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Innovative Waterway-Waterway Transfer Service Models and Experience for Container Logistics in China (Shanghai) Pilot Free Trade Zone: A Case Study of Taicang Express Line

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ABSTRACT

Developing waterway-waterway transfer is an important path for Shanghai's container logistics to innovate service models. Taicang Express Line, a typical case of service model innovation, plays an important role in elevating the standing of Shanghai Port as a container hub port and in developing China (Shanghai) Pilot Free Trade Zone. From the three dominant transfer service models, the waterway-waterway transfer for container logistics of Taicang Express Line has the traits and experience in streamlining logistics processes, innovating logistics clearance models, saving logistics operating costs, offering port logistics cooperation experience for replications and promoting integration of regional port logistics resources. However, it also harbors issues in infrastructure construction, staffing, container resources allocation and transportation, transportation efficiency and policy innovation. In the future, efforts should be invested to strengthening the construction and staffing of port logistics infrastructure, optimizing the container resources allocation and transport of port logistics systems, improving the logistics transportation efficiency of Taicang Express Line, and pushing forward innovation of the synergistic policy mechanism for regional port logistics.

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1. Introduction

As a key operational model of Shanghai International Shipping Center (Zhou et al., 2017), waterway-waterway transfer plays a crucial role in improving the logistics transfer capacity of China (Shanghai) Pilot Free Trade Zone (Yang, 2016). In Suzhou Combined Port, Taicang Port occupies a unique and advantageous location with the best deep-water coastline resources and being the closest to Shanghai Port and the Yangtze River estuary, hence valued by the government and positioned as the North Wing of the Shanghai International Shipping Center. To strengthen the ties between Taicang Port and Shanghai International Shipping Center, Taicang Express Line was opened in 2014, operating 21 sailings of liners featuring “five fix’es”, namely fixed time, fixed duration, fixed route, fixed voyage and fixed berth, per week between Taicang Port and Yangshan Deepwater Port of China (Shanghai) Pilot Free Trade Zone (Li et al., 2015), at an interval of eight hours. The “shuttle buses” between the Waigaoqiao Port Area and the Yangshan Deepwater Port Area were transferred to the South Phase III Terminal of Taicang Port, undertaking the transfer business of Yangshan Port in the middle and upper reaches of the Yangtze River by offering better transport and transfer services than the original

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transfer in the Yangshan Deepwater Port Area and the land-based direct transport logistics by container trucks (Zhong, 2015).

The main purpose of this paper is to summarize the successful experience of regional port logistics cooperation through the research and analysis of the innovative service mode of Taicang Express Line, and to improve and optimize the innovative service mode in view of the current shortcomings, so as to provide a method for replication of similar regional port logistics cooperation mode, and to provide ideas for the government to innovate the policy mechanism of regional port logistics linkage. Based on the case of Taicang Express Line, this paper discusses the problem in four parts. The first part elaborates the important role of “Taicang Express Line” in the waterway-waterway transfer service of container logistics in Shanghai Free Trade Zone; the second part analyses the main service modes of waterway-waterway transfer of “Taicang Express Line” container logistics; the third part mainly studies the main characteristics and experiences of innovative service modes; The fourth part is based on the existing problems of innovative service mode at the present stage, and gives the optimal countermeasures for the development of the two places.

2. Taicang Express Line’s significance in waterway-waterway transfer for container logistics in China (Shanghai) Pilot Free Trade Zone

Container waterway-waterway transfer is a modern way of collection, distribution, and transportation, which can effectively realize the economy of logistics, and help to solve the problem of urban traffic congestion and environmental pollution caused by road transfer. Looking at other world-famous ports, they attach great importance to the development of waterway-waterway, which plays a leading role in the collection, distribution, and transportation. For example, the proportion of road, water and railway transportation modes in Rotterdam port is 45:47:8, while the proportion of road, water and railway transportation in Shanghai Port is not reasonable. The proportion of road is too high (54.9%), while the proportion of water is relatively low (44.7%), and waterway-waterway transfer for container logistics is in urgent need of development (He, 2016).

Both the China (Shanghai) Pilot Free Trade Zone and Taicang Port are located at the intersection of the Yangtze River Economic Belt (Wang, 2017) and the 21st Century Maritime Silk Road (Wang et al., 2018). The government attaches great importance to the development and synergy of the two places and has introduced promotional policies.

