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Investigating the Practices, Problems, and Policies for Port Sea–Rail Intermodal Transport in China

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Abstract

Intermodalism is currently a mainstream mode of international transport because of its operational efficiency and cost-effectiveness compared with unimodal transport. In 2011, the Chinese government launched port sea–rail intermodal transport (PIT) projects to promote and facilitate its transport system. As a result, seaports are now ruling the waves of sea–rail intermodal transport in China. However, barriers have occurred in many parts of the system from transport sectors to government departments, challenging the accessibility, connectivity, and accountability of the intermodal system. This paper investigates the various parties that are involved in PIT, and aims to outline its development, including its present status, bottlenecks, and other influential elements. Through a questionnaire survey and content analysis, the main problems are identified as lack of institutional design and system regulation, resistance from the rail sector, insufficient cooperation and investment, and a fragmented information system. Policy recommendations are addressed through a three-step administrative framework: (a) unification of international regulations and standards; (b) rail sector reform for better alignment with other transport sectors; (c) incentive policies for enterprises instead of direct subsidies.

Intermodalism is a mainstream mode of international transport because of its operational efficiency and cost-effectiveness compared with unimodal transport (*1*, *2*). The movement of cargo in a single unit using two or more successive modes of transport provides a better solution for inland freight distribution (*3*, *4*). Since 2011, China has conducted port sea–rail intermodal transport projects (PIT) to facilitate its intermodal system and six seaports were chosen as representative cases for executing these projects (*5*).

Further, in 2015, China launched the Belt and Road Initiative (BRI) and the Intermodal Demonstration Project (IDP) in quick succession, aiming to improve the development of the country's economy in the west through the construction and deployment of inland ports and, as a result, strengthen land contact with neighboring countries (*6*). Under such circumstances, seaports are the basis of these projects, their mission being to provide seamless transportation for the connection of nodes along the BRI. With the expansion of the hinterland and industrial relocation, the seaports started to cooperate with inland areas to develop uninterrupted transportation of goods (*7*, *8*). A railway network was then constructed and connected directly to the six seaports of Dalian, Tianjin, Qingdao, Lianyungang, Ningbo, and Shenzhen based on their development of dry ports inland in different directions: Dalian to the northeast, Tianjin to the north and northwest, Qingdao to Zhengzhou (Middle China), Lianyungang to Xinjiang (a gateway to Middle Asia), Ningbo to the west, and Shenzhen to the south and southwest.

At present, seaports are ruling the waves of intermodal transport in China by being integrated into national strategies (e.g., the Yangtze River Economic Belt Development Plan and the Pearl River Delta economic integration). In realizing the interaction between port performance and supply chain competitiveness (*9*), seaports work zealously in constructing logistics platforms to upgrade their intermodal systems. For port groups, intermodal transport is an opportunity to extend their market share, especially in inland areas, because of China's export-oriented economy. On the one hand, as

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an interface between the coastal and inland regions, ports play an intermediate role in connecting the sea and rail sections (*10*). On the other hand, as a substantial component of port performance, intermodal transport is a strategic sector in port extension and its regionalization, determining the connectivity between the port and its hinterland (*11–13*).

However, these theoretical benefits of intermodalization have encountered considerable resistance in practice because the transport volume remains at a low level. Before the launching of IDP, not all the six ports under consideration witnessed the anticipated acceleration in volume, and only three of them (Shenzhen, Qingdao, and Ningbo) reached their targets. According to the summing-up meeting about PIT, there are obstacles with regard to technical, institutional, and management issues. Lessons that can be learned from the projects are concerned in particular with service standards, transport connections and institutional design. (*14*). The organization of the transport chain is inefficient and uneconomic.

Above all, the present status, bottlenecks, and other contributary factors are the vital drivers for developing PIT, particularly the success of IDP. However, no exact models in the literature can deal with such a systematic problem. According to a recent review, the operational research and modeling of intermodal transport has been a major focus of debate among researchers (*15*). To improve the performance of the intermodal transport system, scholars, albeit few, also undertook research on its administrative, technical, and management framework design (*16*, *17*). Under such circumstances, this paper aims to investigate China's intermodal transport system, the PIT market in particular, and provide an overview of the practice and problems facing intermodal transport in the country. Based on the empirical assessment, key features will be identified through a questionnaire survey. The findings will support the design of the intermodal transport system's administrative framework for which policy recommendations are put forward accordingly.

Methodology

Design and Analysis

The China Ports and Harbors Association (CPHA) (see http://english.chinaports.org/), a national organization for Chinese ports, has a branch for intermodal transport. Until the end of 2017, it had enrolled more than 60 members spread throughout 20 provinces and represents the main market forces of PIT in China.

