Establish and Implement an Evaluation System for Multimodal Freight Transport Hub Management in China

Implemented by

Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

Supported by

Federal Ministry for Economic Affairs and Climate Action

IKI International Climate Initiative

DGG Deutsche GVZ-Gesellschaft mbH

交通运输部规划研究院 Transport Planning and Research Institute, Ministry of Transport, China

based on a decision of the German Bundestag

Imprint

As a federally owned enterprise, GIZ supports the German Government in achieving its objectives in the field of international cooperation for sustainable development.

■ **Published by**
Deutsche Gesellschaft für
Internationale Zusammenarbeit (GIZ) GmbH
Registered offices
Bonn and Eschborn, Germany

■ **Address**
Tayuan Diplomatic Office Building 2-5
14 Liangmahe South Street, Chaoyang District
100600, Beijing, PR China
T +86-(0)10-8527 5589
F +86-(0)10-8527 5591
E transition-china@giz.de
https://transition- china.org/mobility

■ **Project**
Sino-German Cooperation on Low Carbon Transport (CLCT)
The CLCT project is part of the International Climate Initiative (IKI). Since 2022, the IKI is implemented by the Federal Ministry for Economic Affairs and Climate Action (BMWK) in close cooperation with the Federal Ministry for the Environment, Nature Conservation, Nuclear Safety and Consumer Protection (BMUV) and the Federal Foreign Office (AA)..

■ **Responsible**
Sebastian Ibold (GIZ)
E transition-china@giz.de
https://transition- china.org/mobility

■ **Authors**
Transport Planning and Research Institute, Ministry of Transport.
Wei Wang, Yunhan Li, Xiaotong Liu, Yongcun Wei, Yongfeng Liu, Jiayuan He, Guanliang Luo, Jiahua Gan, Qian Dai
Deutsche GVZ-Gesellschaft mbH
Steffen Nestler, Thomas Nobel

■ **Editors**
GIZ
Xuan Ling (Dr), Sebastian Ibold, Gregor Bauer, Mingshu Yang, Xinghao Lou

■ **Layout**
Beijing team orca culture and Art Co., Ltd
Xin Hu (GIZ), Xuyang Song (GIZ)

■ **Photo credits**
GIZ, Adobe, Pixabay.com, Bing.com, & BTI

■ **Maps**
The maps printed here are intended only for information purposes and in no way constitute recognition under international law of boundaries and territories. GIZ accepts no responsibility for these maps being entirely up to date, correct or complete. All liability for any damage, direct or indirect, resulting from their use is excluded.

■ **URL links**
Responsibility for the content of external websites linked
in this publication always lies with their respective publishers.
GIZ expressly dissociates itself from such content.

Beijing, 2022

Content

Figure Index

Table Index

Executive Summary

1. Research background

In recent years, the Chinese government has attached great importance to the development of multimodal transport as a strategy towards facilitating a shift from carbon intensive road transport to other less carbon intensive modes such as rail and waterways. The construction of multimodal freight transport hubs (MFTH) is also one of its key tasks to promote multimodal transport. A number of documents have been successively promulgated by the Chinese government, such as the Medium and Long-term Development Plan for the Logistics Industry (2014-2020), the Action Plan for the Construction of Logistics Corridors (2016-2020), the Notice on Further Encouraging Multimodal Transport, Three-year Action Plan for Promoting Transport Structure (2018-2020), the National Logistics Hub Layout and Construction Plan, and related policies. The Chinese government has deployed and promoted key tasks with regard to the planning, layout, construction, operation and management of MFTHs at different levels, and organised the establishment of three batches of MFTH demonstration projects, thus providing institutional basis and guarantee policies for MFTH development, with positive results.

However, China has paid attention to promoting the construction of MFTHs, but the consideration on how and when to evaluate their implementation and operation are yet developed. As a result, there is a lack of information relating to the monitoring of operations, and hub efficiency and social benefits concerning MFTHs, as well as a shortage of knowledge on the relationship between market demand and the carrying capacity of hubs. MFTH management and service evaluations are still lacking, and various sectors, regions and modes of transport differ in the basic requirements and services they need from MFTHs. Problems such as a lack of MFTH service functions, insufficient degrees of intensification, and poor operation and management strategies have adversely affected the provision of high quality and sustainable MFTH services. There is therefore an opportunity to establish a sound evaluation mechanism for MFTHs in China.

2. Evaluation Principles

In order to scientifically evaluate the effect of intermodal transport freight hubs, the index system for this task is designed according to the principles of scientific grounding, comprehensiveness, independence, operability, hierarchy and dynamics.

The first element of this design is the scientific principle. The index system can reasonably reflect the construction effect of intermodal transport freight hubs, reflect the combination of theories and practices, and adopt scientific methods to reflect the actual situation.

The second is the principle of comprehensiveness. The indexes can systematically and comprehensively consider the hub infrastructure, service capacity, operation level, social benefits and safety, green and low-carbon and other factors.

The third is the principle of independence, which selects indexes with relatively independent concepts to avoid overlapping concepts between indexes.

The fourth is the principle of operability, which fully considers the feasibility of index value measurement and data collection, uses objective indexes and current statistical indexes as much as possible when determining indexes, and avoids putting significant workloads on evaluation organisations and evaluation objects.

The fifth is the principle of hierarchy. The construction of the index system should have hierarchy, and the high level is the generalisation and comprehensive embodiment of the low-level index system.

The sixth is the dynamic principle. The index system shall be able to adapt to the development and changes of external factors such as social economy, and shall be adjusted regularly.

3. Evaluation objectives and mechanisms

The potential evaluation objects cover all multimodal transport hubs. The evaluation frequency is expected as once per year. . The operators of freight hubs operators with two or more transportation modes can become the evaluation objects. This evaluation work uses scientific appraisal methods to evaluate the service level of the appraised object. It is organised by the Ministry of Transport of the People's Republic of China (MOT) and entrusted scientific research institutions to carry out it once a year.

Evaluation work mainly relies on three channels to obtain data. First, the evaluation agency needs to establish an intermodal transport hub evaluation system, and then the evaluation objects report relevant data on the evaluation system as required. Second, data is taken from the transportation statistics, such as the Statistical Analysis Report on Logistics Park Operation. Third, data is taken from the national logistics park survey reports and other authoritative industry analysis reports.

To ensure the authenticity and accuracy of the reported data, it is first necessary to prepare a technical guide for data filling, and clarify the calculation and filling methods of each indicator data. Second, the evaluation objects are required to provide necessary supporting materials. Third, the assessment agency shall verify all or part of the data through field surveys, the use of remote sensing image analysis, expert consultations and other means, to test the authenticity of the data. In the instance that it is verified that the hub participating in the evaluation has committed false reporting and/or fraud, the hub will be disqualified from participating in the evaluation for two years.

4. Evaluation index systems

The management evaluation index system of intermodal transport freight hub evaluates the operation management level and service levels of hubs, and is divided into three levels of evaluation indexes. There are 5 first-class evaluation indexes, including infrastructure, service capacity, operation levels, social benefits and safety, and green and low-carbon status. Additionally, 11 second-level evaluation indexes are set, including internal facility scales, external traffic support, loading and unloading capacity, service functions, operation efficiency, operation scale, operation quality, social benefits, safety management, conservation and environmental protection, and energy utilisation. There are then 22 third-level evaluation indexes, which are outlined in the management evaluation index system of intermodal freight hubs as shown in Figure 1.

5. Weight of indexes

The evaluation method adopts the expert scoring method to determine the index weight. Guided by the perspectives of The Notice on Further Encouraging the Development of Intermodal Transport issued by the MOT and other documents and combined with the actual situation and target orientation of intermodal transport freight hubs in China, each expert scientifically and objectively compares the importance of each index and determines the weight of each index according to their practical experience. Experts in the fields of railway, highway, waterway, aviation, postal service, integrated transportation, and multimodal transportation divide the indexes into five grades from Grade 1 to Grade 5 according to the importance of each index. Then the Analytic Hierarchy Process (AHP)[1] method is used to assign reasonable weights to the evaluation indexes.

The final weight of each index is shown in Table 1.

[1] The Analytic Hierarchy Process is a simple, flexible and practical method for the quantitative analysis of qualitative questions.