In 2009, the State Council approved the Opinions on Promoting Shanghai to Accelerate the Development of Modern Service Industry and Advanced Manufacturing Industry to Build International Financial Center and International Shipping Center (GF [2009] No. 19, hereinafter referred to as the Opinions), laying out important strategic arrangements for the construction of Shanghai International Shipping Center. The Opinions proposed that by 2020, Shanghai will basically build up an international shipping center capable of global shipping resource allocation (Chen and Fei, 2018), and clearly proposed to actively develop international container logistics transfer services (Polat and Günther, 2016) in Yangshan Port Area, highlighting it as a key task for the new-stage construction of Shanghai International Shipping Center. The Shanghai municipal government also announced the Implementation Opinions on Implementing the State Council's Instructions for Advancing Construction of Two Centers, urging to “optimize the modern shipping collection, distribution, and transportation systems and vigorously develop waterway-waterway transfer” (Wang, 2012). Meanwhile, in response to the construction of the Yangtze River Economic Belt and the Belt and Road Initiative (Chen et al., 2019; Weidong, 2015), and to promote sustainable development of Shanghai city, innovative policies and mechanisms have been proposed for the construction of Shanghai International Shipping Center based on the “Framework Plan for the China (Shanghai) Pilot Free Trade Zone” promulgated by the State Council on September 27, 2013, with a focus on container logistics development in Shanghai (Chen et al., 2019).

To speed up integration of Taicang Port into Shanghai International Shipping Center and gear up Taicang Port for Shanghai Free Trade Zone, the local government pointed out in its Twelfth Five-Year Plan to build Taicang Port into the North Wing Container Trunk Port of Shanghai International Shipping Center, a river-sea intermodal transit hub port, the biggest foreign-trade port in Jiangsu province and one of the modern and international key ports both at home and abroad.

The waterway-waterway transfer has currently played a significant role in cargo collection, distribution, and transportation of Shanghai Port and Shanghai International Shipping Center. Shanghai Port attaches great importance to synergy with the Yangtze River and cooperates with high-quality ports along the Yangtze River such as Chongqing, Changsha, and Jiujiang (Zhu and Shao, 2018). It has pooled a large number of sources of waterway-waterway transfer containers, which has promoted the rapid growth of throughput at Shanghai Port. In 2017, Shanghai Port's container throughput exceeded 40.23 million TEUs, surpassing the 40 million TEUs mark for the first time in the history of global container transportation, and hit 42.01 million TEUs in 2018, ranking first in the world for nine consecutive years. Specifically, its waterway-waterway transfer throughput accounts for half of its container throughput (as shown in Table 1). In 2018, the waterway-waterway transfer throughput of Shanghai Port has a 46.5% share in the total throughput.

Taicang Express Line is one of the successful waterway-waterway transfer models of Shanghai Port and plays an important role in accelerating Taicang Port’s connections with Shanghai International Shipping Center and alignment with Shanghai Free Trade Zone. Leveraging Taicang Port’s superior conditions, Jiangsu province has been encouraging container business development in Taicang Port since the 1990s and the port’s container throughput once reached 4.02

million TEUs. However, the fierce competition among Yangtze River ports led to a decline in the port's throughput to some extent after 2012 (as shown in Figure 1). Since the opening of the Taicang Express Line in 2014, the port has been fully connected to Shanghai Free Trade Zone to enjoy the overflows of Shanghai, and its container throughput has rebounded significantly. By 2018, the throughput of Taicang Port has reached 5,071,000 TEUs, the first time for a single port under the Jiangsu Port Group to exceed 5 million TEUs in terms of container throughput.

Table 1. Total throughput and the throughput of WW transfer of Shanghai Port in 2014-2018

Year	Total throughput (10,000 TEUs)	WW* transfer throughput (10,000 TEUs)	WW transfer share
2014	3529	1615	45.76%
2015	3654	1645	45.02%
2016	3713	1727	46.51%
2017	4023	1879	46.71%
2018	4201	1953	46.49%

* WW: Waterway-Waterway, Data source: China Port Yearbook

In general, Taicang Express Line has not only boosted the development of Taicang Port, consolidating its status as the North Wing of Shanghai International Shipping Center but also has driven up the waterway-waterway transfer throughput and container throughput at Shanghai Port, laying a sound foundation for Shanghai International Shipping Center to develop transfer services. The Taicang Express Line model is a typical case of waterway-waterway transfer for container logistics at Shanghai Port and plays a demonstration role by offering experience in terms of collaboration model between other trunk hubs and branch (Yang and Chen, 2010) and feeder ports.