This branch provided a convenient access to distribute the questionnaire survey. In early April of 2018, we conducted a specific survey on PIT via the CPHA, aiming to gather data on the development of PIT in China. Inspired by the concept of triangulation (*18*, *19*), the content of the questionnaire was designed to extract both qualitative and quantitative data. For example, company A and company B are two respondents who claim to be leading enterprises (qualitative description) for whom information was then sought on their registered capital and revenue, thus categorizing them into different groups of scale (quantitative data). There are eight sections in the questionnaire, including the current situation, the plans and appeal of the multimodal transport operators (MTOs), infrastructure and superstructure projects, requirements, and problems encountered. Part 1 consists of questions to extract basic company information such as number, scale, and geographic distribution to obtain an overview of the PIT market in China. Part 2 collects statistics concerned with PIT's infrastructure and superstructure. The current infrastructure of PIT and the plans to develop it reflect the capacity and prospects of the PIT service. Part 3 investigates the development of the information system, including the technology, mode, and diversity of the information platform. Part 4 is concerned with the institutional organization and regulation of PIT, because these two aspects play a decisive role in this emerging market. Parts 5 and 6 collect problems and suggestions for PIT in practice, respectively. Most questions are open-ended so the companies can detail their perceptions and suggestions, and some questions require both descriptive and numerical answers.

In analyzing the data, text analysis was applied to identify the key factors affecting the development of PIT utilizing the three steps of coding, categorizing, and filtering (*20*). Using the data from open-ended questions, a database with company information and associated data extracted from the questionnaire was created. For the coding process, keywords (mainly common terms in intermodal transport) for each question were identified according to their frequency of occurrence for each respondent. Therefore, each question contains a set of keywords that allows us to highlight what respondents really care about. Inductive category development was applied to separate the keywords into different categories (*21*). With regard to categorizing, a keyword was selected when its frequency was greater than 10% (see Appendix A for further details). Inevitably, some keywords may recur in different but related questions. A further filtration process was conducted to integrate or delete similar or weakly correlated keywords. Based on the context of the answer, the meaning of keywords can be distinguished, facilitating the identification of overlaps or weak relationships. Finally, the filtered keywords were counted by their occurrence according to each respondent. For instance, with regard to Part 5 (main problems in conducting PIT), "Rail Waybill," "Rail Information,"

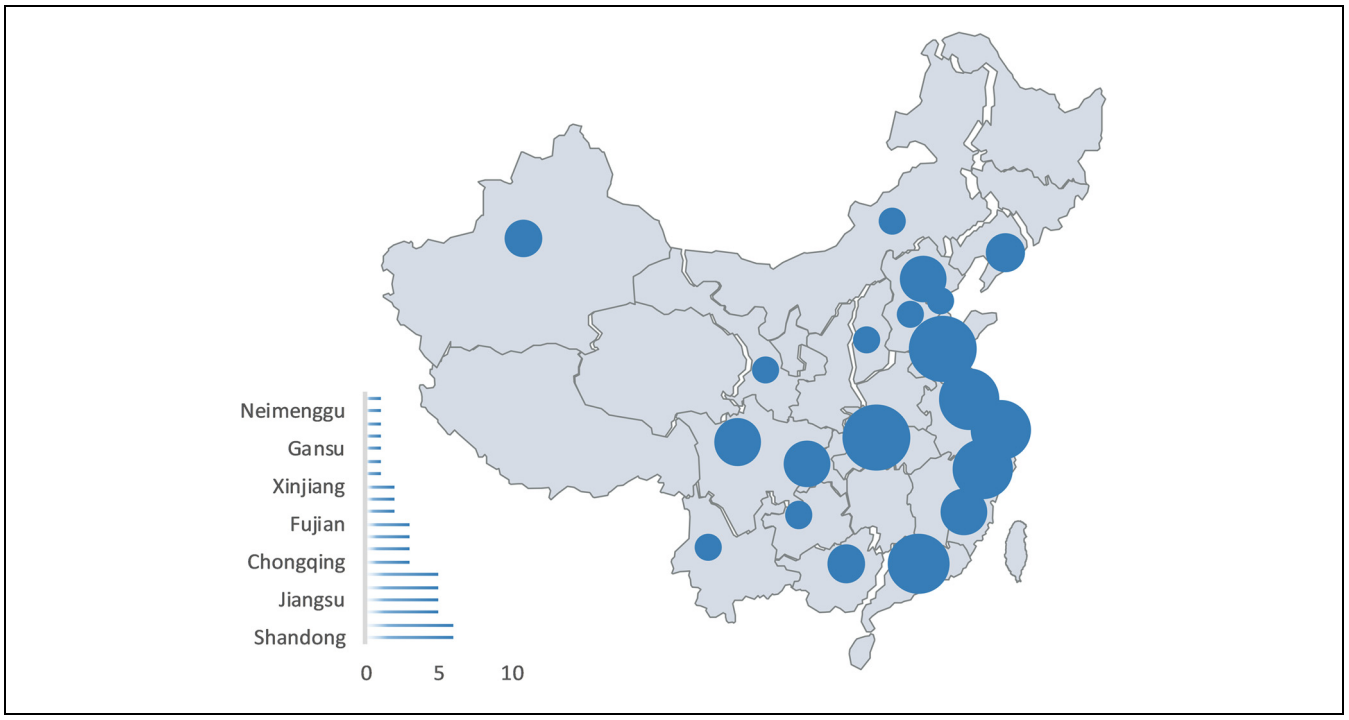

Figure 1. Geographic distribution of MTOs.
Note: MTO = multimodal transport operator.
Source: Survey data.