■ Figure 1 Management Evaluation Index System of Intermodal Transport Freight Hubs

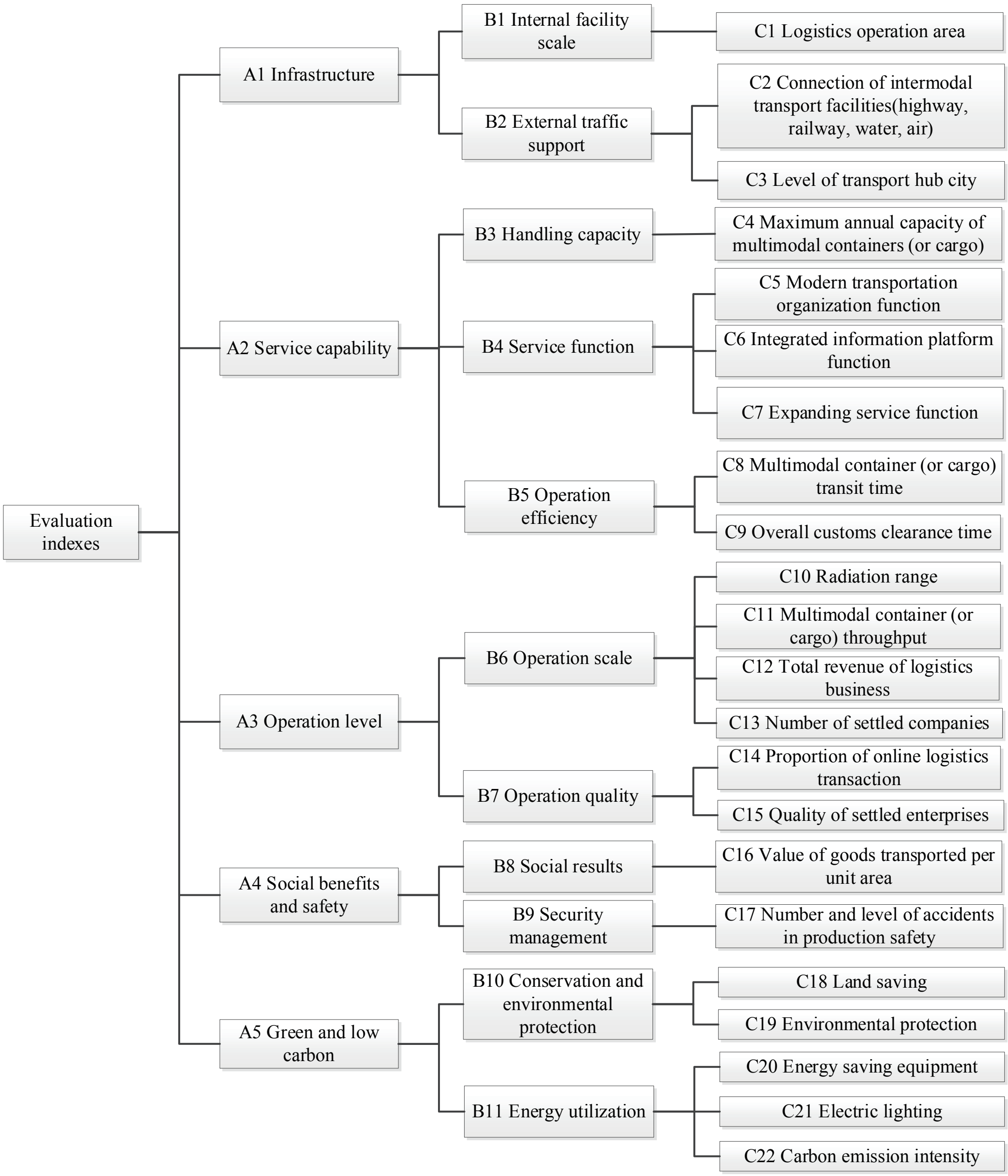


Table 1 Modified multimodal transport hub evaluation index system after pilot application

First-level indicators			Second-level indicators			Third-level indicators		
Serial No.	Index name	Index weight	Serial No.	Index name	Index weight	Serial No.	Index name	Index weight
A1	Infrastructure	0.2	B1	Scale of internal facilities	0.04	C1	Logistics operating area	0.04
			B2	External transport support	0.16	C2	Connection of intermodal transport facilities (highway, railway, water and air)	0.10
						C3	Level of transport hub city	0.06
A2	Service capacity	0.25	B3	Handling capacity	0.05	C4	Maximum annual capacity of multimodal containers (or cargo)	0.05
			B4	Service function	0.12	C5	Modern transport organisation functions	0.04
						C6	Integrated Information platform function	0.04
						C7	Expanding service function	0.04
			B5	Operation efficiency	0.08	C8	Multimodal container (or cargo) transit time	0.04
						C9	Overall Customs Clearance time	0.04
A3	Operation level	0.15	B6	Scale of Operation	0.11	C10	Radiation range	0.05
						C11	Multimodal container (cargo) throughput	0.02
						C12	Total revenue from Logistics business	0.02
						C13	Number of settled companies	0.02
			B7	Operation quality	0.04	C14	Proportion of online logistics transactions	0.02
						C15	Quality of settled enterprises	0.02
A4	Social benefit and security	0.1	B8	Social benefit	0.05	C16	Value of goods transported per unit area	0.05
			B9	Security Management	0.05	C17	Number and level of accidents in production safety	0.05
A5	Green and low carbon	0.3	B10	Conservation and environmental protection	0.10	C18	Land saving	0.05
						C19	environmental protection	0.05
			B11	Energy use	0.20	C20	Energy saving equipment	0.07
						C21	Electric lighting	0.03
						C22	Carbon emission intensity	0.10

6. Countermeasures and suggestions for MFTH evaluations in China

(1) Continuously improve the evaluation index system

A scientific and reasonable evaluation index system is a reliable tool to measure the development of MFTHs, which have multiple functions, long chains of systems and processes, and diverse elements. It is necessary to continuously adjust and improve the evaluation index system according to the progress of evaluation work and changes in external factors such as socio-economic development. It is also possible to develop a more detailed evaluation index system for different types of MFTHs in the future so that the evaluation can play a better role in guiding and serving MFTH development. In the future, a more detailed evaluation index system can be studied for different types of MFTHs.

(2) Establish a pragmatic and efficient evaluation mechanism

MFTH evaluation is a systematic project, involving a large number of departments and enterprises, a large amount of data, and complex work procedures, which requires the establishment of a pragmatic and efficient evaluation work mechanism. It is therefore recommended to establish and improve the data statistics system and guide MFTHs to pay attention to the statistics of relevant indicators such as carbon emission intensity. In addition, efforts should be made to improve the means of obtaining evaluation data. Information should be collected in various forms such as network surveys, telephone surveys, in-depth interviews, field investigations, symposiums, E-mail questionnaires, and government and association data collection activities, so as to ensure the timeliness and accuracy of the base of MFTH evaluations.

(3) Make full use of industry associations and scientific research institutions to carry out MFTH evaluations

As important bridges between governments and enterprises, industry associations and scientific research institutions are eligible to undertake MFTH evaluation work, which would not only use their great advantages in indicator research, survey organisation and result application, but also give full play to their main role in providing decision support for industry development and promoting the vigorous development of MFTHs.

(4) Focus on the publicity and application of the evaluation results

Evaluation results can be used as a basis to measure the service capabilities of a single hub or the development of the entire transport industry. In addition, the results can also become an important tool for identifying problems, promoting competition among hubs, and promoting the high-quality development of the transport industry. It is recommended to release the Annual Report on the MFTH Development Quality based on the evaluation result, which can summarise the annual development of MFTHs, provide excellent cases for the industry to learn from, look forward to future development directions and trends, and increase the amount of attention that the entire industry receives. Furthermore, competent authorities and MFTH operators are also advised to summarise, replicate and promote their typical experiences in terms of infrastructure construction, service capacity enhancement, operation improvement, social benefits, safety guarantees, and green and low-carbon development, so as to provide useful, replicable and effective references for other MFTHs.

1 Study Concept and Work Plan

1.1 Research background

In recent years, the Chinese government has attached great importance to the development of multimodal transport systems, taking the construction of multimodal freight transport hubs (MFTH) as one of its key tasks. A number of relevant plans and documents have been successively promulgated by the Chinese government, including amongst others the Medium and Long-term Development Plan for the Logistics Industry (2014-2020)[1], the Action Plan for the Construction of Logistics Corridors (2016-2020)[2], the Notice on Further Encouraging Multimodal Transport[3], the Three-year Action Plan for Promoting Transport Structure (2018-2020)[4], and the National Logistics Hub Layout and Construction Plan[5]. The Chinese government has deployed and promoted key tasks regarding the planning, layout, construction, operation and management of MFTH at different levels, and has also organised the establishment of three batches of MFTH demonstration projects, thus providing an institutional basis and guaranteed policies for MFTH development, with positive results.

However, China pays more attention to promoting the construction of MFTH than to the monitoring of their subsequent management. As a result, there is a lack of knowledge relating to MFTH operation, efficiency and their social benefits, as well as a shortage of data on the relationship between market demand and hub carrying capacity. MFTH management and service evaluation are also still lacking. Various sectors, regions and modes of transport differ in their basic requirements and needed services relating to MFTHs, and problems such as a lack of MFTH service functions, insufficient degrees of intensification, and poor operation and management contexts, have adversely affected the provision of high quality and sustainable MFTH service across diverse settings. Therefore, it is necessary to establish a sound evaluation mechanism for MFTH services.