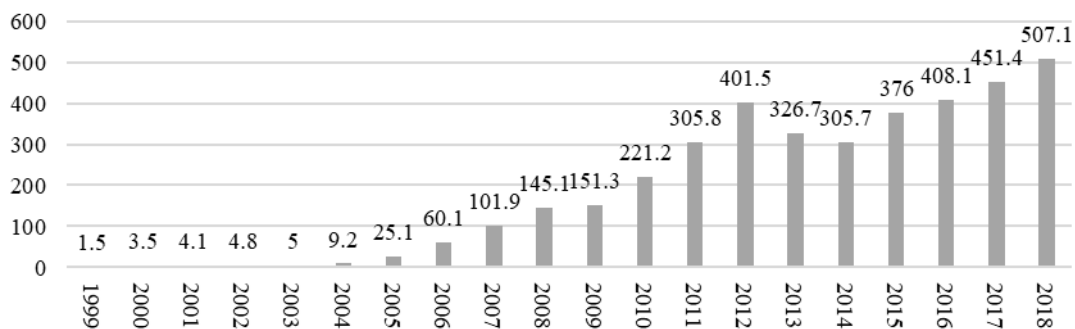


Figure 1. Throughput (10,000 TEUs) trends of Taicang Port

3. Dominant waterway-waterway transfer service models for container logistics on Taicang Express Line

3.1 What is “transfer” on earth?

This article defines “waterway-waterway transfer” of containers as the cargo transfer service model in the case of hub ports. Specifically, “waterway-waterway transfer” includes three models of transferring cargoes via waterway shipping as common definition indicates (as shown in Table 2), namely waterway-waterway transfer of domestic-trade cargoes, waterway-waterway transfer of cargoes on inland branch routes in coastal areas and along the Yangtze River, and the waterway-waterway transfer of international-trade cargoes (Chen and Zhu, 2012). If both the departure and destination ports are domestic ports, it belongs to the waterway-waterway transfer of domestic-trade cargoes; if only the departure or destination port is a domestic port, it belongs to the waterway-waterway transfer of cargoes on inland branch routes in coastal areas and along the Yangtze River for the purpose of connecting to international routes; if both the departure and destination ports are in a third country or region, it belongs to the waterway-waterway transfer of international-trade cargoes.

In essence, the “Taicang Express Line” model belongs to the waterway-waterway transfer on inland branch routes in coastal areas and along the Yangtze River (as shown in Figure 2). The Taicang Express Line model refers to the “waterway-waterway transfer” of cargoes between a domestic port and a foreign port with Yangshan Deepwater Port as the import and export transit hub port.

Table 2. Main models of waterway-waterway transfer

Destination port		In China		Outside China	
Departure port		In China		Outside China	
In China	Waterway-waterway transfer for domestic trade	Waterway-waterway transfer on inland branch routes in coastal areas and along the Yangtze River			
Outside China	Waterway-waterway transfer on inland branch routes in coastal areas and along the Yangtze River	Waterway-waterway transfer for international trade			

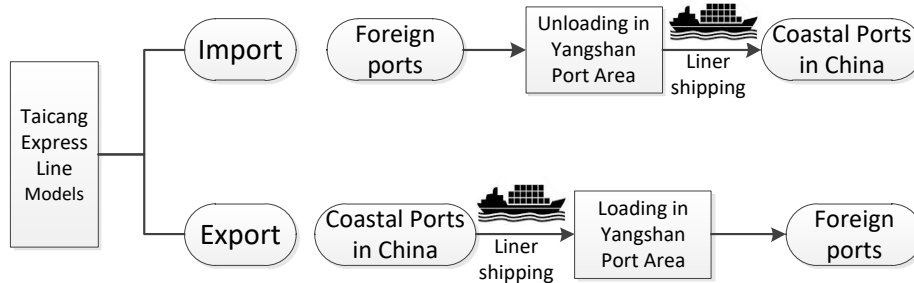


Figure 2. Traits of “Taicang Express Line” models

3.2. Concrete analysis of models

Currently, there are three innovative service models, namely the Yangshan direct transport/logistics customs clearance model, the Shanghai-Taicang customs clearance integrated model, and the customs declaration in origin/customs transfer at Yangshan Port model.

3.2.1 Yangshan direct transport/logistics customs clearance model

In the Yangshan direct transport/logistics customs clearance model, customers transport containers to the container depot at Taicang Port on their own and the containers are then shipped to the Yangshan Deepwater Port Area by domestic-trade barges. After the containers are unloaded, the export customs declaration procedures are performed to connect to trunk routes. The trade treaty is “FOB Shanghai, the gate to depot” (Jin, 2015). For example, cargo owners in south Jiangsu province transport cargoes from the processing sites of factories to Taicang Port via container trunks and then barge the cargoes along the “Taicang Express Line” to Yangshan Deepwater Port for customs declaration and inspections. The cargoes are finally transferred to large ships on trunk routes to depart from the port.

