be the multimodal transportation nodes.

Based on above background, the essay assumes the multimodal transportation nodes within China includes China (CHONGQING) pilot free trade zone, China (ZHEJIANG) pilot free trade zone and China (SHANGHAI) pilot free trade zone within China, gathering cargo from the inland of China. Outside the nation, Countries such as South Korea, Mexico, Columbia, Peru and Chile, have signed free trade agreement with China. Even there is no specific area of free trade zone, main container ports in these countries could be multimodal transportation nodes.

After determining the multimodal nodes in one multimodal route, MTO should

choose different transportation modes considering freight rates, durations, transportation quality, cooperative carriers, agents and so on. In this case, it is assumed that MTO taking charge of the multimodal transportation mission chooses rails to carry on the transportation within China, namely connecting the three free trade zones with railways. From the third node to the final node, namely from China (SHANGHAI) pilot free trade zone to Port of San Antonio, the MTO basically use ships to fulfill the transportation. Apart from the choice of general transportation mode, highway transportation could be arranged in needed.

The essay assumes the regular multimodal transportation interval of the whole route, namely from China (CHONGQING) pilot free trade zone to Port of San Antonio is eight days. Interval of the route from China (CHONGQING) pilot free trade zone to Busan Port is four days. The routes within China, from China (CHONGQING) pilot free trade zone to China (SHANGHAI) pilot free trade zone, starts every two days.

Need to mention that the schedules released on the platform are for general routes, giving traders basic knowledge of the multimodal transportation routes. When customers propose a specific demand, MTOs could flexibly leverage existing routes and partnerships to carry out the multimodal transportation.

5.2.2 Multimodal transport schedule

Based on above hypothesis, a multimodal transport schedule can be designed as in Table 4.

Table 4 Multimodal transport schedule

Transshipment point		China (CHONGQING) pilot		China (ZHEJIANG) pilot free trade zone		China (SHANGHAI) pilot free trade zone		Busan Port		Port of Ensenada		Port of Buenaventura		Port of ancon		Port of San Antonio	
Country		China		China			China	South Korea		Mexico		Colombia		Peru		Chile	
Distance		1500KM			170KM		489NM		5386.78NM		2959.33NM		1136.68NM		1369nm		
Transportation duration (with safty margin)		3			2		3		20		12		5		6		
		CLOSING TIME	DEPARTURE	CLOSING TIME	DEPARTURE	CLOSING TIME	DEPARTURE	CLOSING TIME	DEPARTURE	CLOSING TIME	DEPARTURE	CLOSING TIME	DEPARTURE	CLOSING TIME	DEPARTURE	CLOSING TIME	DEPARTURE
INTERVAL	8	5/9	5/10	5/12	5/13	5/14	5/15	5/16	5/18	6/1	6/7	6/16	6/19	6/22	6/24	6/28	6/30
		5/17	5/18	5/20	5/21	5/22	5/23	5/24	5/26	6/9	6/15	6/24	6/27	6/30	7/2	7/6	7/8
		5/25	5/26	5/28	5/29	5/30	5/31	6/1	6/3	6/17	6/23	7/2	7/5	7/8	7/10	7/14	7/16
		6/2	6/3	6/5	6/6	6/7	6/8	6/9	6/11	6/25	7/1	7/10	7/13	7/16	7/18	7/22	7/24
		6/10	6/11	6/13	6/14	6/15	6/16	6/17	6/19	7/3	7/9	7/18	7/21	7/24	7/26	7/30	8/1
		6/18	6/19	6/21	6/22	6/23	6/24	6/25	6/27	7/11	7/17	7/26	7/29	8/1	8/3	8/7	8/9
		6/26	6/27	6/29	6/30	7/1	7/2	7/3	7/5	7/19	7/25	8/3	8/6	8/9	8/11	8/15	8/17
		7/4	7/5	7/7	7/8	7/9	7/10	7/11	7/13	7/27	8/2	8/11	8/14	8/17	8/19	8/23	8/25
		7/12	7/13	7/15	7/16	7/17	7/18	7/19	7/21	8/4	8/10	8/19	8/22	8/25	8/27	8/31	9/2
	4	5/9	5/10	5/12	5/13	5/14	5/15	5/16	5/18								
		5/13	5/14	5/16	5/17	5/18	5/19	5/20	5/22								
		5/17	5/18	5/20	5/21	5/22	5/23	5/24	5/26								
		5/21	5/22	5/24	5/25	5/26	5/27	5/28	5/30								
		5/25	5/26	5/28	5/29	5/30	5/31	6/1	6/3								
		5/29	5/30	6/1	6/2	6/3	6/4	6/5	6/7								
		6/2	6/3	6/5	6/6	6/7	6/8	6/9	6/11								
		6/6	6/7	6/9	6/10	6/11	6/12	6/13	6/15								
		6/10	6/11	6/13	6/14	6/15	6/16	6/17	6/19								
		6/14	6/15	6/17	6/18	6/19	6/20	6/21	6/23								
	2	5/9	5/10	5/12	5/13	5/14	5/15										
		5/11	5/12	5/14	5/15	5/16	5/17										
		5/13	5/14	5/16	5/17	5/18	5/19										
		5/15	5/16	5/18	5/19	5/20	5/21										
		5/17	5/18	5/20	5/21	5/22	5/23										
		5/19	5/20	5/22	5/23	5/24	5/25										

5.3 Platform interface

5.3.1 Platform interface developing method

Logic tree is a model commonly used to classify information through progressive method and finally to present the results in a logic way, whose main advantages include strong interpretability, easy application and easy comprehension.

When designing the platform, interface functions should be determined by customers' demands. As the permissions discussed above also depends on demands of different users, functions could be matched with permissions. When presenting the corresponding relationships between permissions and interface functions, the model of logic tree could be used.

5.3.2 Platform interface

As mentioned above, functions on interfaces of different roles should be matched with permissions. The overall functions are shown in Table 5 , while detailed interface presentation would be presented in the continuous parts.

Table 5 Interface functions corresponding to permissions

ROLE	PERMISSION	FUNCTION
Trader	Individual released demand	transport demand release
	Individual quotation from MTO & Contract information	contract confirmation (with MTO)
	Requiring ultimodal transport consult	multimodal transportation consulting
	Individual transportation mission information	transportation mission management
	Individual performance data	overall management (trader)
Administrator	All multimodal transportation mission information (apart from confidential data)	view all multimodal transport mission
	Certification information	MTO company certification
	Overall platform performance data	platform management(in overall management)
MTO	Multimodal transportation capacity information & Quotations	tansportation demand release
	Multimodal transportation demand & Contract information	contract confirmation (with trader & carrier & TP operator & agent)
	Multimodal transportation mission information	transportation monitor & management
	Consulting demand from trader	respond to traders' consult
	Individual performance data	overall management (MTO)
Carrier	Released multimodal transportation demand from MTO	respond to MTO demand
	Individual transportation mission information	segmented transportation management (basic & update)
	Expected transportation mission information	volume expectation
	Individual performance data	overall management (carrier)
Transshipment point operator	Released transshipment demand from MTO	respond to MTO demand
	Individual transshipment mission information	transshipment mission management (mission list & update)
	Expected transshipment mission information	volume expectation
	Individual performance information	overall management (TP OP)
Agent	Individual agency mission information & relevant segment transportation information	agency mission list check
		transportation status update
	Individual performance data	overall management (agent)

5.3.2.1 Trader interface

For traders, they want to have point-to-point transportation service with high reliability. If a platform is able to offer more diversified multimodal transportation choices with transparent freight rates and reliable transportation performance, traders would prefer carrying out transportation mission through the information platform.

There are five main functions on trader's interface, namely transportation demand release, contract confirmation, multimodal transportation consulting, transportation mission management and overall management.

From the function of transportation demand release in Figure 2, trading companies would be able to report the cargo type, cargo description, LAYDAY and other necessary information for MTO's reference. After submitting the demand, a random transportation number would be generated, which is used for identification before the actual multimodal transportation contract is signed.