and "Rail Price" were keywords mentioned by many respondents (high frequency). The filtration process excludes "Rail Waybill" as a subordinate problem. Then, obstacles that were identified in the rail section were summarized using those keywords. Similarly, because "Rail Mispricing" could also appear in Part 6, it was combined with "Rail Price" and presented as an obstacle in the rail section.

In complying with practice and resolving any problems accordingly, a hierarchical policy framework was proposed with a Venn diagram as the logic from problem identification to policy making.

Sample Collection

The survey lasted for more than two months and 54 questionnaires were sent via post and email to CPHA members who share over 80% of the PIT market in China and most of whom are MTOs and can supply firsthand information (*22*). Half of them answered (50% refusal rate). Figure 1 shows the number and geographic distribution of MTOs. The scope of this survey includes most of the provinces in mainland China, namely, 31 administrative districts. The coastal area leads with regard to the number of companies, there being more than five MTOs in each coastal province of Shandong, Jiangsu, Shanghai, Zhejiang, Fujian, and Guangdong. The inland capital cities of Sichuan and Chongqing are included in the next tier, and Hubei has six MTOs in operation because of its strategic location on the Yangtze River Economic Belt. The basic geographic framework of China's MTO market is along the Yangtze River coastal and riverside regions. Its eastern region is more significant than its western one, partly because of the local terrain and associated economic development.

Table 1 summarizes the characteristics of MTOs for further analysis. MTOs consist of port groups, shipping companies, rail companies, truck companies, non-vehicle operating common carriers (NVOCC), freight forwarders, third-party logistics companies (3PL), and others. Port groups account for nearly 35% of the MTOs, showing this category's dominant position in intermodal transport. Although other parties such as carriers and agencies want to share the market, the service and scope they offer cannot reach that far. Actual carriers such as shipping, railway, and truck companies make up 2.33%, 11.63%, and 9.3% of the MTOs, respectively, indicating the different emphases on the coastal and inland sectors. Agent-based companies such as freight forwarders, NVOCCs, and 3PLs make up about 30% of the MTOs. From the perspective of capital scale, the MTOs are very polarized in that nearly 70% of companies are distributed between the two extremes: a total revenue of less than $15 million (27.27%) or more than $300 million

Table 1. Characteristics of MTOs

Type	Port groups	Shipping companies	Railway companies	Truck companies	NVOCC	Freight forwarders	3PL	Others
Proportion	34.88%	2.33%	11.63%	9.30%	6.98%	13.95%	9.30%	11.63%
Scale ($ million)								
	< 15	15–30	30–80	80–150		150–300	> 300	
	27.27%	4.55%	13.64%	9.09%		4.55%	40.91%	
Ownership								
	State-owned	Private	Overseas investment			Others (combined)		
	81.48%	11.11%	3.70%			3.70%		

Note: MTO = multimodal transport operators; NVOCC = non-vehicle operating common carriers; 3PL = third-party logistics companies.
Source: Survey data.

Table 2. Survey Statistics

Most requested regulations for PIT						
Standard contracts	Standard service regulations	Documents	R&O of MTO	R&O of actual carriers	R&O of shippers	Claims and litigations
37%	44%	30%	30%	30%	15%	26%
Elements in rail sector most complained about						
Mispricing	System sharing	Punctuality	Marketization	Reliability	Standardization	Infrastructure
63%	59%	22%	19%	15%	15%	11%
Elements of PIT development most complained about						
Documents	MTO	Claims and litigations	Foreign counterparts	Subsidy system	Cargo monitoring	
44%	56%	22%	44%	22%	67%	

"Connected" and "expect to connect" parties on the information platform								
	Road	Rail	Air	Sea	Port	Customs	Inspection	Freight forwarder
Connected	78%	78%	11%	33%	78%	22%	33%	0%
Expect to connect	78%	89%	44%	56%	78%	89%	67%	78%

Note: MTO: multimodal transport operators; R&O = rights and obligations; PIT = port sea–rail intermodal transport.