1.2 Content of the study and research methodology

1.2.1 Research definition and scope

MFTH are important nodes on integrated transportation networks. As the main focus of this study, MFTHs refer to areas where multiple modes of transportation are centrally laid out, usually in the form of project packages or collections. There can be one or more operating entities that realise the convenient conversion and efficient organisation of goods between different modes of transportation through facility connections, business synergies and information sharing systems.

The spatial scope of this study focuses on China's MFTH, but the report also includes an examination of the construction, operation and management experience of MFTHs from the United States, Europe and other regions.

1.2.2 Content of the study

In order to further promote the development of MFTHs, improve their service quality, establish a service evaluation mechanism for MFTHs, and provide strong support for the scientific evaluation, systematic analysis, optimisation and improvement of MFTHs, this study had the following goals:

Review and assess the existing MFTH evaluation methodologies, which specifically includes evaluation indexes, weights, index calculation methods, and data sources of domestic and international MFTH evaluation methodologies.

Analyse the current situation of MFTH development in China, including: a) the development status of China's MFTHs as a whole, including in key regions such as the Yangtze River Economic Belt, Beijing-Tianjin-Hebei and Pearl River Delta; b) relevant policies, strategies, roadmaps and measures issued by China's national and local governments, with a view to promote and standardise the development of MFTHs; c) analysis of existing types of MFTHs in China; d) practices of MFTH operating entities, management difficulties, the need for policies and support measures stipulated by the government, as well as the extent and requirement for climate and environmental performance indicators.

On the basis of the aforementioned (1) and (2) studies, a MFTH evaluation system suitable for China's characteristics and strategic development requirements will be developed.

Test and improve China's MFTH evaluation system through pilot applications by applying the evaluation methodology to at least three typical MFTHs, and subsequently validate and improve evaluation methodology and implementation guidelines based on the results of this evaluation process and pilot applications. Following this step, summarise the advantages and problems in the evaluation process of a typical MFTH.

Recommend policies and measures for relevant stakeholders, taking into account the issues identified in study step (4). These recommendations include: a) proposing policy and measure recommendations for Chinese national and local governments to improve the oversight of MFTHs by the Ministry of Transport (MOT) and other key stakeholders; b) putting forward application and operation suggestions for MFTH operators to achieve more efficient and climate-friendly operations; c) exploring the potential for the promotion and implementation of MFTH evaluation systems in China.

1.2.3 Technical scheme and study structure

According to the terms of reference (TOR) for this study, this research will carry out in-depth work on the following two aspects:

Development of a MFTH management evaluation system that suits the characteristics and strategic requirements for MFTH development in China. The evaluation system will include evaluation methodology and implementation guidelines, covering at least two or three modes of intermodal transport, (such as roads, waterways and railroads), with particular attention to the impact of MFTHs on the environment and greenhouse gases. Furthermore, the system incorporates potential indicators concerning air pollution and greenhouse gas emission reduction into its methodology, thus encouraging green and sustainable development in line with environmental and climate protection objectives.

Testing and improvement of the evaluation methodology of MFTHs in China through pilot applications. The evaluation methodology will be applied to at least three typical MFTHs, covering the main intermodal modes in China (such as sea-rail, road-rail, and road-water transport, etc.). From the common problems and shortcomings identified during the evaluation process and the results of the pilot application, this study then improves and validates the evaluation methodology and implementation guidelines, revises and develops a comprehensive evaluation system for the management, service quality, and environmental and climate performance of MFTHs in China.

The study structure is outlined in Figure 1-1.

1.2.4 Research Methodology

Based on the six tasks in this study's TOR and the specific outcomes of each task, the research team will use the methods of literature reviews, quantitative analysis, field research, expert consultations, and case studies to complete each research goal.

(1) Literature review

The study will collect and summarise relevant information available in the transport sector, which will then be deeply analysed and assessed to determine the basic situation and existing problems concerning MFTHs in China, including data pertaining to their evaluation. The study will also examine advanced MFTH experiences at home and abroad as research references.

(2) Quantitative analysis

In the process of analysing MFTH development, the Analytic Hierarchy Process (AHP)[2] method is used to assign reasonable weights to the evaluation indexes of MFTH service levels. Moreover, the evaluation criterion is scientifically determined according to the statistical data of relevant indexes in China and relevant standards and norms, such as The Basic Requirements for Classification and Planning of Logistics Parks (GBT 21334-2017).

(3) Field investigation

This study selects railway logistics bases, logistics parks, ports, airport hubs and other MFTHs of different regions, scales, and forms for field research to understand and summarise the core situation of MFTHs in terms of their

[2] The Analytic Hierarchy Process is a simple, flexible and practical method for the quantitative analysis of qualitative questions.

operational efficiency, management benefits and service levels. Questionnaires are designed and organised to be filled out according to identified concerns.

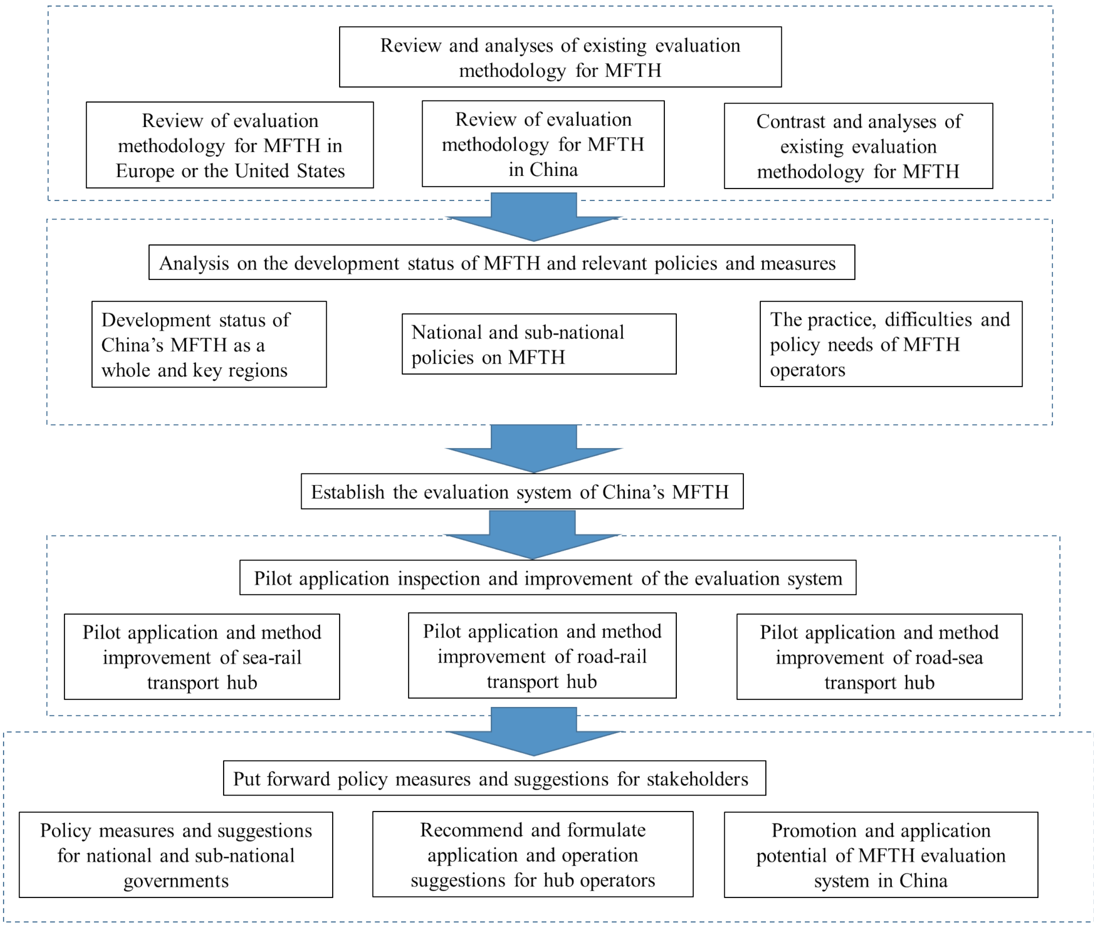
(4) Expert Consultation

Experts in the fields of railway, highway, waterway, aviation, postal service, integrated transportation and multimodal transportation will be invited to share their opinions and suggestions for key indicators relating to MFTH service assessments, as well as ways to generally promote the development of MFTHs.

(5) Case studies

By selecting typical MFTHs to be used as case studies relating to service evaluation analysis, the feasibility and validity of the evaluation index system and methods can be verified. Overall evaluation systems will therefore be improved on the basis of case study findings. A work and time schedule relating to each task and related deliverables of the study is outlined in Section 1.3.