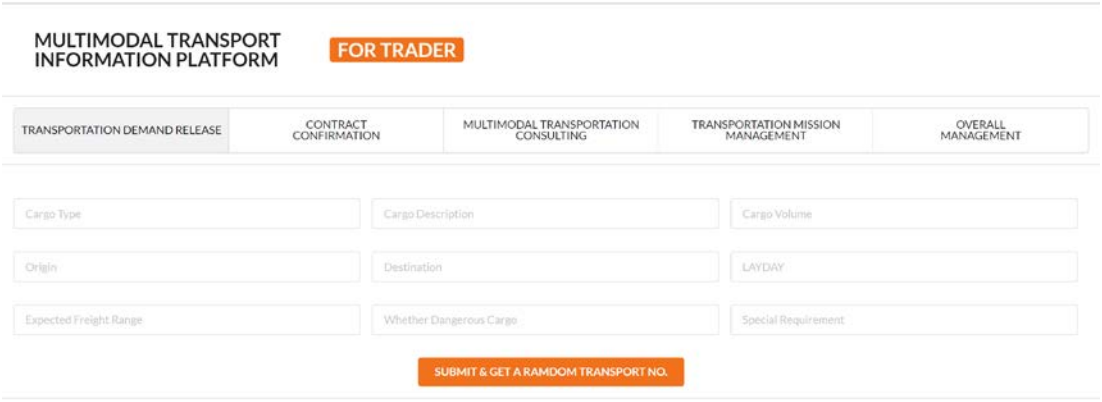


Figure 2 Trader interface – transportation demand release

As shown in Figure 3, after getting random transportation numbers, traders would receive bids from MTOs offering different freight rate. Traders could communicate with different MTOs by clicking the "further communication" button. When finally decided which MTO to cooperate with, a unified multimodal transportation number,

namely “MTxxxxx”, will be generated and the contact will also be updated onto the platform.

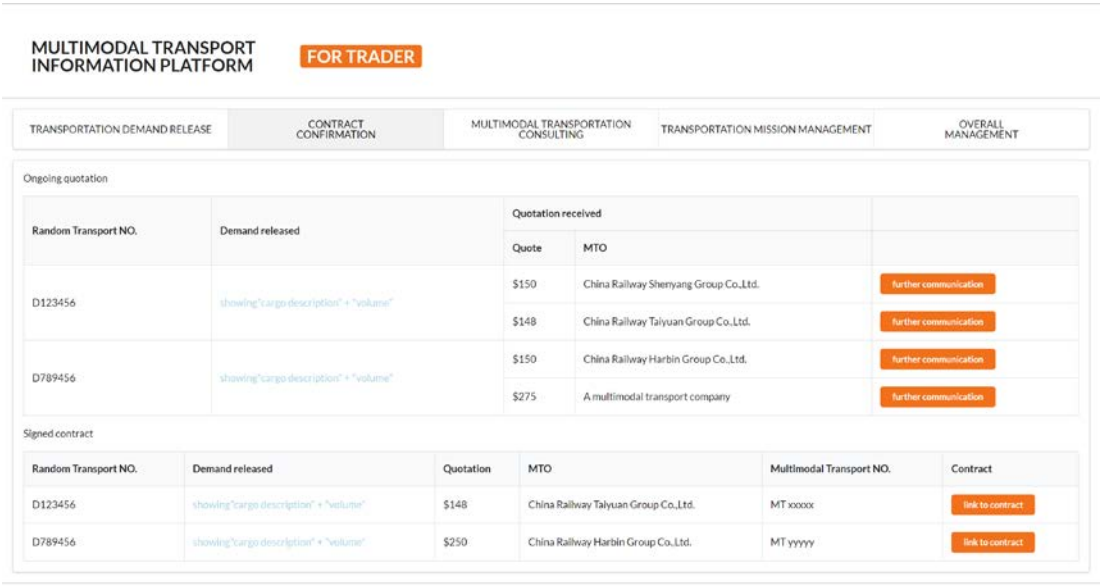


Figure 3 Trader interface – contract confirmation

As trading companies sometimes lack the knowledge in actual transportation, a consulting function is designed for traders, which is shown in Figure 4.

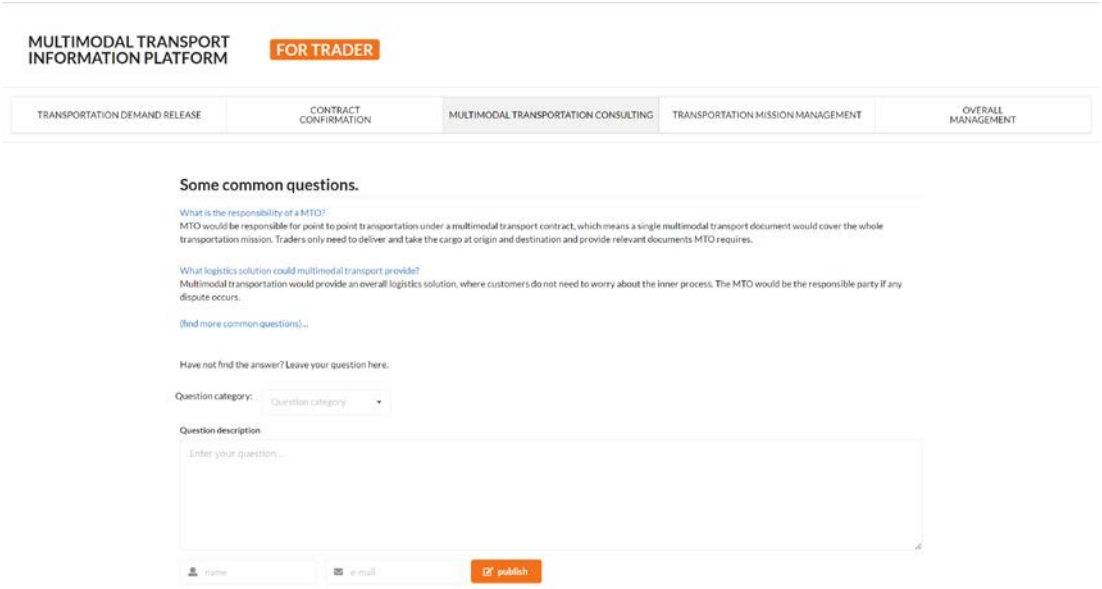


Figure 4 Trader interface – multimodal transportation consulting

In the function of transportation mission management, which is shown in Figure 5, trader is able to search multimodal transportation mission by entering the unified multimodal transportation number. On the page, on-going and completed multimodal transportation mission could be searched.

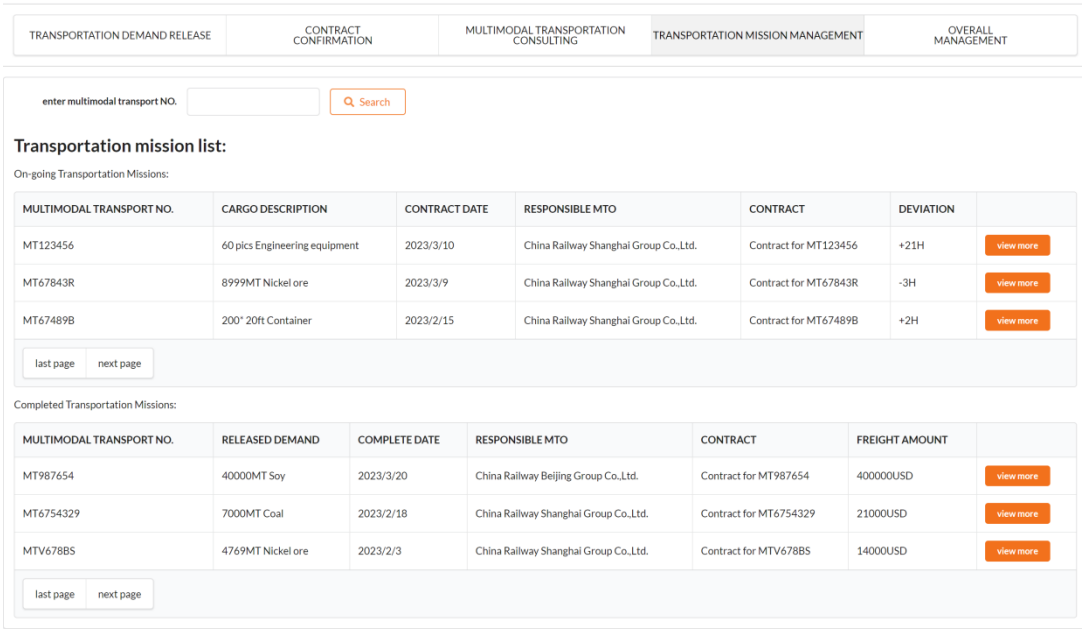


Figure 5 Trader interface – transportation mission management

Last function on trader's interface is overall management in Figure 6 and Figure 7. This function gathers the history transportation data and further gives the analysis on cargo volume, transportation reliability and cost. Additionally, when involving disputes, traders can settle them in this function.