(40.91%). The large MTOs are port groups with strong capital support, whereas the smaller ones are agent-based entities focusing on business management. Notably, through the distribution of ownership, it can be observed that PIT has a great many more public companies because over 80% of respondent companies were state owned.

Problem Identification

In this section, the main problems of PIT are related to the current situation. The last decade has witnessed a rapid development of intermodal transport including the rise in infrastructure construction, increased throughput of PIT, and wide application of the blockchain. However, key problems remain to be resolved as follows.

Lack of Institutional Design and System Regulation

The main barriers are at the institutional level. Most respondents remarked that PIT was lacking in institutional design and system regulation. The main obstacles are listed as service standards, contracts, documents, rights and obligations (R&O), and claims and litigation (see Table 2). Since 2011, PIT has entered into a period of accelerated development with continuous and strong political support at the national level. The throughput of PIT has witnessed several increases in the last five years.

However, although the companies are chasing increased throughput, relatively speaking, institutional design and system regulation still lag behind, hindering the advancement of intermodal transport.

Over 40% of MTOs regard the standardization of PIT as the first priority, indicating a service difference among the various participants. A standardized service means better coordination of seamless transportation, which is embodied in the uniformity of regulations, contracts, transport vehicles, documents, information, language (specific terms and conditions such as Incoterms 2010), and so on. The R&O of each party, followed by claims and litigations, were ranked after the standardization of PIT. R&O are concerned with the market position of contracting parties, in which the status of MTOs, actual carriers, and shippers can be reflected in the content of the R&O in the service contract. Because shippers' R&O are those that are least complained about, it should be more straightforward to develop them into a fully regulated system for this part of intermodal transport in China.

In addition, 'claims and litigations' is the most popular dispute settlement mechanism for an international business and PIT will certainly encounter this because of the difference between the legal systems of various countries. Without uniform laws and regulations, it is necessary to resort to national law in spite of its lack of applicability to international transport (*23*). There are several unified conventions or agreements based on substantive laws, for example, the Hague Rules (1924) for maritime transport, the Warsaw Convention (1929) for air transport, and the Convention on International Multimodal Transport (1980). However, the sovereign interests of each country can hardly be adapted to claims and litigations, which depend on procedural laws; therefore, conventions or agreements with regard to claims and litigations in relation to PIT remain, as yet, unwritten (*24*).

Resistance from the Rail Sector

There are many complaints to the effect that the rail sector blocks the development of inland intermodal transport. Although intermodal transport includes container movements by rail, barge, air, and road, rail transport is by far the most common topic in the literature (*25*). Similar to its popularity, the rail sector has been a chronic problem for PIT in China, and this lies in external and internal inefficiency.

With regard to external communication, the rail system is a sector seems to be blocking development because its weak linkage hinders its cohesion with other modes of transport. The elements most complained about in relation to the rail sector in Table 2 emphasize that the main complaints are concerned with pricing and information sharing. Nearly 63% of respondents claimed the unreasonable charges caused their entire transportation costs to rise. In addition, nearly two-thirds of respondents stated that the rail companies' information-sharing system did not comply with modern intermodal transport both in content and technical standards. Customers were hardly able to track the status of their cargoes once they had left the port.

A typical case of PIT is China Railway Express (CR Express). As an important part of the BRI, its priority level in the rail transport system is above ordinary cargo transportation. However, CR Express has also suffered from many problems including a high freight rate and long transfer time because of non-standardization of regulations and documents (*24*, *26*). The pricing of rail transport is illogical, and this erodes CR Express' competitiveness. Although subsidies have been introduced to cultivate the PIT market, local governments compete for the market share, leading to disruption on a regional scale (*27*).

Internally, the sprawling organization of the rail sector impedes its operational efficiency. As an important indicator of transport service quality, the punctuality of rail services is criticized by many customers. An oft-cited example is the volume restriction: trains cannot leave until the cargo volume reaches its minimum level, for example, 100 TEU (20-ft equivalent unit) per set. On the other hand, the expansion of high-speed rail for passengers squeezes the development space for cargo transportation (*28*). Blockchains are known for their stable services, but punctuality cannot be assured during peak hours because of capacity constraints. Other problems expressed are weak marketization (19%), low reliability (15%), lack of standardization (15%), and poor infrastructure (11%), most of which arise from the difference between administrative authorities and government policies.

Insufficient Cooperation and Investment

Port-related or land-based transport companies account for a large proportion of MTOs, and the shipping companies are next in relation to numbers. A low level of sea–land cooperation reduces the connecting efficiency of PIT, which makes it clear that seamless transportation can hardly be realized or welcomed without support from the coastal side. The operational mode of liner shipping companies (LSCs) does not comply with PIT at present, calling for considerable improvement in the synergy between LSCs and MTOs. In practice, LSCs set a time window for shippers to pick up and return the container. However, compared with road transport, the container turnaround time is longer on the rail side, thus limiting the potential for sea–rail transport of cargo.