■ Figure 1-1 The Study Structure



1.3 Work schedule and time schedule

Table 1-1 Work schedule and time schedule

Task	Submission time	Deliverables
Task 1: Develop a study concept and work plan	End of January/2021	MS Word document, outlining the work plan and concept (at least 5 pages)
Task 2: Review existing international evaluation systems, studies, relevant information and data sources	Early March/2021	Research work (MS Word document, at least 8 pages)
Task 3: Review and analyse the current MFTH devolvement status in China	Early March/2021	Research work (MS Word document, at least 10 pages), 3 overview tables
Kick-off - Review workshop	Mid to late March /2021	MS Power Point Presentation and workshop (at least 20 participants)
Capacity Building Events (1 or 2) - International experience & Local practice survey	Flexible arrangement /2021	Gathered international experience for evaluation method development and implementation and MFTH operators' current practice, difficulties and further demands in China
Task 4: Develop the evaluation methodology for assessing MFTH management in China	End of June/2021	Research works (MS Word document, at least 20 pages)
Task 5: Apply the developed evaluation methodology on 3-6 selected MFTH for evaluation pilots	End of September /2021	Research work (MS Word document, at least 20 pages) and a MS excel table of selection factors for MFTH
Capacity Building Event - Dissemination of the methodology	Flexible arrangement /2021	MS Power Point Presentation and workshop (at least 50 participants)
Interims report	End of October /2021	Interims report, (MS Word Document, at least 55 pages)
Interims workshop	End of October /2021	MS Power Point presentation, Workshop (at least 20 participants)
Task 6: Develop policy and operation suggestions for the MOT, MFTH operators and other key stakeholders.	End of 2021	Report (MS Word document, at least 12 pages), summary report (at least 3 pages)
Final Report	End of January /2022	Final report (MS Word Document, at least 70 pages), Executive summary
Final workshop	End of January /2022	MS Power Point Presentation, Workshop (at least 20 relevant participants)

2 Study on Domestic and International MFTH Management Evaluation Systems

Multimodal transport is a leading international form of transport organisation. As a key component of multimodal transport, multimodal transport freight hubs (MFTHs) are highly valued and widely discussed in the field of transportation. Governments, enterprises, research institutions, scholars and experts have carried out different forms of evaluation studies on MFTHs, producing relatively rich research deliverables. Some mature hub evaluation systems have been applied to management practices in the transport sector, thus providing strong support to promote the efficient and intensive development of MFTHs. This study focuses on MFTH evaluation systems that are widely used and highly recognised in different countries, with an in-depth comparative analysis of their strengths and weaknesses, so as to provide a useful reference for the establishment and implementation of China's overall MFTH management evaluation system.

2.1 Domestic and international MFTH evaluation

2.1.1 China's freight Hub (Logistics Park) evaluation index system

China has attached great importance to the construction of freight hubs (logistics parks)[3], which serve as an important means to promote modern integrated transport systems. The Chinese MOT has provided financial support to freight hubs that have outstanding public service attributes and can provide freight service functions such as multimodal transport, intermediate conversion, and regional distribution services. The MOT entrusted a third-party research institution to study and establish a freight hub construction evaluation system for assessment work, in order to strengthen follow-up monitoring and performance evaluations of policy support targets, analyse the status quo and identify problems and development directions concerning the construction implementation of freight hubs.

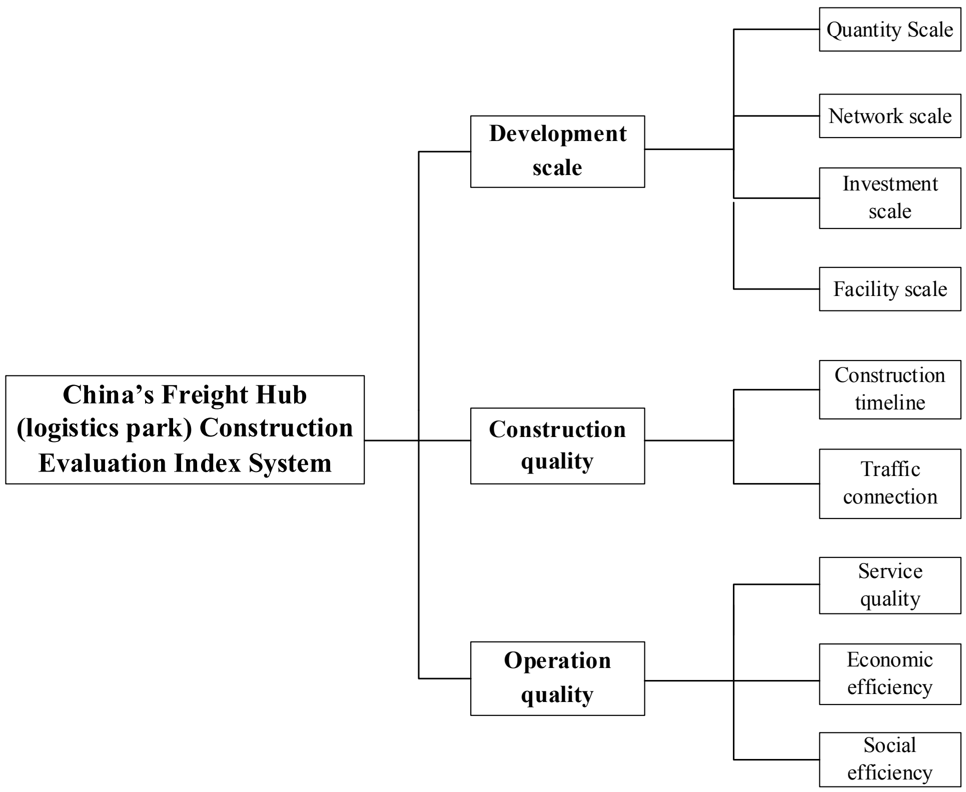
The evaluation index system takes the freight hub projects subsidised by the MOT as the assessment targets and establishes an index system in accordance with the principles of scientific foundations, comprehensiveness, independence, operability, hierarchy and dynamism. Specifically, the index system uses three primary evaluation indicators, namely the scale of development, construction quality and operation quality (see Figure 2-1). The system then uses 9 secondary evaluation indicators, including scales relating to quantities, networks, investments, facilities, construction timelines, traffic connections, service quality, economic efficiency and social efficiency.

Related evaluation work has been carried out every five years, organised by the MOT and conducted by relevant research institutions, mainly by the way of correspondence research, supplemented by field research (see Figure 2-2).

Relevant data concerning subsidised freight hubs has been obtained through provincial departments of transport (see Table 2-1). Since 2010, the MOT has organised third-party assessment agencies to apply the assessment index system to more than several hundred freight hubs for a comprehensive assessment, providing strong support for their MOT in terms of hub policy research and development.

[3] Note: Logistics Parks can be referred to as freight hubs, and these terms can be used interchangeably in this report.

■ Figure 2-1 China's Freight Hub Construction Evaluation Index System



■ Figure 2-2 China's Freight Hub Construction Evaluation Mechanism

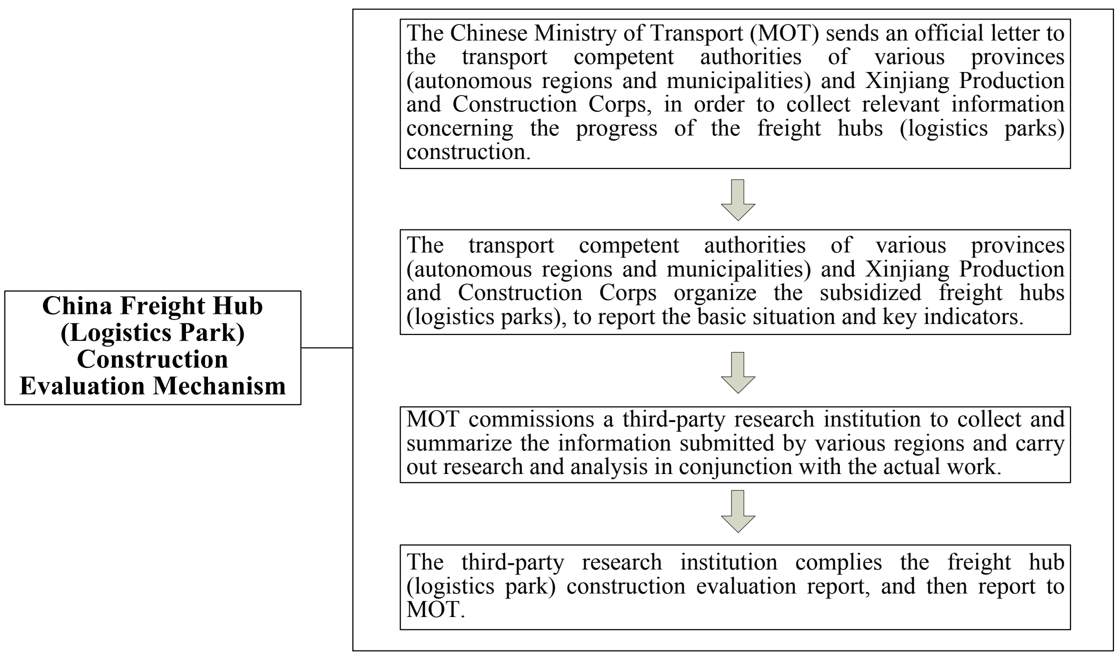


Table 2-1 China's Freight Hub Construction Evaluation Index System[4]