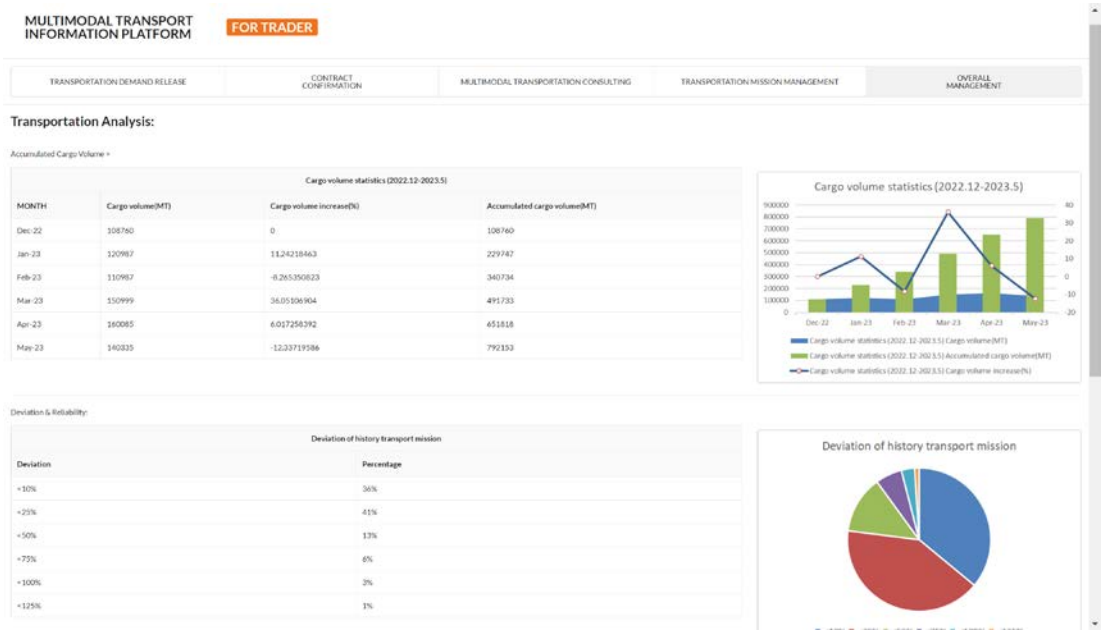


Figure 6 Trader interface – overall management (transportation analysis)

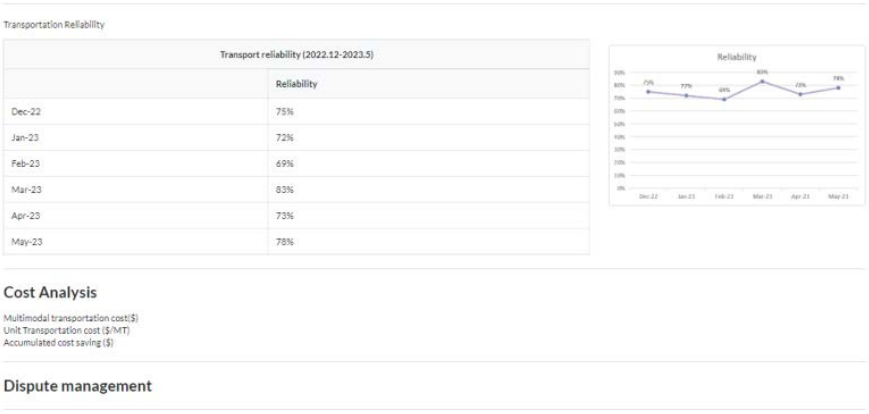


Figure 7 Trader interface – overall management (cost analysis & dispute management)

5.3.2.2 Administrator interface

For administrator, namely the China Railway Shanghai Group Co. Ltd., the company is appointed to operate and manage the international multimodal transportation of the nation. Therefore, in order to do so, the company would be able to view all transportation missions on the platform. Plus, as competitions could boost

the energy of markets, administrator would allow users be offered with different roles, giving more possibilities in multimodal transportation choices. Therefore, the three functions on administrators' interface are transportation monitor and management, platform overall management and company certification.

In the function of transportation monitor and management shown in Figure 8, the administrator would be able to see all multimodal transportation missions. But as mentioned above, when coming to contracts, the administrator is not authorized to view sensitive business secrets.

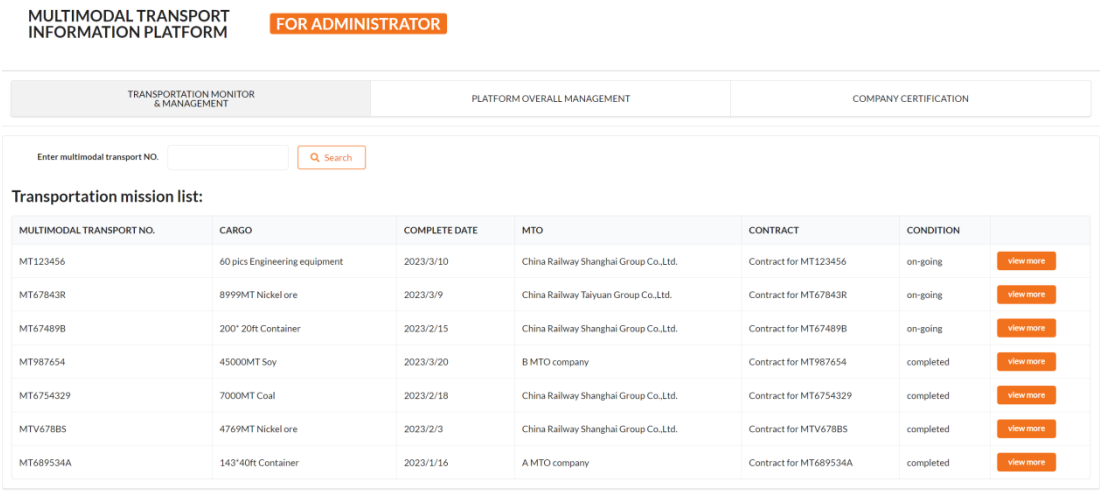


Figure 8 Administrator interface – transportation monitor & management

In the function of platform overall management in Figure 9, the algorithm and technologies supporting the platform would gather the background data and summarize the performance of overall platform, giving the administrator ideas on how the platform is operating.