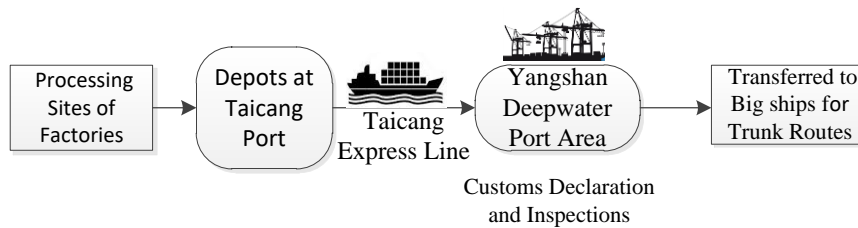


Figure 3. Yangshan direct transport/logistics customs clearance model

3.2.2 Shanghai-Taicang customs clearance integrated model

Shanghai-Taicang customs clearance integrated model refers to the customs clearance model where Yangshan Port and Taicang Port work in concert, with the latter acting as an extension of Shanghai Port to combine Shanghai and Taicang ports, that is, the new logistics model of “one port for cargo collection and distribution and two ports in synergy”. The containers for export that enter SP Zhenghe Terminal of Taicang Port are regarded as having entered Yangshan Port in Shanghai. Customers only need to send their for-export containers from Yangshan terminals to SP Zhenghe Terminal within a specified period of time and complete the customs declaration, inspections and clearance procedures at Taicang Port, the cargoes can then be barged to Yangshan Port terminals through the “Taicang Express Line” for loading and departure directly.

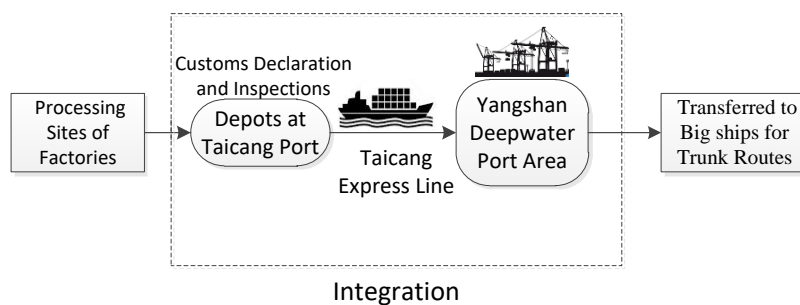


Figure 4. Shanghai-Taicang customs clearance integrated model

3.2.3 Customs declaration in origin/customs transfer at Yangshan Port model

Customs transfer refers to the action of transferring cargoes from one customs office to another one for handling customs procedures under customs supervision. The customs declaration in origin/customs transfer at Yangshan Port model refers to the model where cargo owners carry out customs declaration and inspections with the customs office of the origin and then transfer the customs office to ship cargoes to Yangshan Deepwater Port Area via waterway, under the trade treaty of “FOB Shanghai, customs transfer to container depots of Yangshan Deepwater Port Area for delivery”. The model is a temporary workaround (Jin, 2015).

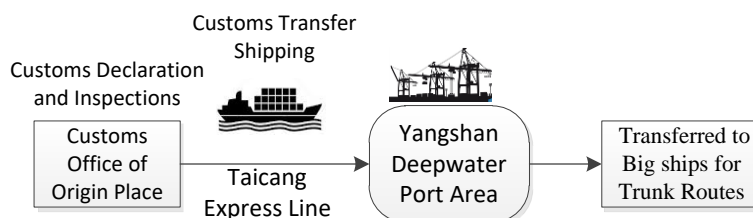


Figure 5. Customs declaration in origin/customs transit at Yangshan Port model

4. Traits and experience of “Taicang Express Line” innovative service models

Taicang Express Line's innovative service models not only streamline logistics processes but also create flexible customs clearance modes and save operating costs for cargo owners and ship companies, providing valuable experience for integrating regional port resources and accelerating the regional promotion of the experience. They also play a demonstration role in building an international shipping center in Shanghai and boost waterway-waterway transfer for container logistics.

4.1 Streamline logistics operation processes

In the conventional waterway combined transport model, cargo owners need to entrust cargoes to a freight forwarding company which then books spaces with a branch route shipping company that has signed a service agreement with a shipping company on trunk routes. Both the branch route ship company and the trunk route ship company need to entrust a feeder agent of Shanghai Port to handle berthage and customs transfer procedures of Yangshan Deepwater Port. There are many customs clearance procedures to undergo and cargo owners need to wait for a long time to complete customs clearance (Jin, 2015).