Primary evaluation indicators	Secondary evaluation indicators	Indicator description	Specific use	Data source
Development scale	Quantity Scale	The number of subsidised freight hub projects as a percentage of the total number of freight hubs nationwide	Reflect the transport industry's support for the logistics infrastructure backbone network	The provincial transport authorities in charge of the organisation of the survey to report relevant data and information.
	Network scale	The ratio of the number of cities covered by subsidised freight hubs to the number of municipalities nationwide	Reflect the breadth of coverage of the freight hub system	
	Investment scale	The completion of investment within the project site	Reflect the intensity of the use of funds and the scale and strength of fixed asset investment.	
	Facility scale	Project storage area and total construction area	Reflect the scale and strength of construction of storage facilities in the transport sector	
Construction quality	Construction timeline	The number of projects completed and put into operation as a proportion of the total number of projects	Reflect the actual construction timeframe of the project	
	Traffic connection	With multimodal transport functions and development conditions	This indicator reflects the level of multimodal transport development	
Operation quality	Service quality	The business functions and cluster development of the hub	Reflect the degree of diversification of service functions provided by freight hubs and the level of development of logistics intensification	
	Economic efficiency	Project-driven investment and logistics cost savings	Reflect the leveraging effect and strength of national financial investment on social capital, and the ability of transportation to promote logistics cost reduction and efficiency	
	Social efficiency	Driving industry development and reducing freight vehicle idling rates	Reflect the ability of freight hubs to attract industrial clusters, support poverty alleviation, and improve organisational efficiency	

[4] Note: The evaluation index system is aimed at the evaluation of the overall situation of the logistics park supported by the policy support of the Ministry of Transport of China.

2.1.2 Evaluation system of German logistics parks

Germany has the leading multimodal transport system in Europe. Compared with other developed countries, Germany is not an 'early bird' in the construction of logistics parks. In the 1990s, Germany started the planning of logistics parks to support and serve its economic development after the reunification of the two Germanys. With the accelerated construction of logistics parks all over the country, Germany gradually began to attach great importance to the evaluation of logistics parks, with particular attention to the multimodal transport function of these locations. Since 2004, the Deutsche GVZ Gesellschaft (DGG) has been evaluating logistics parks and publishing the results to the public, and its influence has been expanding (see Figure 2-3). By 2010, the evaluation objects of the DGG had expanded to the whole of Europe, and the number of logistics parks included in their evaluation had increased to nearly 200. The top 20 logistics parks in Europe selected by the DGG have been benchmarked by other park operators. The DGG has established a scientific evaluation index system with 40 indicators in 16 categories, including key indicators such as multimodal hub capacity, load capacity, load factor, service, and traffic mode conversion. Every five years, the DGG distributes questionnaires to participating organisations to obtain relevant data and adopts a benchmarking method to score the participating logistics parks (see Table 2-2). In 2015, the DGG used this evaluation system to rank dry ports[5] in 32 European countries and announced the top ranked dry ports, which provided a benchmark for the development of logistics parks in Germany and even Europe, and promoted the further development of logistics parks across Europe to form a healthy competition.

[5] Note: As the scope of evaluation has been extended to other European countries, it is difficult for the German definition of logistics park to include some different forms of logistics nodes used in other countries. In order to evaluate the development level of logistics parks in various countries, the DGG began to use the concept of "dry port" in 2015. Dry port is a multimodal transport hub that connects inland with seaports directly by rail or road, which serves the transit of goods between seaports and inland destinations, and also provides cargo storage and facility integration, maintenance of road or rail freight carriers and customs clearance services. Some inland ports are part of logistics parks and they are therefore automatically included in the DGG evaluations.

Figure 2-3 German Evaluation Index System of Logistics Parks

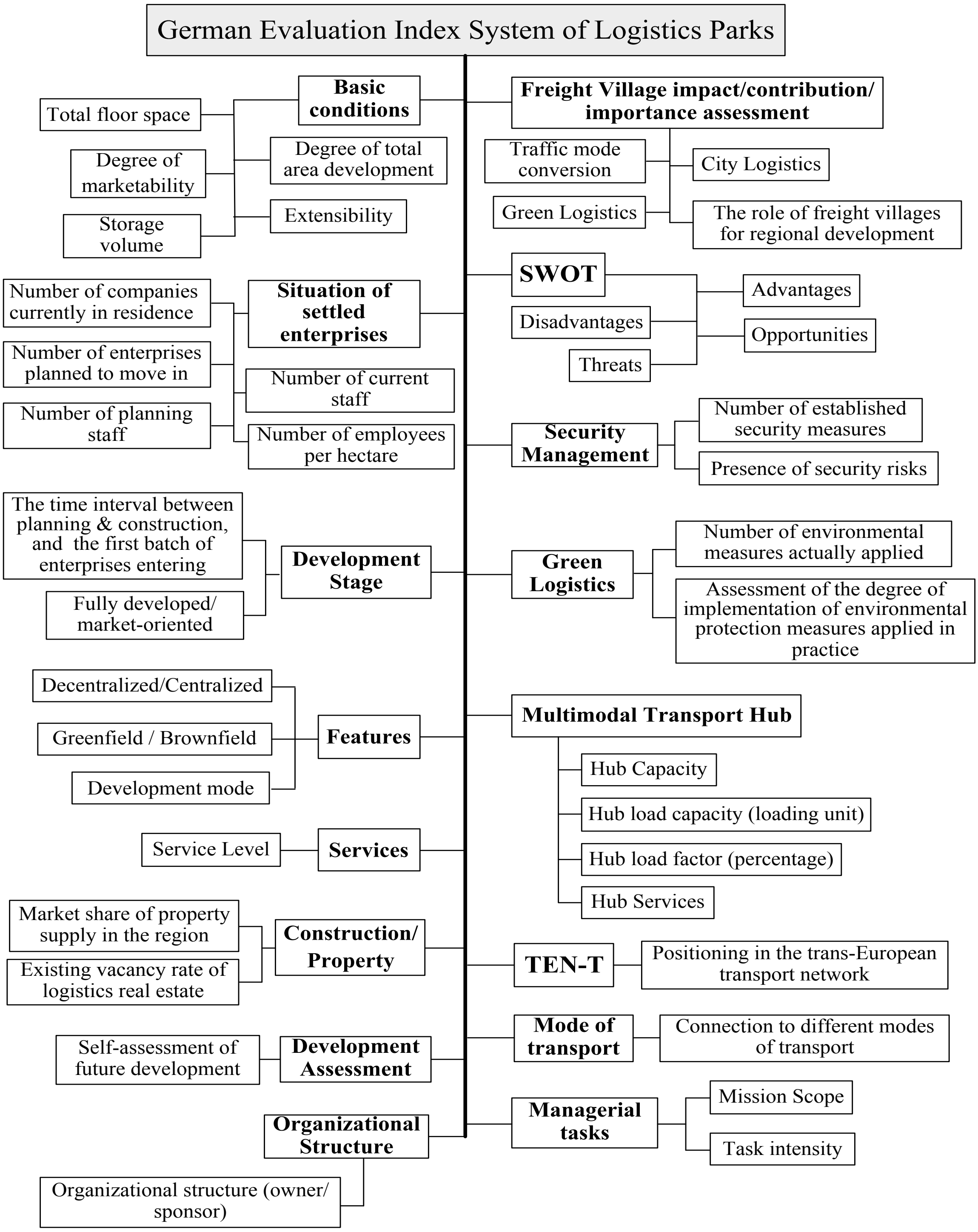


Table 2-2 German Evaluation Index System of Logistics Parks

Primary evaluation indicators	Secondary evaluation indicators	Indicator description	Data source
Basic conditions	Total floor space	It refers to the total area occupied by the hub.	Obtain corporate data through questionnaires.
	Degree of total area development	This indicator is determined by using the ratio of developed area to total area.	
	Degree of marketability	This indicator is determined by using the ratio of marketed area to developed area.	
	Extensibility	This indicator is used to measure the expandable area of the hub.	
	Storage volume	This indicator is used to measure the capacity of the hub's storage facilities.	
Situation of settled enterprises	Number of companies currently in residence	The number of companies currently in residence and number of enterprises planned to move in are important indicators for the development of European dry ports. In addition, DGG's indicators also include the current number of staff and the number of planning staff to estimate the number of staff per hectare of market-oriented areas. These figures are very helpful for assessing the resulting tax revenue and the multiplier effect of each dry port area.	
	Number of enterprises planned to move in		
	Number of current staff		
	Number of planning staff		
	Number of employees per hectare		
Development Stage	The time interval between planning & construction, and the first batch of enterprises entering	It describes the length of the process from planning until the tenants can use the facility "speed of development").	
	Fully developed/market-oriented	It describes the share of the logistics park area which is already sold or rented to tenants/users (e.g., logistics companies).	
Features	Decentralised/Centralised	This indicator is used to distinguish the layout characteristics of logistics park. Decentralised (multi-location logistics park, e.g., warehousing complex in one location and intermodal terminal in a separate location) /centralised (all logistics park facilities are located in one place).	
	Greenfield / Brownfield	This indicator is used to distinguish the land characteristics of logistics park. Greenfield (new location on land which was not used before for industrial purposes) /brownfield (redevelopment of an abandoned industrial area into a logistics park)	
	Development mode	Public, private or PPP (public private partnership).	
Services	Service Level	It refers to the types of service facilities provided or planned, including gas stations, truck repair stations, social facilities (such as sanitation facilities) or catering (such as restaurants or canteens).	