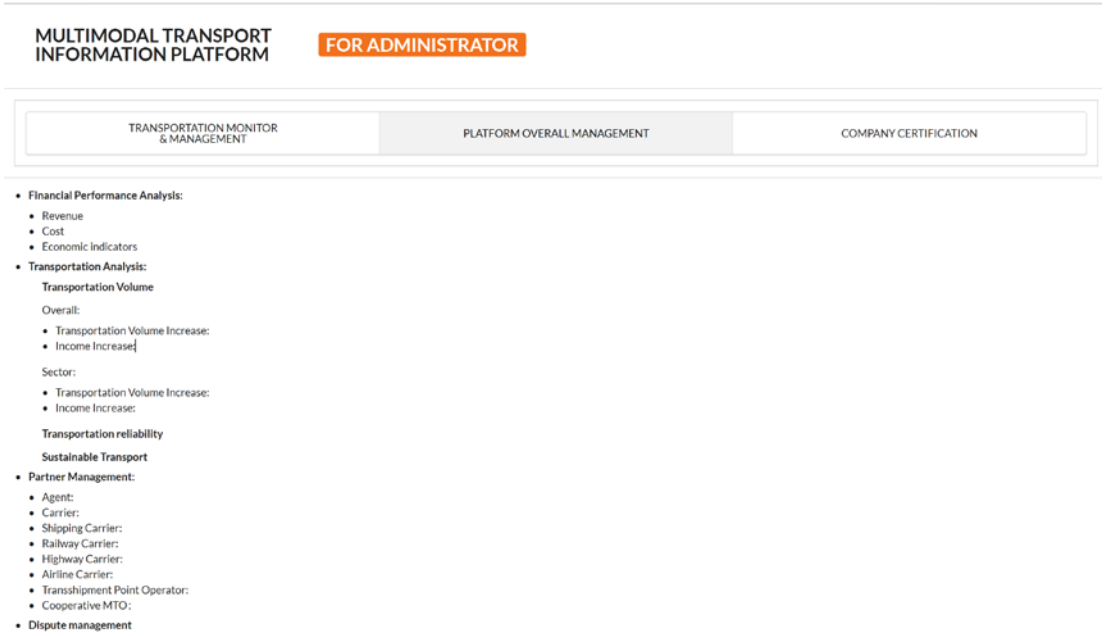
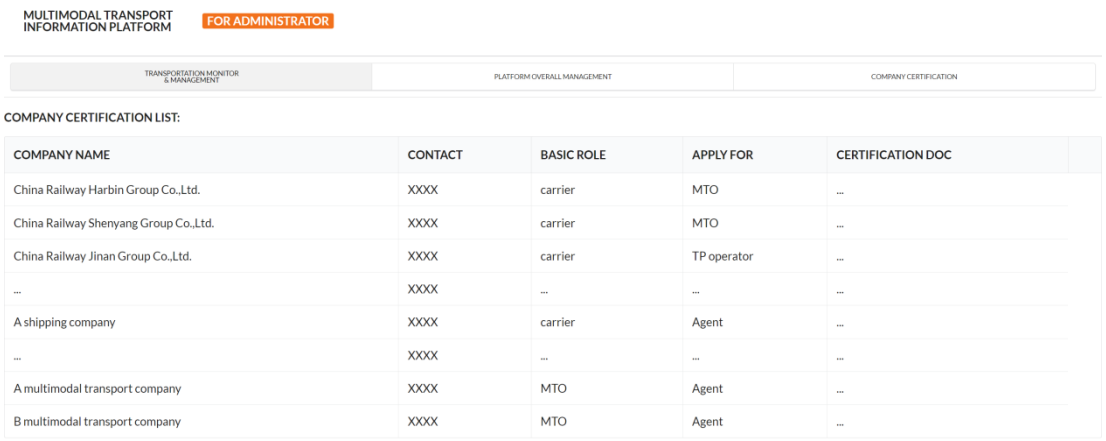


Figure 9 Administrator interface – platform overall management

In the function of company certification in Figure 10, the administrator could view the certification documents from different users. Namely, any user with a basic role could be authorized with another role by submitting relevant documents.



COMPANY NAME	CONTACT	BASIC ROLE	APPLY FOR	CERTIFICATION DOC
China Railway Harbin Group Co.,Ltd.	XXXX	carrier	MTO	...
China Railway Shenyang Group Co.,Ltd.	XXXX	carrier	MTO	...
China Railway Jinan Group Co.,Ltd.	XXXX	carrier	TP operator	...
...	XXXX	...	...	...
A shipping company	XXXX	carrier	Agent	...
...	XXXX	...	...	...
A multimodal transport company	XXXX	MTO	Agent	...
B multimodal transport company	XXXX	MTO	Agent	...

Figure 10 Administrator interface – company certification

5.3.2.3 MTO interface

For MTOs, who act as the coordinator of the multimodal transportation, they

pursue the ability to monitor and manage the overall transportation mission, where requires the platform to offer them sufficient information of reliable carriers, agents and transshipment point operators. After finding trustworthy cooperators, it would be better if the platform could update and visualize the transportation statues for MTO's easier operation.

In the first function of contract confirmation in Figure 11 and Figure 12, MTO is able to sign contracts with traders and carriers.

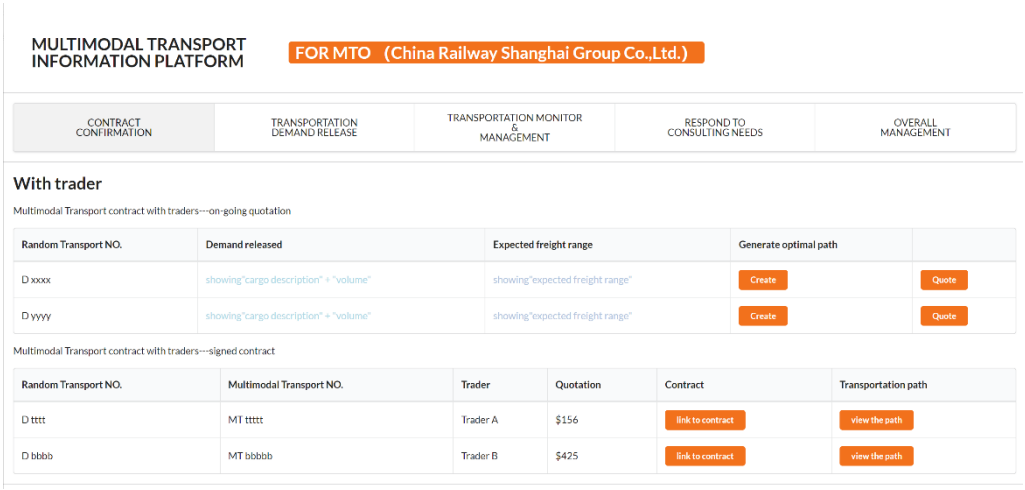


Figure 11 MTO interface – contract confirmation with trader

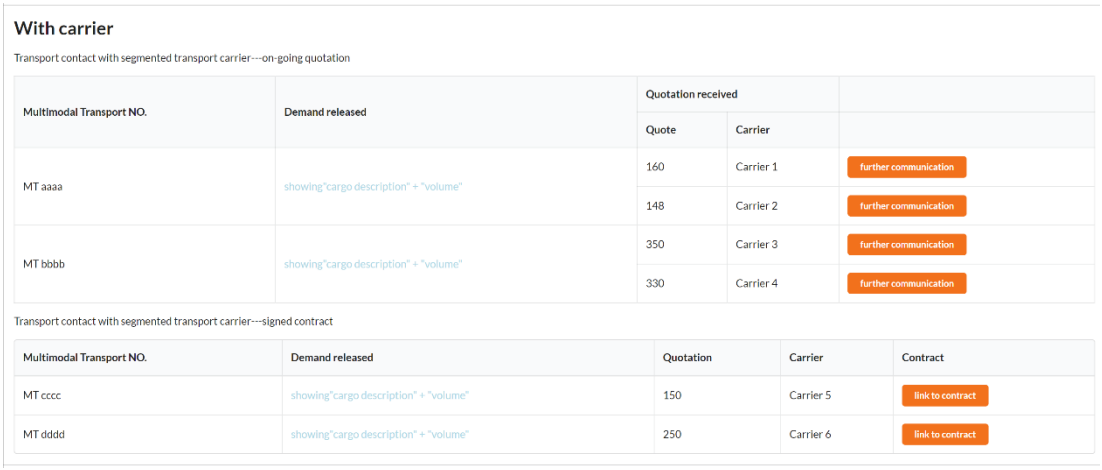


Figure 12 MTO interface – contract confirmation with carrier

When making agreements with traders, MTO could first get an optimal path

generated by the platform automatically, based on which, MTO can have a basic idea on the multimodal transportation route and further quote to traders. Once a contract is confirmed, a multimodal transportation number is generated, where contract and multimodal path can be viewed.