In the Yangshan direct transport/logistics customs clearance model, although the operation process is similar to that in the waterway combined model, the service agreements between trunk route ship companies and branch route ship companies are avoided, saving the branch route agent processes such as customs transfer during transport. In the Shanghai-Taicang customs clearance integrated model, it also bypassed the service agreement between the main line ship company and the feeder ship company, the cargoes can be directly declared, inspected and cleared at Taicang Port without being transferred to Yangshan Deepwater Port Area, achieving one-time declaration, one-time inspection, and one-time clearance. For example, by using the Shanghai-Taicang customs clearance integrated model mode, the customs can be directly released after declaration by agent, and the average customs clearance time is shortened from the original 3 days to 2 days.

4.2 Innovate logistics clearance models

The innovative service models offer a variety of customs clearance models for cargo owners to choose from based on

customs clearance locations. The innovative service models offer a variety of customs clearance models for cargo owners to choose from based on customs clearance locations. In the Yangshan direct transport/logistics customs clearance model, cargoes need to be transported by waterway to the Yangshan Deepwater Port Area and undergo export customs clearance at Yangshan Customs. In the Shanghai-Taicang customs clearance integrated model, customs clearance is carried out at Taicang Port in place of Yangshan Port. Containers that have completed customs clearance at Taicang Port are transported by waterway to Yangshan Deepwater Port Area to be loaded to trunk route liners. Cargo owners can also choose the customs declaration in origin/customs transfer at Yangshan Port model to complete customs declaration at a location near the origin and then transport the cargoes for customs transfer to the depots in Yangshan Deepwater Port Area for delivery.

For trunk route ship companies that handle more imported containers than exported ones at Taicang Port, they can also choose the customs declaration in origin/customs transfer at Yangshan Port model to effectively leverage the empty containers around Taicang Port and transport the excess empty containers back to Shanghai Port or other ports in the Yangtze River Delta.

4.3 Save logistics operation costs

For cargo owners, the innovative service mode of "Taicang express line" is compared with land transportation mode. First, the export container is towed to Taicang port by truck, and then transported to Yangshan deep-water port by water by barge. The cargo owners book space with the main line shipping company or entrust the local agent company of Taicang to book space. The main line shipping company (most of which have cargo charges corsigned with the main line shipping company) On behalf of the main line shipping company, the branch line shipping company under the agreement (CCA) accepts the space booking from the customer, the cargo owner transports the container to the container yard of Taicang port, and the main line shipping company entrusts the branch line shipping company with which it has an agreement to transport it to Yangshan deep water port to connect the ocean main line; at the same time, its trade terms are changed to "FOB Taicang", that is, the foreign buyer shall bear the additional freight for foreign trade going out of the mountain, insurance, etc. The main line shipping company will increase the freight of 50 USD / 20 ft container or 100 USD / 40 ft container based on the original freight of "FOB Shanghai" as the overall freight of "FOB Taicang" and report it to foreign customers. Take a 40 foot export container of a factory in Suzhou New Area as an example. See Table 3 for the FOB price comparison between land transportation and combined transportation by water and land. It can be seen from this that in the "Taicang express" innovative service mode, the shipper enterprise will pay less 500 yuan, saving the logistics operation cost. According to the calculation of Taicang port, with the throughput of 600000 TEUs, it will save about 300 million yuan for barge companies and import and export enterprises along the middle and upper reaches of the Yangtze River (Jin, 2015).

Compared with the traditional waterway transportation mode, the innovative service mode of "Taicang express" can be seen from the above analysis feature 1 that it reduces the branch line agent links such as customs transfer in the transportation process, shortens the customs clearance time and reduces the transportation cost. The customs declaration in origin/customs transfer at Yangshan Port model lifts the restrictions of trunk route ship companies' service agreements on cargo owners, facilitating fairer market competitions for branch route shipping businesses, so as to reduce operating costs and expand benefits for cargo owners.

Table 3 Comparison of FOB price of 40 foot export container transportation by land and combined transportation by water and land in a factory in Suzhou New Area

pattern	Foreign buyer		Domestic seller	Total logistics cost
	Ocean freight	Taicang Port Surcharge	Land freight	
land transportation	C	0	2200	C+2200
Combined water and land transportation	C	600	1100	C+1100

Note: the buyer and the seller can coordinate the actual fees paid by the customer through the commodity price; the fees are only theoretical fees, and some logistics links may require the customer to pay additional surcharges

Data source: Jin 2015

For trunk route ship companies, the customs declaration in origin/customs transfer at Yangshan Port model enables them to capitalize the gap between the handling charges for exported containers in Yangshan Deepwater Port Area and the handling charges for transferred containers to form a new source of revenue. Moreover, this model leverages the empty containers around Taicang Port, cuts down the expenditure of trunk route ship companies for allocating and transporting empty containers, so as to elevate the overall benefits of trunk route ship companies.