Primary evaluation indicators	Secondary evaluation indicators	Indicator description	Data source
Construction/Property	Market share of property supply in the region	To find out which share in logistics capacity the logistics park has in comparison to the total land use for logistics in the region where the logistics park is located.	Obtain corporate data through questionnaires.
	Existing vacancy rate of logistics real estate	It refers to indicator “fully developed/marketed”, i.e., in addition to the information, which part of the logistics park total area is already covered by warehouses etc., to know the level of utilisation by the tenants.	
Development Assessment	Self-assessment of future development	Logistics Park managers are asked to give an outlook to the future development of their logistics park (e.g., for the coming evaluation period of 5 years).	
Organisational Structure	Organisational structure (owner/sponsor)	To find out who is involved in logistics park development and operation (share of public and private sector).	
Managerial tasks	Mission Scope	It means that the development company supports the planning process of the area, supports the implementation process of the operational phase, acquires new tenants, conducts location marketing (participation in trade fairs, etc.), organises resource integration (e.g. joint use of energy, telecommunications, materials, etc.), provides continuing education and training (e.g. through seminars), logistics and consulting activities, research project cooperation, development and leasing of logistics facilities.	
	Task intensity	It means that the person in charge evaluates the relevance of the development company’s management activities through their own evaluation methods, thereby evaluating the task intensity of the development company.	
Mode of transport	Connection to different modes of transport	It refers to the number of externally connected transportation modes.	
TEN-T	Positioning in the trans-European transport network	Indicator for the location at one of the main routes of European trade flows.	
Multimodal Transport Hub	Hub Capacity	It refers to the scale of the loading unit available to the hub.	
	Hub load capacity (loading unit)	It refers to the number of loading units completed by the hub.	
	Hub load factor (percentage)	It refers to the ratio of the number of completed loading units to the hub capacity.	
	Hub Services	Logistics Park (intermodal terminals) can also act as a hub for inbound and outbound freight flows (consolidation, redistribution) rather than as destination for local freight consignments only.	

Primary evaluation indicators	Secondary evaluation indicators	Indicator description	Data source
Green Logistics	Number of environmental measures actually applied	Green logistics and climate protection become increasingly important, therefore we ask for measures in these fields.	Obtain corporate data through questionnaires.
	Assessment of the degree of implementation of environmental protection measures applied in practice	To measure the state of development of these measures (e.g., planned, pilot phase or fully operational).	
Security Management	Number of established security measures	It refers to whether the hub has a physical security system (e.g., fencing) for the entire dry port area, a security system in the form of entrance and exit gates, deployment of security officers, development of contingency plans, etc.	
	Presence of security risks	Security assessment and scoring of possible risks.	
SWOT	Advantages	Advantages of the hub.	
	Disadvantages	Disadvantages of the hub.	
	Opportunities	Opportunities for the hub.	
	Threats	Threats to the hub.	
Freight Village impact/contribution/ importance assessment	Traffic mode conversion	Modal shift from road traffic to rail or inland waterway.	
	City Logistics	Consolidation of urban freight flows in order to reduce road freight in city centres (e.g., micro hubs with cargo bikes, electric delivery vehicles, collaborative consolidation of consignments of various freight operators).	
	Green Logistics	Measure to reduce greenhouse gas emission in logistics (e.g., reduction of energy consumption in warehouses, use of alternative fuels for vehicles etc.).	
	The role of freight villages for regional development	Reference to indicator "market share of property supply within the region": The higher the capacity of the freight village, the higher is their influence on regional development e.g., on logistics real estates/properties and regional freight flows.	

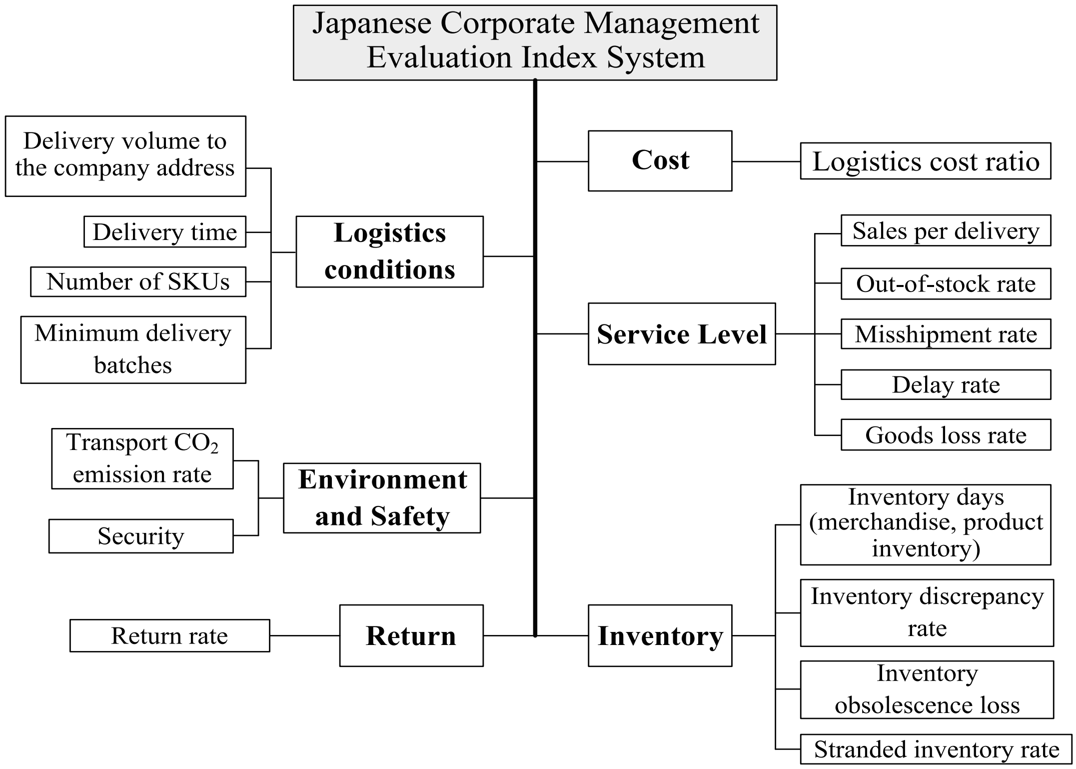
2.1.3 MFTH evaluation in the U.S.

No evaluation system related to MFTHs in the U.S. was found in this study, but the U.S. has taken a number of initiatives to promote MFTH development. The U.S. government has elevated intermodal transport systems to the level of national strategies. The U.S. adopted the Intermodal Surface Transportation Efficiency Act (ISTEA) in 1991, thus making the establishment of an efficient and environmentally-friendly national intermodal transportation system into a national strategy. ISTEA required the establishment of a multimodal advisory committee within the federal Department of Transportation, consisting of the Federal Highway Administration, Aviation Administration, Maritime Administration, Railroad Administration and related departments, and authorised the establishment of an Office of Multimodal Transportation within the Department of Transportation to develop and implement the multimodal transportation policy, which provides strong support for the development of MFTHs in the United States. The U.S. Department of Transportation (USDOT) has placed intermodal transportation at the forefront of its efforts to promote transport development. The focus of freight planning in the USDOT's successive five-year plans has been to address the three major bottlenecks in the intermodal transportation system (infrastructure, institutional systems, and financing), to implement policies to build intermodal transportation centres, and to continuously improve the intermodal hub station collection and distribution system. The USDOT organised a comprehensive assessment of the country's ports, airports, highways and railroad hubs and yards, and finally identified 616 multimodal logistics nodes nationwide. In order to ensure the distribution and transportation services of these nodes, the government has built 1,222 miles of dedicated highway lines for them. For some of these nodes with high freight volumes, multiple consolidation routes were ensured; for other sites, a seamless connection to the national highway network was developed.

2.1.4 Japan's Logistics Management Evaluation Index System

In order to give full play to the comprehensive benefits of logistics parks with high population density and scarce land resources, Japan attaches importance to the evaluation of logistics operating enterprises related to MFTHs. The analysis of the evaluation system of logistics enterprises related to MFTHs in Japan provides a reference for the building of operational efficiency indicators of logistics enterprises in the MFTH evaluation system in China. Since 2005, the Japan Logistics Society has been focusing on the study of management-related logistics evaluation indicators, and has established a committee composed of learned and experienced people and business practitioners to conduct a comprehensive study of freight companies, so as to grasp and evaluate their performance, understand their position in the industry, provide them with decision support, analyse the reasons behind decision making processes, and improve their overall management. The index system selected 17 indicators from six areas such as "cost", "service level", "inventory", "returns", "environmental safety", "logistics conditions", with key indicators including logistics costs, cargo loss rates, and CO2 emissions from transport being considered. These indicators are obtained through enterprise surveys and scored by the committee on a comprehensive basis, aiming at determining the level of their logistics operations (see Figure 2-4 and Table 2-3).