In case the automatically generated optimal path is not feasible or with already existing cooperative carrier better transportation performance can be achieved, MTO can also release transportation demand to carriers, which is the second function of MTO interface shown in Figure 13. With the released demand, MTO can receive bids from carriers and choose which one to cooperate with.

Figure 13 MTO interface – transportation demand release

The third function on the MTO's interface is transportation monitor and management as presented in Figure 14. From the function, MTO can easily look up multimodal transportation missions under its control.

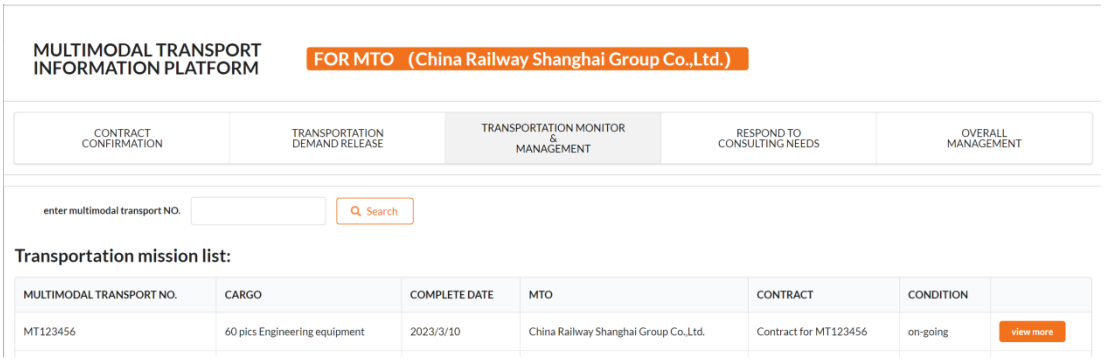


Figure 14 MTO interface – transportation monitor & management

By clicking “view more”, the page in Figure 15 is shown, where information on every transportation segment and transshipment point can be checked, and the visualization of the whole transportation route is available as well.

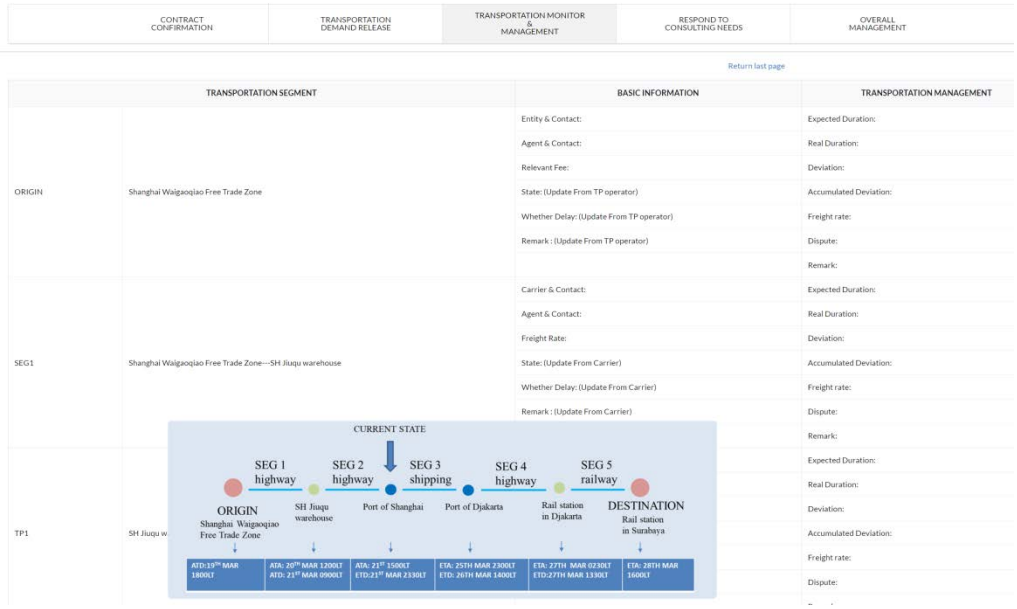


Figure 15 MTO interface – MTO interface – transportation monitor & management (view more)

To respond to traders’ questions, MTO could click the button “lick to respond” in Figure 16.

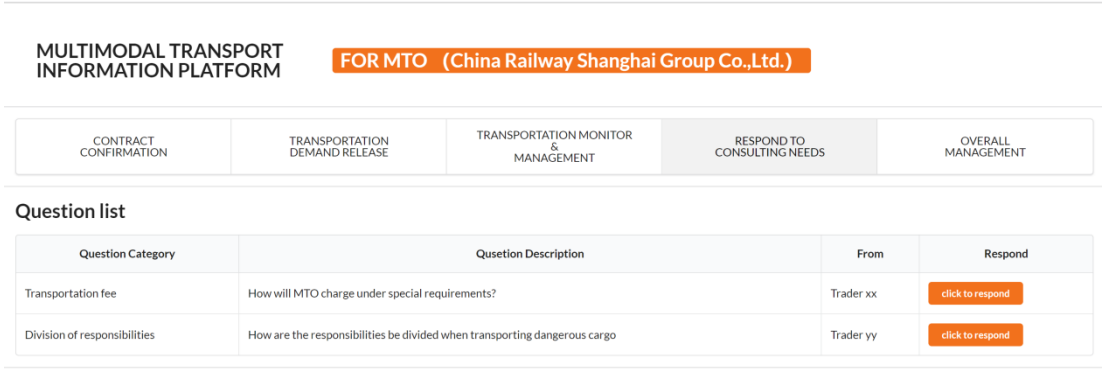


Figure 16 MTO interface – respond to consulting needs

In the last function on MTO's interface, every MTO can analyze their own business through the platform, where the platform will give analysis on financial performance, transportation quality, partner and dispute management, as shown in Figure 17.

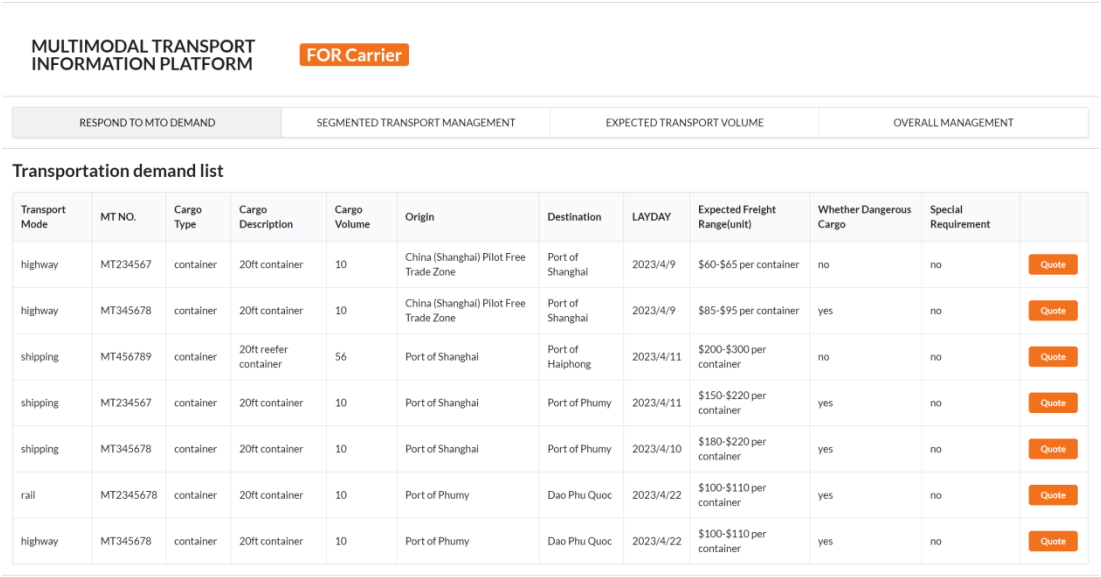
Figure 17 MTO interface – overall management

5.3.2.4 Carrier interface

For carriers who actually carry on the transportation segments, the platform is

designed to offer them opportunities of signing long-term contract with MTOs and quoting to MTO directly. With signed multimodal transportation contracts, carriers could easily update and remark on the transportation status from the platform.