4.4 Promote integration of regional port logistics resources

Port integration (Huo et al., 2018) aims to coordinate port development, coordinate container market capacity and

demand, and coordinate the capacity of trunk ports, branch ports and feeder ports within the container port system. These synergies are necessary for integrating port resources and securing benefits. The areas around Shanghai Port, such as the ports along the Yangtze River in Jiangsu province, are characterized by a high number of cargo owner terminals and weak presence of the port group, which makes homogeneous competition between coastal ports prominent, and even leads to vicious competition against Shanghai Port, restricting sustainability of Shanghai Port (Wang et al., 2015).

Before Shanghai Port Group intervened, there were 3 container terminal companies operating 10 container berths in Taicang port. The modern container terminal Co., Ltd. under Hong Kong Jiulongcang group and Suzhou modern container terminal Co., Ltd., a joint venture of Suzhou municipal government, currently operate four container berths, with an annual handling capacity of 1.8 million TEU; the project of Taicang International Container Terminal Co., Ltd., a joint venture of Modern Container Terminal Co., Ltd., COSCO Group and Suzhou Port Development (Group) Co., Ltd. Before that, it operated two container berths and two multi-purpose berths for general cargo, with an annual container handling capacity of 700000 TEU; Taicang Zhenghe Container Terminal Co., Ltd. invested and established by Taicang Port Investment Development Co., Ltd. operated four container berths, with an annual container handling capacity of 2 million TEU. It can be seen that Taicang port resources are relatively scattered, port groups are numerous, and its strength is weak, which restricts its own development.

We should learn from Shanghai Port Group's practice of involving itself in Taicang Port, acquiring a 45% stake in Taicang Port SP Zhenghe Container Terminal Co., Ltd., and integrating port resources for joint operation of Taicang Port. This move includes Taicang Port into the Yangtze River strategy of Shanghai Port Group (Jiang et al., 2019) to avoid Shanghai Port's vicious competition with Taicang Port. Taicang Port is hence positioned as a transfer platform for foreign-trade containers and has opened the Taicang Express Line to build an innovative model for Shanghai-Taicang custom clearance services, alleviating the cargo collection, distribution, and transportation pressure on the Yangshan Deepwater Port Area while ensuring better alignment with China (Shanghai) Pilot Free Trade Zone. This has promoted the waterway-waterway transfer for container logistics between Shanghai Port and Jiangsu ports and allows for benign development of regional ports. Meanwhile, this model also integrates management and information to trim operation procedures between the two ports, improving the production efficiency of terminals, cutting down operating costs and improving overall earnings to achieve mutual benefits.

4.5 Offer port logistics cooperation experience for replications

Ports in the Yangtze River Delta can try to find other port areas similar to Taicang Port in the northern part of the Yangtze River in Jiangsu province. Such ports are near to the sea and Shanghai as well and can act as extensions of Shanghai Port for staggered development to undertake part of the businesses of Shanghai Port. They can grow into domestic-trade transfer hubs, offshore cargo collection and distribution centers, or ocean-going cargo transfer centers to promote the development of China (Shanghai) Pilot Free Trade Zone, get geared to the Yangtze River strategy and drive the Yangtze River Economic Belt. For example, Changshu Port and Zhangjiagang Port in Jiangsu province both enjoy similar geographical locations and port conditions. They can draw on the model of Taicang Port and Yangshan Deepwater Port, open a channel similar to Taicang Express Line, and innovate the waterway-waterway transfer service model.

For the other four major port groups, they can learn from relevant experience. Shanghai Port's involvement in Taicang Port is because of the scarcity of high-quality terminal shoreline and its fierce competition with nearby peers, such as Port of Busan, Hong Kong Port and the Ningbo Port of the same level in particular, in addition to the prominent cargo collection, distribution, and transportation congestion at Shanghai Port. As a result, the portland and Shanghai's urban planned land are in conflict. Yangshan Deepwater Port, by virtue of its special location, is only connected by the East Sea Bridge, and highway transport is hard to meet the cargo collection, distribution, and transportation demand of Yangshan Deepwater Port. That is why waterway-waterway intermodal transport is required to ease the transport pressure. In the case of Tianjin Port, it shares the issues of scarcity of high-quality terminal shoreline, fierce competition with nearby peers, and prominent cargo collection, distribution, and transportation congestion. This makes it necessary to find some port to function like Taicang Port around Tianjin Port. Ports in Hebei province have similar conditions, such as Huanghua Port and Tangshan Port (Zhang and Zhu, 2018), which two exhibits rapid growth of throughput. Tianjin Port can learn from the development model of Taicang Port and Shanghai Port, utilizing advantageous railways to transport cargoes to an appropriate port in Hebei province (similar to Taicang Port), and then transport the cargoes to Tianjin Port through waterway-waterway transfer. The port in Hebei province can act as the feeder port and branch port of Tianjin Port, promoting Tianjin to become a transfer port of foreign-trade containers and a branch port of domestic-trade containers in the Bohai Rim area (Wang et al., 2018), thereby promoting integrated development of the Beijing-Tianjin-Hebei region (Zhang et al., 2018).