■ Figure 2-4 Japanese Corporate Management Evaluation Index System



■ Table 2-3 Japanese Corporate Management Evaluation Index System

Primary evaluation indicators	Secondary evaluation indicators	Indicator description	Data source
Cost	Logistics cost ratio	The logistics cost is divided by the sales to get the ratio.	Organise a comprehensive survey of enterprises to obtain data.
Service Level	Sales per delivery	The sales amount is divided by the number of pieces delivered.	
	Out-of-stock rate	The number of out-of-stocks as a percentage of the number of orders.	
	Mis-shipment rate	The ratio of the number of incorrectly shipped pieces to the number of orders.	
	Delay rate	Proportion of the number of violations of the designated time pieces	
	Goods loss rate	Rate of damaged goods	
Inventory	Inventory days (merchandise, product inventory)	Days from inventory to sale.	
	Inventory discrepancy rate	Error between booked and actual inventory at period-end (month-end) count	
	Inventory obsolescence loss	Refers to the loss or expense incurred with the obsolescence of used products, expired goods, and seasonal goods that are not sold.	
	Stranded inventory rate	Inventory that exceeds a certain level of inventory days is defined as stranded inventory, and the ratio to sales is found.	
Return	Return rate	Return amount is divided by sales amount.	
Environment and Safety	Transport CO_2 emission rate	CO_2 emissions from transportation is divided by sales.	
	Security	Enterprise's considerations for security.	
Logistics conditions	Delivery volume to the company address	Sales are divided by the number of deliveries to the company address.	
	Delivery time	Delivery time is the time from order closing to delivery (agreed delivery period).	
	Number of SKUs	Save minimum available units for inventory control.	
	Minimum delivery batches	Minimum number of delivery batches.	

2.2 Analysis of the advantages and disadvantages of MFTH evaluation index systems at home and abroad

2.2.1 Analysis of strengths and weaknesses

Domestic and international MFTH evaluation index systems have been adopted in different times, situations, and backgrounds. Therefore, each evaluation index system has its own advantages and disadvantages, which are mainly reflected in the following aspects:

Firstly, regarding evaluation targets, all MFTH evaluation index systems clearly define their evaluation targets, but the scope and depth of these targets differ. China's freight hub construction evaluation index system focuses on freight hubs that enjoy subsidised policies, whereas the DGG's system evaluates logistics parks that provide combined systems of two or more modes of transport, specifically setting indicators for multimodal transport. The U.S. hub assessment covers the nation's ports, airports, highways, rail hubs and yards, and related locations, with a broader scope, and the Japanese logistics management evaluation index system focuses on the evaluation of logistics companies rather than specific facilities.

Secondly, regarding evaluation content, evaluations generally cover infrastructure, service functions, operational efficiency, external benefits, and related topics. China's freight hub construction evaluation index system focuses on measuring the effectiveness of subsidy policies, with extensive evaluations being made on the scale, scope, and effectiveness of the use of the subsidy funds. German logistics park evaluation index systems take into account the past, present and future of logistics park operations, and sets up evaluation contents in terms of their development stages, SWOT analysis, and related topics. The Japanese logistics operation evaluation index system does not specifically evaluate infrastructure, but reflects on the operational effectiveness of facilities through business operation efficiency indicators. In general, China places emphasis on construction-related indicators, while Japan and Germany place emphasis on operation-related indicators.

Thirdly, regarding evaluation methodologies, the cross-sectional comparison method, comprehensive scoring method, and statistical analysis method are relatively mainstream evaluation methodologies. China's freight hub construction assessment index system adopts statistical analysis processes. The advantage of this method is that it portrays the general trend of hub development, but as a result, evaluation results are too macro and lack the exploration of the specific conditions of hub operation. German logistics park evaluation index systems and the Japanese Corporate Management Evaluation Index System use a comprehensive scoring method, using expert scoring and weighted sum approaches to calculate the comprehensive score of the hub. This method has the advantage of being able to measure the level of development of the hub comprehensively and objectively. These results are then easy to compare between hubs, which is conducive to promoting the industry to learn and catch up where needed.

Fourthly, regarding data sources, data mainly comes from transport statistical yearbooks, written correspondence surveys, door-to-door questionnaire surveys, departmental or enterprise direct reports, and related publications. All data on China's freight hub construction assessment index systems are provided by hub operators and submitted directly to the provincial transport authorities for summary analysis by the MOT. The data of German logistics park evaluation index systems and the Japanese logistics operation evaluation indexes are obtained by questionnaire surveys.

Fifthly, regarding working mechanisms, hub evaluation is a systematic project, covering a wide area, with multiple tasks and involving many subjects. Generally, it is organised by competent authorities and commissioned by industry associations or third-party research institutions on a regular basis. Given their varying depth and breadth, the evaluations usually take more than a year. Due to the long time-span of the construction of hubs, the effect of subsidy policies can be slow to appear. Since these policies are included as a target of hub evaluations in China, China's freight hub construction assessment index system is assessed every 5 years. Most of the evaluation targets of German logistics parks are related to completed facilities, so their evaluation can be carried out every year. The advantage of the German system is that evaluation findings can strengthen the guidance of logistics park development and lead lagging parks to adjust their development strategies in time to cope with market changes. The evaluation of logistics operations in Japan is not carried out regularly, therefore they have a weak impact on the actual operation of enterprises, but findings can indirectly provide guidance on the construction and operation of logistics parks. See Table 2-4 for a further comparison of systems between China, Germany, and Japan.

■ Table 2-4 Comparison of Advantages and Disadvantages of Evaluation Index System

	Evaluation Target	Evaluation Content	Evaluation Methodology	Data source	Work mechanism
China's freight hub construction assessment index system	Freight hub projects subsidised by MOT	Development scale, construction quality and operation quality, with a focus of indicators related to construction	The statistical analysis method is adopted to conduct a comprehensive summary analysis of the projects that received grants.	1. Competent authorities of the transport sector collect data by letter, and then provincial transport departments and subsidised freight hubs report the data to MOT; 2. Transport industry; 3. China's logistics development statistical yearbook, etc.	MOT organises research institutions to carry out the work, every five years.
German logistics park evaluation system	Logistics Park with the following conditions: 1. It is a commercial gathering place for transport, logistics enterprises and industrial trade enterprises; 2. It is the interface point of different modes of transport with the ability to provide joint transport of 2 and more modes of transport; 3. It should have the ability to provide commercial and non-commercial services for the resident enterprises and should have a special logistics park management agency.	The system is divided into basic conditions, the situation of resident companies, development stage, characteristics, services, building/real estate, development assessment, organisational structure, managerial tasks, transport modes, multimodal transport hubs, green logistics, safety management, SWOT, freight village impact/contribution/importance assessment, etc. In-depth consideration is given to the intermodal capacity of the hub. Great importance has been attached to operation-related indicators.	A comprehensive scoring method was adopted. Firstly, the weights of each indicator were developed and divided into six levels from 1 (low importance) to 6 (very important). In order to analyse the development level positioning of each dry port, the assessment value of each indicator was divided into four levels from 0 to 3. The assessment value multiplied by the weight is used as the assessment score of each indicator. The weights and scores of each indicator were multiplied and summed to obtain the total assessment score of each dry port, which was between 0 (minimum) and 380 (maximum).	DGG collects data and information by distributing questionnaires.	DGG has been collecting information on logistics parks and conducting evaluation studies every year since 2004, and the final results have been made public.
Japan's logistics management evaluation index system	The main target is freight companies.	It is divided into cost, service level, inventory, returns, environmental safety, and logistics conditions, focusing on the evaluation of business operations. Great importance has been attached to operation-related indicators.	According to the "upper", "middle", "lower" or "no answer" of baseline data produced by this survey, the required score for each company's logistics indicator is recorded. Then, the points assigned to each indicator are summed up as a "composite indicator".	The Japan Logistics Society has obtained data and information through a questionnaire survey of nearly 100 companies.	Since 2005, the Japan Logistics Society has been conducting research on freight companies by establishing a committee composed of learned and experienced people and business practitioners.

2.2.2 Existing Problems

A number of hub evaluation index systems have been formed in China and world-wide, and some initial applications of these processes have already been carried out. However, from the perspective of what is actually needed for the development of China's multimodal transport hubs, these evaluation index systems have different degrees of deficiencies and are not sufficient to effectively work within the rapid growth of China's multimodal transport hub system. It is therefore necessary to establish and implement a multimodal hub management evaluation system methodology that works in the context of the Chinese market, mainly regarding the following aspects.