Among the various parties involved, problems also occur at the initial investment stage, especially in constructing the inland terminals and superstructure, which are capital intensive. Most respondents from the big port groups are suffering from financial constraints, and small transport companies even more so. The motivation for them to become a MTO is being able to extend their market share to the larger hinterland (*29*), which also hints at their optimism for the future of intermodal transport.

Furthermore, because of economic conditions and strategies in relation to logistics development, infrastructure construction in inland areas generally lags behind that in coastal areas, with more cargo transported by road instead of rail (*30*). More than half of the respondents have plans to upgrade and increase their investment in infrastructure development and superstructure construction, thus complying with the standard of modern intermodal transport and further promoting its handling capacity and attractiveness in relation to cargoes.

Figure 2 shows a strong demand for rail line construction at inland terminals because the existing railway lines are one of the weakest areas of PIT. For a long time, the port collection and distribution system has been dominated by road traffic with few terminals directly linked with rail lines. Railways have long been an important component of intermodal transport for medium and long distances (*31–33*); however, because of the efficiency and cost advantages of road transport, the market is less concerned about the theoretical advantages of railways.

It is worth noting that in 2007 the Ministry of Railways (now the Ministry of Transport) established China Rail Intermodal (CR Intermodal), an affiliate of the China Railway Corporation, with 12 billion RMB registered capital to take charge of the construction, management, and operation of 18 modern logistics centers throughout the country as an encouragement to the development of intermodal transport in China. So far, 9 out of 18 logistics centers are in operation throughout the country. However, their contribution to PIT is not as significant as expected. Over 80% of the respondents state that the throughput volume of PIT is less than 100,000 TEU, which is far behind that of major seaports (over tens of millions TEU). As a result, the construction of two of the logistics centers has been postponed because of diseconomies of scale.

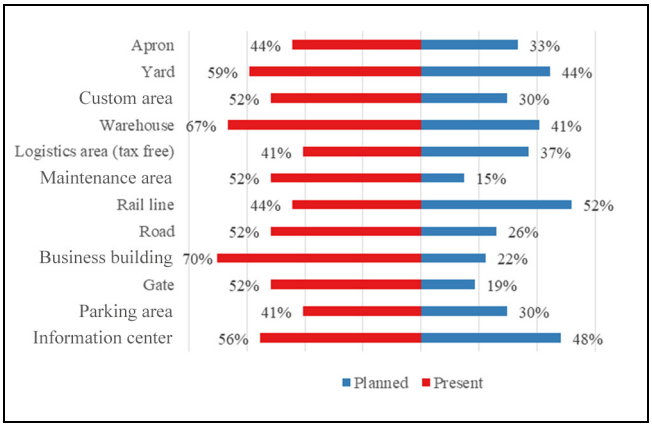

Figure 2. Present situation and construction plans in relation to infrastructure.
Source: Survey data.

Fragmented Information System

Modern information technologies such as electronic data interchange, global positioning systems, geographic information systems, and decision support systems have been widely adopted in transportation (*34–37*). Barriers still occur in relation to how accessible these information systems are to each transport sector and, at the moment, so-called "isolated information islands" are the norm. Initially, an information system can be launched for the improvement of transport efficiency and service as part of a port logistics platform (*38*). With the development of information technology, transport companies have upgraded their information systems in line with this; however, information barriers still exist and may become even more entrenched along with the extension in scale and scope of the business process. For example, cargo-tracking information is fragmented in different transport stages because the port, rail, truck, and shipping sectors record the information on their own platforms without exchanging it (see "Elements of PIT development most complained about" in Table 2) These circumstances result in an abnormal market such that most shippers prefer road transport no matter the distance and how expensive it is.

Only one-third of the companies investigated established an information platform with three types of data: tracking, transaction, and documents. Tracking, as the fundamental function, contains information on cargo movement during the whole process of transportation. Transaction information refers to supply and demand data, including shipping inquiry and capacity information. Documents are bills or certificates, such as waybills, container loading plans, dock receipts, and so on, relating to the operational procedures involved in intermodal transport.

The information is collected from various sources including official websites, telephone or fax interviews, certain systems that integrate with those of port and rail companies, and freight information platforms and business systems of related enterprises, in which system integration plays a major part.

According to the "'Connected' and 'Expect to Connect' parties on the information platform" in Table 2, the road, rail, and port sectors offer independent

accessibility to information. Government departments are another important aspect of the information platform because customs clearance and inspection are compulsory procedures for international trade. However, lack of accessibility to government departments makes it difficult to realize government information exchange. Furthermore, air transport is observed as an emerging market for China's intermodal transport system with a strong desire to take part in the information exchange.