5. Countermeasures for innovative waterway-waterway transfer service models of Taicang Express Line

The innovative service models of Taicang Express Line, though having accumulated extensive experience, still have issues of infrastructure construction, staffing, and empty container resource allocation and transport. With the throughput

of Shanghai Port continuing to rise, the waterway-waterway transfer volume is also climbing year by year. In the current stage, Taicang Express Line is still falling short in terms of transportation efficiency and promotion and optimization of related policies, restricting the development of Taicang Express Line's innovative service models. In the next section, we list targeted countermeasures for advancing the development of the innovative waterway-waterway transfer service models of Taicang Express Line.

5.1 Strengthen port logistics infrastructure and staffing

Yangshan Deepwater Port Area is located in the Qiqu Archipelago of Shengsi county, Zhejiang province, outside the mouth of Hangzhou Bay. It consists of dozens of islands such as Greater Mount Yang and Lesser Mount Yang. The port area is connected to the outside world only through the East Sea Bridge, boasting a special location and environment. Besides, the customs staffing of Yangshan Deepwater Port Area is subject to restrictions, making it difficult to carry out open box inspections and further realize the Yangshan direct transport/logistics customs clearance model.

In view of the special environment of Yangshan Deepwater Port Area, it is necessary to adapt to local conditions, build living and working areas for related personnel on the archipelago, and include infrastructure construction into the planning and construction of Yangshan Deepwater Port Area, while accelerating the optimization of seafarer staffing to Yangshan Port Customs, such as increasing the number of archipelago-based seafarers and improving the welfare for those living on the island, so that the port area can have the required conditions and human resources for open box inspections to improve the Yangshan direct transport/logistics customs clearance model.

5.2 Optimize container resource allocation and transportation of port logistics systems

The changing cargo source structures in the same region and the regional uncertainties give rise to the imbalanced distribution of containers in various ports or regions, and some regions even see a pileup of empty containers against the shortage of empty containers in some other regions. No matter whether it is the Yangshan direct transport/logistics customs clearance model or the Shanghai-Taicang customs clearance integrated model, the imported and exported containers of ports are not balanced in number, raising the cost for ship companies to allocate and transport empty containers.

With regard to the transport of empty containers, ship companies can ally or collaborate with other peers, expand the operational plans and share container resources while setting up multiple networks on major trading routes to facilitate container exchanges between ship companies and thereby enable container ship companies to move empty containers more efficiently. Meanwhile, container leasing companies can enter into alliances, sign container leasing contracts, and launch flexible leasing modes. Based on the actual container use requirements, container leasing services can be offered at ports and regions with a shortage of empty containers or with high allocation and transport interest rates, while empty container collection services can be offered at ports or regions experiencing pileup of containers. An electronic information platform can also be built up to achieve data sharing, intelligent planning, and well-designed allocation of empty containers. Third-party e-commerce service solutions can be leveraged to address empty container allocation and transport to improve working efficiency and expand sources of revenue or profits leveraging the limited container resources.

5.3 Improve logistics and transport efficiency of Taicang Express Line

As the throughput of Yangshan Deepwater Port Area increases year by year, the cargo throughput of Taicang Port, as a feeder port, has risen dramatically, even giving rise to traffic congestion in the port area. Meanwhile, the containers transferred from the middle and upper reaches of the Yangtze River to Yangshan Port are shifted to Taicang Port for handling, posing a huge challenge on the port's cargo collection, distribution, and transportation system and impacting the berthing and exit efficiency of the Taicang Express Line. Besides, the Yangshan Deepwater Port Area has priority for ship berthing, resulting in low berthing efficiency of waterway-waterway transfer ships and reducing the transport efficiency. In addition, the time and container throughput of foreign-trade transfer cargoes from ports in the upper reach of the Yangtze River to Taicang Port are unevenly distributed. The Taicang Express Line, which operates scheduled sailings to Yangshan Port on a weekly basis, is troubled by low load rates on average and low utilization rates among other problems. These have limited Taicang Express Line for better exerting the waterway-waterway transfer capacity.