As the MTO may pose the transportation mission on the platform awaiting the bids from carriers, carriers could quote from the function of “RESPOND TO MTO DEMAND” as shown in Figure 18.



Transport Mode	MT NO.	Cargo Type	Cargo Description	Cargo Volume	Origin	Destination	LAYDAY	Expected Freight Range(unit)	Whether Dangerous Cargo	Special Requirement	
highway	MT234567	container	20ft container	10	China (Shanghai) Pilot Free Trade Zone	Port of Shanghai	2023/4/9	$60-$65 per container	no	no	Quote
highway	MT345678	container	20ft container	10	China (Shanghai) Pilot Free Trade Zone	Port of Shanghai	2023/4/9	$85-$95 per container	yes	no	Quote
shipping	MT456789	container	20ft reefer container	56	Port of Shanghai	Port of Haiphong	2023/4/11	$200-$300 per container	no	no	Quote
shipping	MT234567	container	20ft container	10	Port of Shanghai	Port of Phumy	2023/4/11	$150-$220 per container	yes	no	Quote
shipping	MT345678	container	20ft container	10	Port of Shanghai	Port of Phumy	2023/4/10	$180-$220 per container	yes	no	Quote
rail	MT2345678	container	20ft container	10	Port of Phumy	Dao Phu Quoc	2023/4/22	$100-$110 per container	yes	no	Quote
highway	MT345678	container	20ft container	10	Port of Phumy	Dao Phu Quoc	2023/4/22	$100-$110 per container	yes	no	Quote

Figure 18 Carrier interface – respond to MTO demand

After quotation, the successful quotations would be shown in the next function, namely in Figure 19.

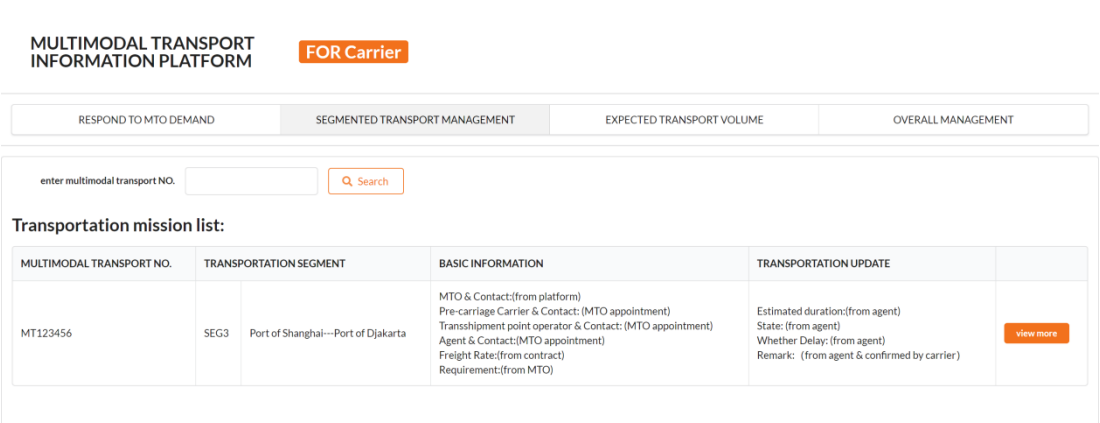


Figure 19 Carrier interface – segmented transport management

In this function, carrier could view the segments that under its business. By clicking “view more”, segment transportation is visualized as in Figure 20, and basic information about the multimodal transportation can be shown. Plus, as one of the actual carriers of the multimodal transportation mission, the carrier has responsibility to update the transportation status. But considering the cooperative agents of the transportation mission can be more familiar with the standard of transportation status update, and they are also employers of MTO, it is the agents that first communicate with the carrier and further update the latest information onto the platform, waiting for carriers’ confirmation. But in case the carrier needs to remark on the transportation status, carrier can click the “REMARK” button to realize it.

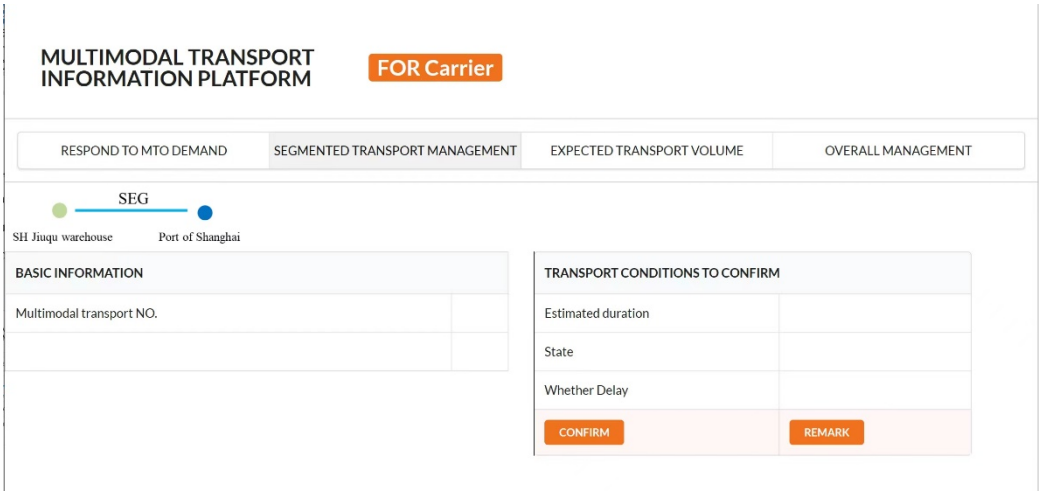


Figure 20 Carrier interface – segmented transport management (view more)

The third function on carriers' interface is cargo volume prediction, where expected transport volume will be arranged by the platform as shown in Figure 21, helping the carrier to better arrange its transportation capacities.

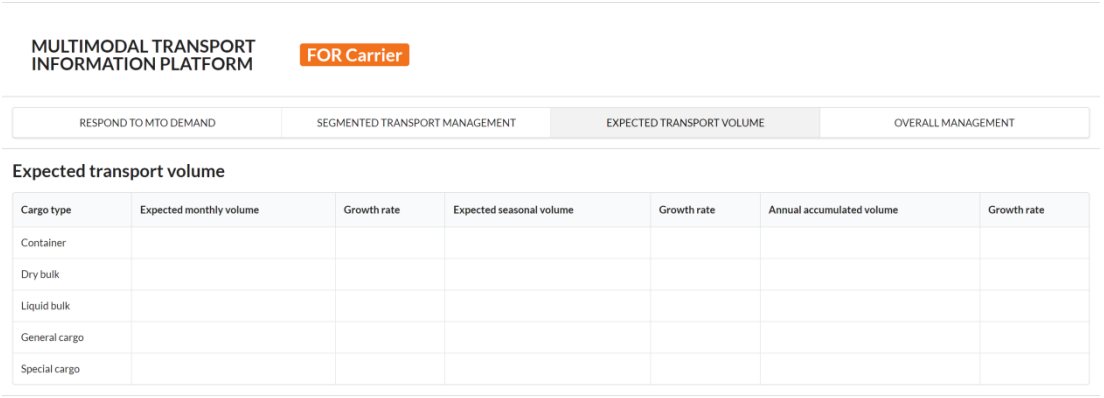


Figure 21 Carrier interface – expected transport volume

Finally, the function of "overall management", as shown in Figure 22,will give the enterprise ideas on their business performance, enabling them to discover the business value the platform brings them.