A single platform for information sharing can hardly be established at the outset, although MTOs are eager to be embedded in the whole transport system. "Expect to connect" shows that future development still focuses on the accessibility to government departments and other transport sectors. Notably, respondents attach great importance to the role of freight forwarders because they can provide information to improve transactions on the platform.

Assessment and Policy Recommendations

The problems in relation to PIT in China have occurred systematically from its institutional design through to its practical operation. This section considers these problems in depth, thus establishing an administrative framework and recommending policy solutions accordingly. Thematic elements are generated from their related keywords. The overlaps between the circles and the rectangles in the Venn diagram (Figure 3) express the scope of related thematic elements (see Figure 4 in Appendix B for more details). These themes can be further distilled into institutional-, industrial-, and individual-level issues. Institutionally, the regulations and standards are not only intended to apply to the system design of PIT as a whole, but also to the rail sector in particular because its containerization and pricing systems are in need of regulation. On the industrial level, the rail sector and its need for reform was found to be creating difficulties. Meanwhile, on an individual level, institutional design and system regulation are the problem. When competition among the state-owned port groups is taken into consideration, the regional balance becomes an institutional issue (8).

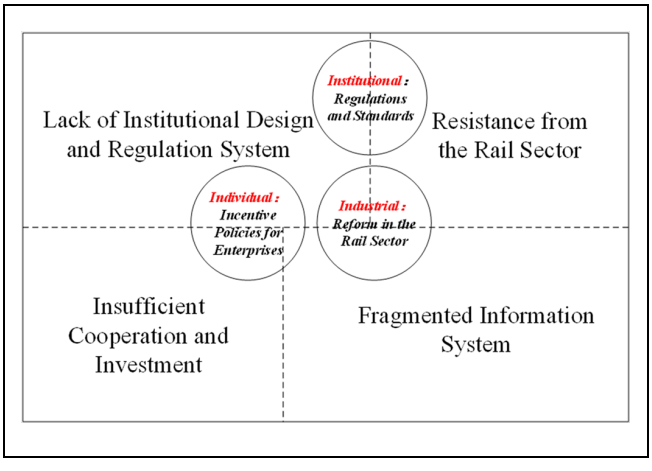

Figure 3. The logic from problem identification to policy making.

Step One: Unification of International Regulations and Standards

Regulations and a standard system are vitally important in international trade and transportation because these clarify risks, responsibilities, and costs. (*39*, *40*) PIT is concerned with R&O involving cross-border or multi-regional laws and regulations; therefore, international coordination and cooperation should be facilitated to establish a state-of-the-art convention, treaty, or agreement for PIT. Because the Convention on International Multimodal Transport of Goods is still not in effect yet (*41*), an updated alternative should be established as a unified framework for international cooperation under PIT with regard to sector liabilities, document format (the standardization of rail waybills, for example), and a mechanism for arbitration (*3*). The Agreement on International Goods Transport by Rail (SMGS) waybill has dominated rail transport in China and the surrounding Asian countries, whereas European counterparts have applied the Uniform Rules Concerning the Contract for International Carriage of Goods by Rail (CIM) (*42*). Furthermore, the intermodal bills of lading issued by MTOs as documents of title could facilitate international trade. However, in most cases, MTOs only issue waybills that are non-negotiable and erode their incentive to trade.

The launching of BRI provides a good opportunity for establishing a unified framework for regulations and standards. The cooperation and coordination mechanism has been strengthened among BRI countries, which makes bilateral or multilateral agreements more applicable and acceptable than international convention (*43*). In addition, after several years' operation of the CR Express from China to Europe, the practicalities concerning a new intermodal agreement have already been addressed, and an attempt at creating a unified framework for regulations and standards can be made, perhaps using a pilot.

Step Two: Rail Sector Reform for Better Alignment with Other Transport Sectors

Although high-speed rail is well developed in China, its cargo transportation system has long been overlooked. Before the establishment of the China Railway Corporation in 2013, the railways were independent from other transport modes, hindering their marketization and coordination with the others under PIT. There

are disparities between the railways and other transport modes in many respects, for example, containerization, pricing, and load limitation.

Containerization as far as China's rail system is concerned means that most goods that are suitable for container transport are still transported via railway wagon or in individual loads. Container transport only accounts for 5.4% of the total volume, although more than 10% of the cargo is suitable for this type of transport (*44*). Such a low rate of containerization can be explained by not only the tradition that the rail system is designed for moving bulk cargoes such as coal, ore, cement, or other building materials, but also the competition from existing transloading business at ports, with many interested parties. Therefore, future transport institutional reform should put more emphasis on improving containerization in the rail sector.

The rail freight rate consists of the transport charge, the loading/unloading charge, the storage charge, and other operational charges, resulting in a rigid and complex pricing mechanism. Although a floating freight rate at approximately 30% to 50% discount is applied on many rail routes, the sea–rail intermodal freight rate is still less competitive than that of road transport (truck) with a door-to-door service. In addition, the pricing of the rail system varies according to which regional rail authority is involved and which cargo category is being applied, thus leading to price competition between different parties.