In view of the above issues, the following measures can be taken. First, operate the "shuttle buses" more efficiently and plan the "shuttle bus" schedules to effectively improve the efficiency of cargo transfer and ease the pressure on depots of Taicang Port and Yangshan Port. Meanwhile, the Yangshan Port Marine Department should continue to explore and launch measures such as "two-way navigation" (Zhang et al., 2017) and "double-ship berthing" to boost berth utilization of Yangshan Port. Second, build dedicated waterway-waterway transfer terminals in Yangshan Deepwater Port Area to centralize the transferred containers to be reloaded to the dedicated terminals for operations, which can ensure timely berthing, handling and trip schedules of ships on branch routes and facilitate uniform scheduling, centralized handling and centralized management of ships to keep terminal production and management in good order (Tan and Wei, 2016).

Third, speed up infrastructure construction of Taicang Port. While the completion of Phase IV container terminal construction is ensured, the land issues with the Phase V and Haitong projects can be collaborated and resolved and the Haitong project coastline can be well adjusted. Efforts should be made to resolve the environmental compliance, land and capital issues to gain approval for the Phase V construction project as soon as possible.

5.4 Push forward the innovation of synergetic policy mechanism for regional port logistics

We should expand the dividends of Shanghai-Taicang integration policy (Chen et al., 2018) and encourage more enterprises to transport cargoes via the Shanghai-Taicang customs clearance integrated model. In view of the operation status of the model in the previous years, we can say that the model has become full-fledged and is feasible to be promoted and applied to the entire Suzhou region, with effort in pushing forward formulation of related implementation schemes required (Chen et al., 2018). Meanwhile, after the implementation of the tax rebates at ports of departure, Taicang Port will transfer cargoes to Yangshan Deepwater Port via waterway, which will shorten the tax rebate period to 10 days and attract more enterprises to adopt the waterway-waterway transfer model. On January 8, 2019, the Ministry of Finance, the General Administration of Customs and the State Taxation Administration of China jointly issued the Notice on Improving Tax Rebates Policies at Ports of Departure, and identified 13 ports of departure for the policy, including Taicang Port in Suzhou city, and clarified it as one of the four “stopover ports” (Zhang and Zhu, 2018). Therefore, we can continue to expand the scope of “tax rebates at ports of departure” and seek support from government authorities to extend the customs declaration coverage for enterprises entitled to “tax rebates at ports of departure” to all customs offices in Suzhou to benefit more enterprises. Moreover, we can also enhance the policy incentives for inland river shipping. To ease the cargo collection, distribution and transportation congestion at Yangshan Deepwater Port, we must expand the share of waterway-waterway transfer in Shanghai Port and attract more cargo owners to adopt waterway-waterway transfer through preferential policies, such as granting some subsidiaries for inland river shipping routes to elevate water transport competitiveness so that more cargo owners will treat waterway transport as a preferred option. This way, the development of waterway-waterway transfer for container logistics in China (Shanghai) Pilot Free Trade Zone can be boosted.

6. Concluding remarks

This article explores the three innovative waterway-waterway transfer service models of Taicang Express Line, analyzes the main traits of the three innovative service models, the conclusion is that compared with the traditional service mode, the innovative service mode of Taicang Express Line not only simplifies the logistics links, innovates the logistics customs clearance mode, it also reduces logistics costs, but with the rapid development of Taicang and Shanghai's economy, we still need to further improve and optimize the innovative service model to provide security for the development of container logistics in both places. The issues in the innovative waterway-waterway transfer service models, though having been identified by some experts, fail to see countermeasures available. This article, based on actuality, offers four targeted measures to improve and optimize the innovative waterway-waterway transfer service models of Taicang Express Line, making it more suitable for the development of container logistics in Taicang and Shanghai.

Research and improvement of the innovative waterway-waterway transfer service models of Taicang Express Line are conducive to enhancing the synergy between Taicang Port and China (Shanghai) Pilot Free Trade Zone and the improvement of waterway-waterway transfer volume in China (Shanghai) Pilot Free Trade Zone, which may finally contribute to healthy competition (Chen et al., 2019), collaboration and common development of ports in the two places, it is the key to getting geared to the development of China (Shanghai) Pilot Free Trade Zone and boosting implementation of the policies of the Belt and Road and the Yangtze River Economic Belt. At the same time, we can get relevant enlightenment, that is, Taicang Express Line as a typical case of the waterway-waterway transfer for container logistics in China (Shanghai) Pilot Free Trade Zone, it provides ideas and models for the main hub ports and feeder lines of other important port groups (Bohai Rim Port Group, Pearl River Delta Port Group, etc.). It is conducive to replicating and imitating innovative service models in similar regions, and also provides valuable experience for resource integration of regional ports.

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