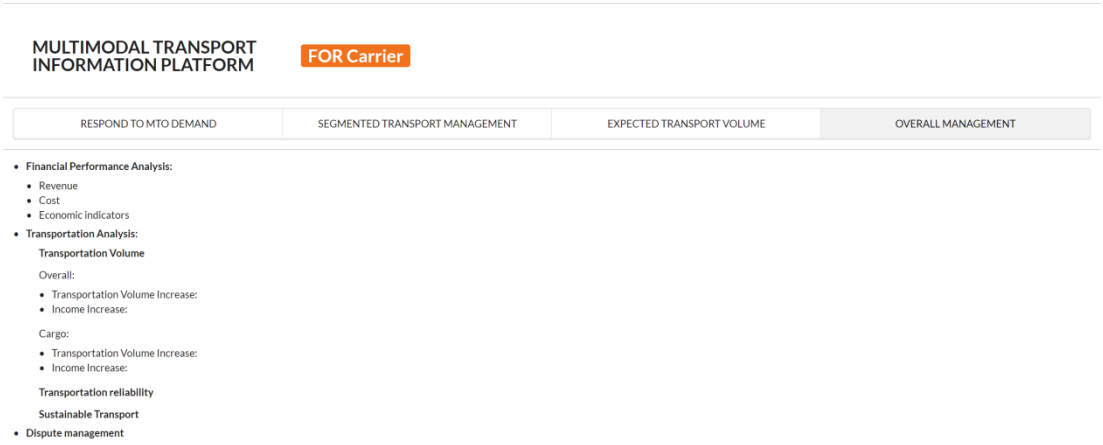


Figure 22 Carrier interface – overall management

5.3.2.5 Transshipment point operator interface

For transshipment point operators, the first function on the interface is respond to MTO demand as in Figure 23. Different from the choice of carrier by MTO, the choice on transshipment point is largely determined by multimodal routes. Therefore, when coming to the contacts between MTO and multimodal transportation point operator, the essay assumes that direct appointment takes bigger proportion, which can be checked from the transshipment mission list.

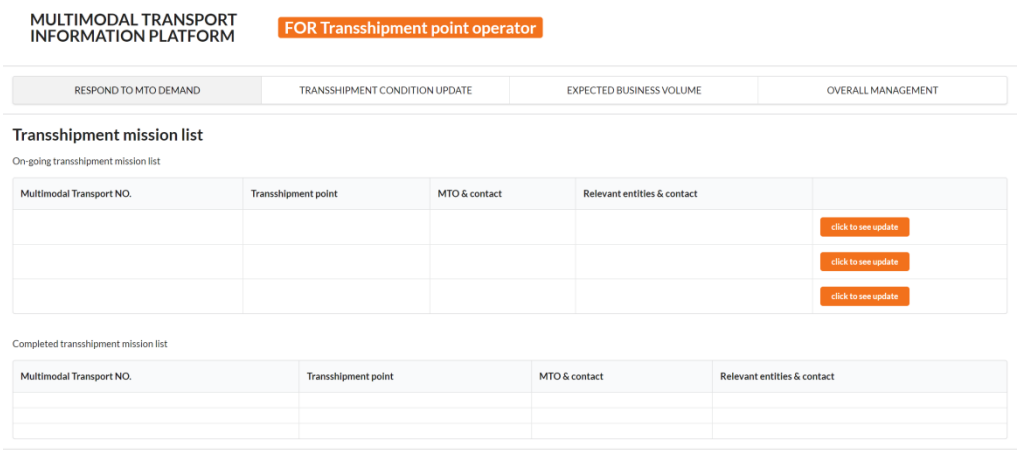


Figure 23 Transshipment point operator interface – respond to MTO demand

Similar to carriers, transshipment operators should also take the cargo status

update as its responsibility, which is realized by the function “transshipment condition update” in Figure 24.

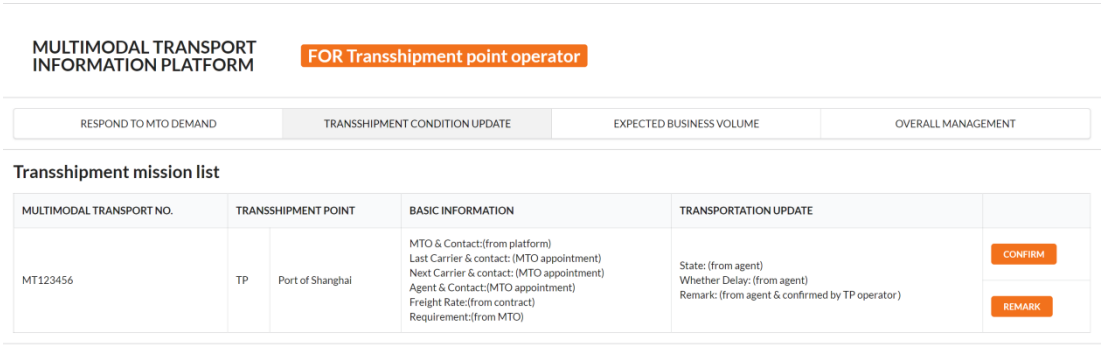


Figure 24 Transshipment point operator interface – transshipment condition update

As profits of transshipment point operator comes from good management of limited resources, they desire to know the future cargo volume. For example, a port with good prediction of cargo volume could better organize the layout of goods in the yard to improve the efficiency of cargo distribution, rather than arranging the storage of goods at the dock based on real-time cargo volume. Therefore, there is a function called “volume expectation” as in Figure 25.

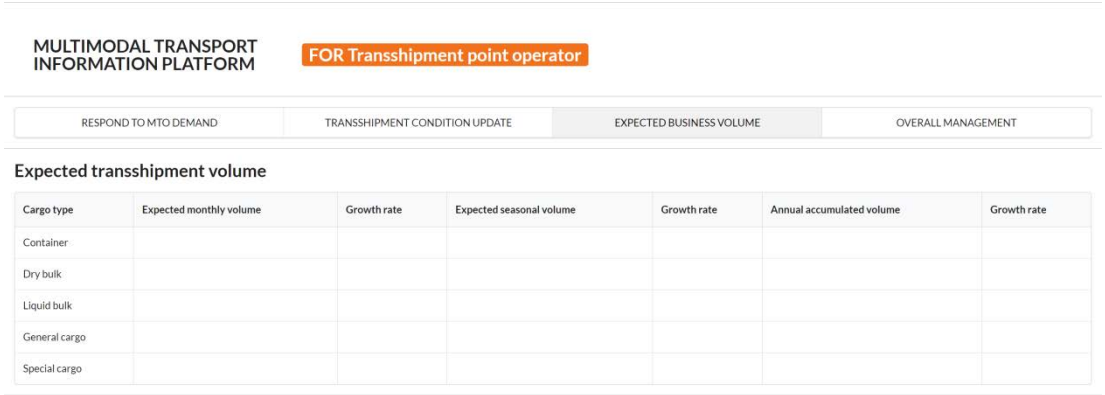


Figure 25 Transshipment point operator interface – expected business volume

Finally, Figure 26 shows the function of overall management, where individual business performance can be viewed.

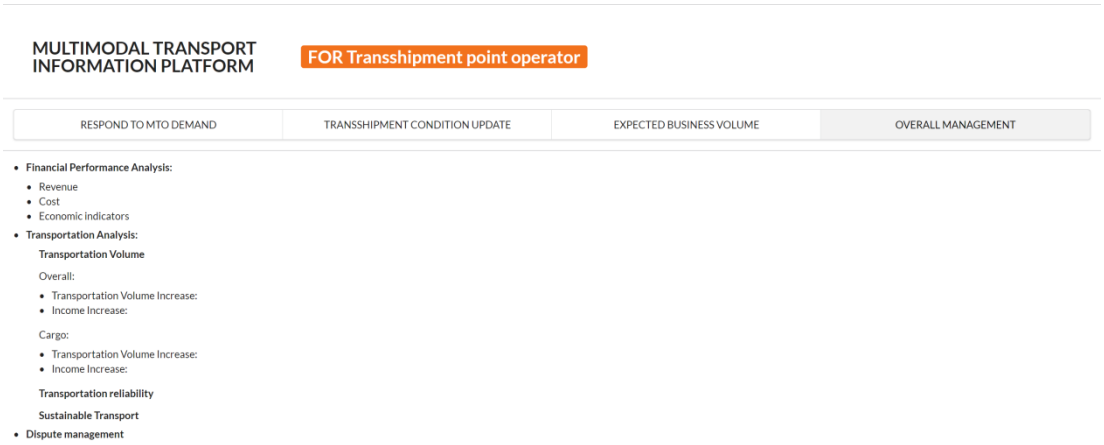


Figure 26 Transshipment point operator interface – overall management

5.3.2.6 Agent interface

To realize agents' easier checking on its agency business list, the function of "AGENCY MISSION LIST" in Figure 27 is designed, where ongoing agency missions and completed agency missions can be easily checked.