Last but not least, there are many different definitions of the load limit depending on different national regulations and the type of transportation, especially with regard to shipping and inland transport in different countries. Take the 20-ft container for example, for which there are three definitions of maximum gross weight: International Organization for Standardization (less than 30.48 ton); liner shipping company (less than 15 to 30 ton); and inland transport (port, rail, and road) (less than 17.3 ton in the USA). The load limitation requires a concession from the rail sector.

To facilitate the rail revolution, the central government further reformed the China State Railway Group Co. in 2019, a big step for rail institutional reform in complying with market change. With more market-oriented measures, the coordination between the rail sector and other service providers may get easier, as will the issues in relation to containerization, pricing, and the load limit.

Step Three: Incentive Policies for Enterprises Instead of Direct Subsidies

Because there is little willingness at the moment to participate in PIT, a common solution would be to stimulate the enterprises concerned with government subsidies. However, subsidies would vary according to the local situation, leading to competition and price wars. According to the questionnaire survey, more incentive policies rather than direct subsidies should be introduced.

Regional Balance. The regional disparity of PIT reflects the distribution of ports in the hinterland and the local economic situation. PIT coincides with the BRI and the "Go West" policy, thus a geographic balance of PIT enterprises or their agents throughout the country is vital to the successful execution of a national strategy of economic development. From the perspective of geographic division as seen in Figure 1, the coastal region has the majority of MTOs, whereas there are only a few companies participating in PIT in the central and western areas. Supporting policies should focus on inland enterprises in developing and connecting PIT to achieve regional balance.

Private Sector Participation. Public–private partnerships are encouraged to invest in the infrastructure and superstructure of PIT (*45*, *46*). With regard to the pattern of ownership, market-oriented private sectors are more receptive to market change. It would be a good idea to tap into the potential of private capital, that is, to advocate private enterprises becoming members of MTOs, thus encouraging the market to become more buoyant. In addition, competition from new market entrants will lead to an open market with fair competition.

Driven by Technology and Talent. The informatization of intermodal transport remains backward in relation to its technology, mode, and diversity, thus, potentially, offering huge opportunities for development. A capital support policy is necessary for constructing the PIT information platform; however, the main factors affecting the information-sharing system are the inconsistency of standards and each party's accessibility to that information. The government needs to play its role in coordinating those involved and encouraging industry associations to harmonize technical standards.

Further, MTOs need to develop an effective talent pool. (*47*, *48*). Human resources are a more worthwhile investment for business growth than computer hardware (*49*, *50*). Companies need to have skilled staff who can execute business procedures successfully and handle any emergencies that arise during transportation, keeping each process working effectively. A company's workforce needs to have a comprehensive range of talent at different levels including professionals who can think strategically and technicians with strong practical skills.

As stated by the Notification on Further Encouraging Intermodal Transport jointly issued by the Ministry of

Transport and other 17 departments, China will strive to increase the volume of intermodal transport by 1.5 times by 2020 compared with 2015, reaching 3.028 billion tons with a compound growth rate of 20.11% (*5*). Because the PIT market still has huge potential, it may attract more investment and companies, and further incentive policies are expected to activate the market.

Conclusion

Although China's PIT has been developing for nearly 10 years, its achievements have been hindered by obstacles in certain areas. Based on the questionnaire survey to MTOs, this paper has explored the main problems that have eroded the competitiveness of PIT.

From the administrative framework design to the operational and management system, the development of PIT is restricted in several aspects. First, reforming its institutional design and system regulation is an urgent issue with regard to creating a stable business environment and standardized service. Second, the rail sector is the weak link in the transport connection with poor practical organization and operation leading to external and internal inefficiency. Third, there is insufficient cooperation and investment with a low level of participation. Last but not least, the information systems of the different transport modes are fragmented. These problems exceed the ability of market forces. Such a situation calls for radical, systematic development as well as the intervention of government.

Under such circumstances, we argue that the government's role should lie in the regulation, coordination, and motivation of PIT. A three-step policy framework needs to be established on an institutional, industrial, and individual level: (a) unification of international regulations and standards; (b) rail sector reform for better alignment with other transport sectors; (c) incentive policies for enterprises instead of direct subsidies.

Appendix A

The frequency is the number of occurrences of keywords among respondents.

$$frequency = \frac{Number\ of\ Occurences}{Number\ of\ Respondents}$$

The number of occurrences is counted once if the keyword is mentioned by a respondent. The number of respondents is the number of valid responses to the questionnaire survey. Table 3 shows a selection of the results.

Table 3. A Selection of Keywords Generated from the Survey

Category	Keywords	Frequency
Legal system		
	Service regulation	0.44
	Contracts	0.37
	Documents	0.3
	Rights and obligations of PIT	0.3
	Rights and obligations of actual carriers	0.3
	Claims and litigations	0.26
	Rights and obligations of shippers	0.15
	…	-
Service regulation		
	Information exchange	0.33
	Waybills	0.3
	Insurance indemnity	0.26
	Cargo exchange	0.22
	Definition of containerized cargo	0.15
	Pricing	0.15
	Loading limitation	0.11
	…	-
Insufficient infrastructure		
	Business building	0.7
	Warehouse	0.67
	Yard	0.59
	Custom area	0.52
	Maintenance area	0.52
	Road	0.52
	Gate	0.52
	Apron	0.44
	Rail line	0.44
	Logistics area (tax free)	0.41
	Parking area	0.41
	…	-
Insufficient superstructure		
	Gantry crane	0.41
	Rail line	0.41
	Quay crane	0.37
	Stacker	0.33
	Truck-tractor	0.33
	Container	0.33
	Transmission band	0.26
	Conveyor	0.22
	Weighbridge	0.19
	Electricity supply	0.11
	…	-
Rail obstacles	Mispricing	0.63
	System sharing	0.59
	Punctuality	0.22
	Marketization	0.19
	Reliability	0.15
	Standardization	0.15
	Infrastructure	0.11
	…	-
Coordination and technology	Information exchange	0.33
	Cargo monitoring	0.22
	Foreign counterparts	0.15
	…	-

(continued)

Table 3. (continued)

Category	Keywords	Frequency
Capital mode	Project financing	0.56
	Financial party lending	0.3
	International leasing	0.19
	…	-
Labor shortage	Manager	0.48
	Professional worker	0.41
	Skilled worker	0.41
	Researcher	0.37
	…	-

Note: PIT = port searail intermodal transport.

Appendix B

Thematic elements are generated with inductive category development (*21*). Keywords with similar meanings are grouped together (see different colors in Figure 4). Some of the keywords are included in two or more thematic elements with overlapping colors (e.g., "waybills" belongs both to the rail sector and institutional system).

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Author Contributions

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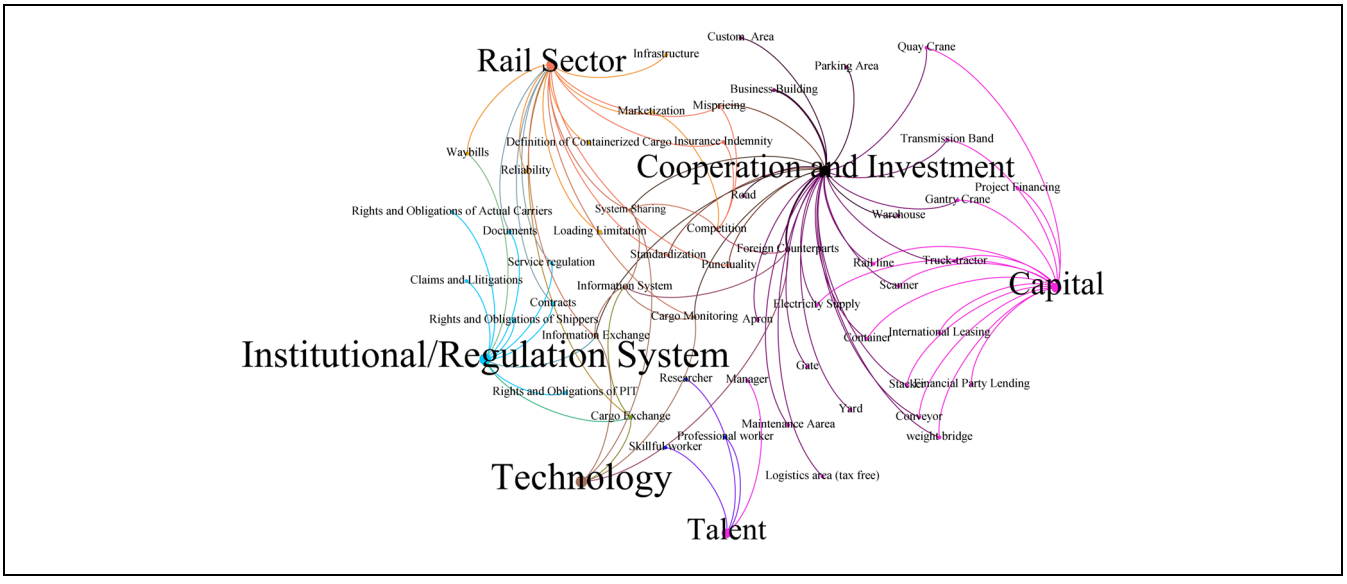

Figure 4. The generation of thematic elements from keywords.
Note: PIT = port sea–rail intermodal transport.

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