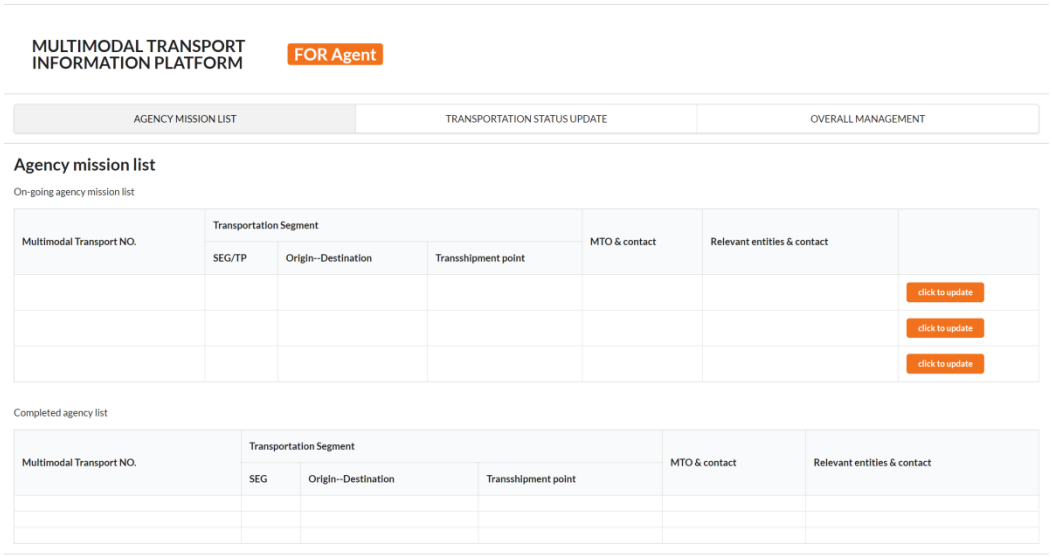


Figure 27 Agent interface – agency mission list

Agents who help the MTO to connect every transportation segment and transshipment points together, should constantly monitor the transportation status and

update it on the platform from the function of “transportation status update” in Figure 28.

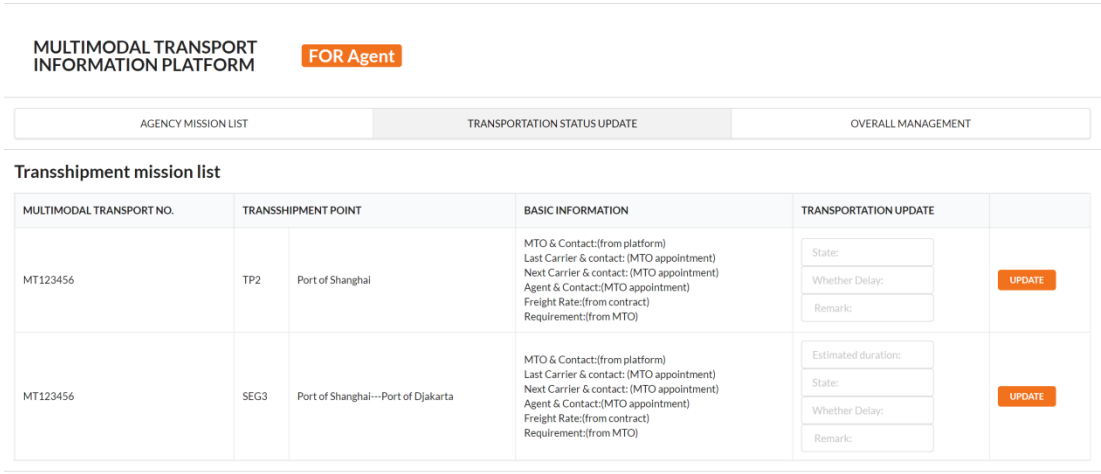


Figure 28 Agent interface – transportation status update

In such multimodal transportation process, even doing some similar work to traditional transportation, issues, such as custom declaration, could be saved because of the character of multimodal transportation. As a result, agents could expend their business with relatively small efforts.

Same to other entities, agents value business performance improvements, which could be realized by the last function of “OVERALL MANAGEMENT” in Figure 29.

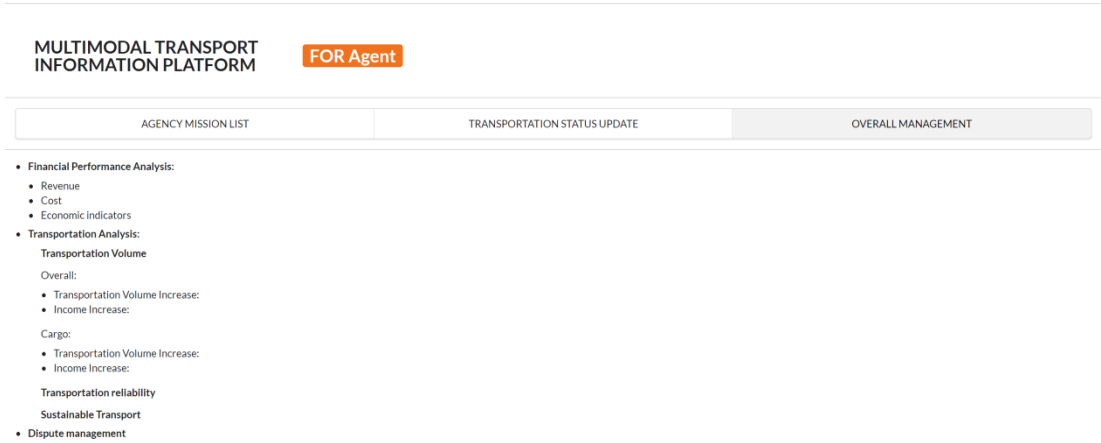


Figure 29 Agent interface – overall management

6 Conclusion and recommendation

The essay focuses on the multimodal transportation information platform development in Shanghai, which could empower the international multimodal transportation in China.

The analysis starts from the actual multimodal situation in China by summarizing the problems and reasons of multimodal transportation of the nation, comparing the multimodal transportation networks around the world, and further giving implications for multimodal transportation development in China indicating China can largely take advantages of the advanced technology and economic level of Shanghai to develop an information platform boosting the international multimodal transportation in China.

Then, based on the assumption that the China Railway Shanghai Group Co. Ltd would act as the administrator of the information platform, the essay analyzes the strength, weakness, opportunities and threats of the company being the overall administrator under the overall market conditions using PEST-SWOT model. As the platform involves a lot of users, the essay uses the RBAC model to distinguish different users into different roles, and further separate permissions accordingly, then the general functions are given.

After the general platform design, the last part of the essay focuses on detailed platform implementation, presenting the flow chart of the multimodal transportation platform, giving an example schedule and further designing the interfaces of different roles.

However, there exist limitations of the dissertation. For example, the essay basically summarizes the problems of international multimodal transportation in China from existing researches and reports, rather than carrying on actual field study. Plus, due to time and word limitations, the dissertation is not able to cover every detail. For instance, the discussion on platform implementation only gives platform interface sketches showing the general functions for different roles on the platform, but does not

design the algorithms supporting the platform. Therefore, for further study, research could be carried on from the perspective of latest multimodal transportation market analysis and detailed platform implementation.

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