Firstly, there is still much room for the further improvement of current MFTH evaluation index systems. At present, China is still in the primary stage of multimodal transport development, and lacks evaluation indicators relating to multimodal transport hub facility layout, information systems, operation efficiency, service quality, operators and stakeholders, and related components. The evaluation depth of multimodal transport operations is particularly insufficient, and multimodal transport information evaluation indicators are seriously lacking.

Secondly, multimodal transportation hub evaluation work mechanisms have not been established. Multimodal transport involves many departments, a wide geographic area, and a long chain of actions. At present, China's transport sector has carried out evaluation work on the construction of freight hubs. However, for more professional multimodal transport hubs, a professional and normalised working mechanism has not yet been established that is in accordance with their technical and economic characteristics. The components of evaluation objects, evaluation periods, organisational units, implementation bodies, and information sources are still unclear.

Thirdly, the application of multimodal transportation hub evaluation results has not yet been carried out. There is no comprehensive and systemic multimodal transportation hub evaluation index, and no scientific and perfect evaluation mechanism has been established to support the development of China's MFTHs in terms of hub policy evaluation, hub competitiveness ranking, suggested measures to improve hubs, and related activities. The scope for the application of the existing relevant evaluation index systems is very limited and needs further innovation and expansion.

Table 2-4 Comparison of Advantages and Disadvantages of Evaluation Index System

	Evaluation Target	Evaluation Content	Evaluation Methodology	Data source	Work mechanism
China's freight hub construction assessment index system	Freight hub projects subsidised by MOT	Development scale, construction quality and operation quality, with a focus of indicators related to construction	The statistical analysis method is adopted to conduct a comprehensive summary analysis of the projects that received grants.	1. Competent authorities of the transport sector collect data by letter, and then provincial transport departments and subsidised freight hubs report the data to MOT; 2. Transport industry; 3. China's logistics development statistical yearbook, etc.	MOT organises research institutions to carry out the work, every five years.
German logistics park evaluation system	Logistics Park with the following conditions: 1. It is a commercial gathering place for transport, logistics enterprises and industrial trade enterprises; 2. It is the interface point of different modes of transport with the ability to provide joint transport of 2 and more modes of transport; 3. It should have the ability to provide commercial and non-commercial services for the resident enterprises and should have a special logistics park management agency.	The system is divided into basic conditions, the situation of resident companies, development stage, characteristics, services, building/ real estate, development assessment, organisational structure, managerial tasks, transport modes, multimodal transport hubs, green logistics, safety management, SWOT, freight village impact/contribution/ importance assessment, etc. In-depth consideration is given to the intermodal capacity of the hub. Great importance has been attached to operation-related indicators.	A comprehensive scoring method was adopted. Firstly, the weights of each indicator were developed and divided into six levels from 1 (low importance) to 6 (very important). In order to analyse the development level positioning of each dry port, the assessment value of each indicator was divided into four levels from 0 to 3. The assessment value multiplied by the weight is used as the assessment score of each indicator. The weights and scores of each indicator were multiplied and summed to obtain the total assessment score of each dry port, which was between 0 (minimum) and 380 (maximum).	DGG collects data and information by distributing questionnaires.	DGG has been collecting information on logistics parks and conducting evaluation studies every year since 2004, and the final results have been made public.
Japan's logistics management evaluation index system	The main target is freight companies.	It is divided into cost, service level, inventory, returns, environmental safety, and logistics conditions, focusing on the evaluation of business operations. Great importance has been attached to operation-related indicators.	According to the "upper", "middle", "lower" or "no answer" of baseline data produced by this survey, the required score for each company's logistics indicator is recorded. Then, the points assigned to each indicator are summed up as a "composite indicator".	The Japan Logistics Society has obtained data and information through a questionnaire survey of nearly 100 companies.	Since 2005, the Japan Logistics Society has been conducting research on freight companies by establishing a committee composed of learned and experienced people and business practitioners.

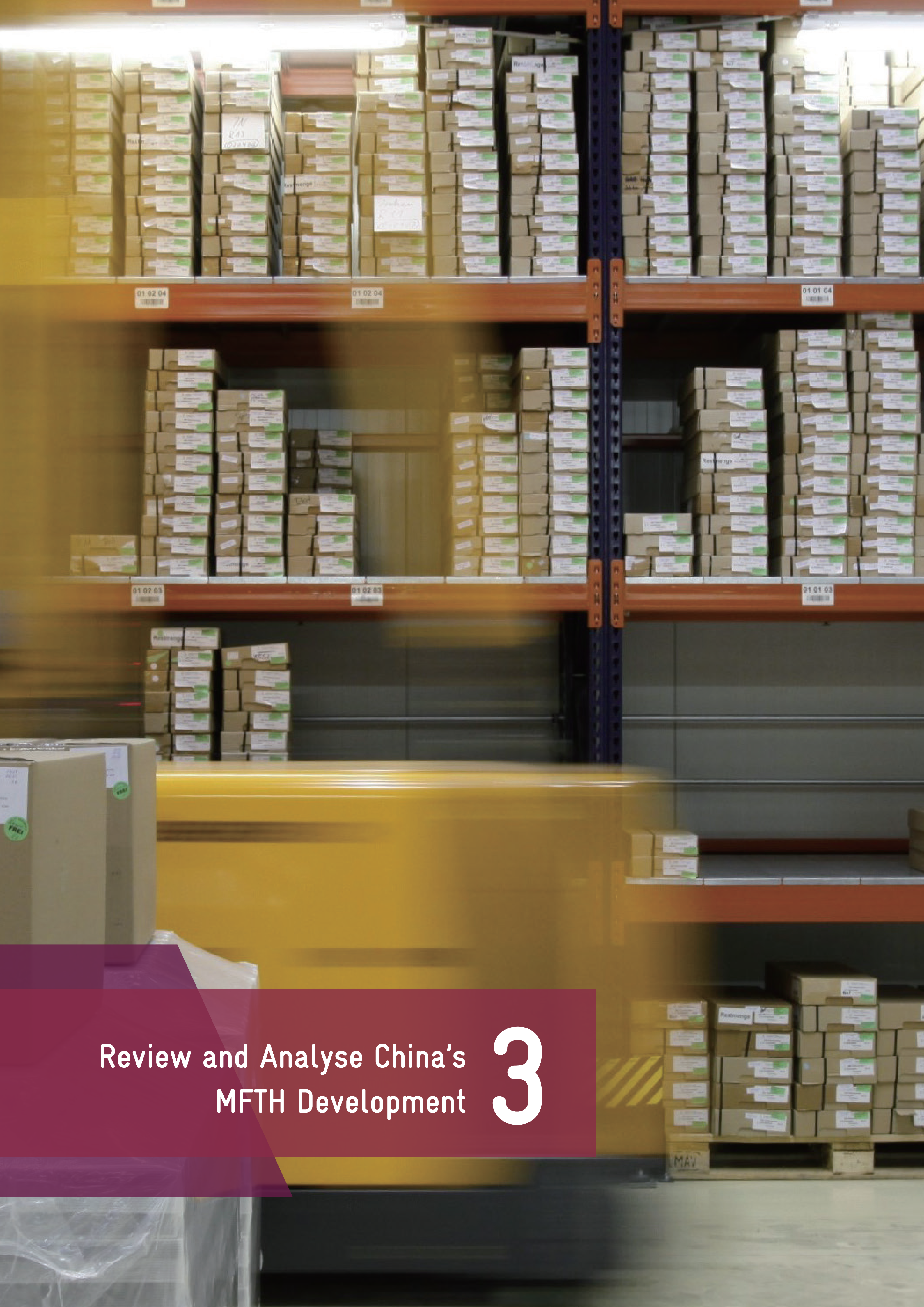
2.2.2 Existing Problems

A number of hub evaluation index systems have been formed in China and world-wide, and some initial applications of these processes have already been carried out. However, from the perspective of what is actually needed for the development of China's multimodal transport hubs, these evaluation index systems have different degrees of deficiencies and are not sufficient to effectively work within the rapid growth of China's multimodal transport hub system. It is therefore necessary to establish and implement a multimodal hub management evaluation system methodology that works in the context of the Chinese market, mainly regarding the following aspects.

Firstly, there is still much room for the further improvement of current MFTH evaluation index systems. At present, China is still in the primary stage of multimodal transport development, and lacks evaluation indicators relating to multimodal transport hub facility layout, information systems, operation efficiency, service quality, operators and stakeholders, and related components. The evaluation depth of multimodal transport operations is particularly insufficient, and multimodal transport information evaluation indicators are seriously lacking.

Secondly, multimodal transportation hub evaluation work mechanisms have not been established. Multimodal transport involves many departments, a wide geographic area, and a long chain of actions. At present, China's transport sector has carried out evaluation work on the construction of freight hubs. However, for more professional multimodal transport hubs, a professional and normalised working mechanism has not yet been established that is in accordance with their technical and economic characteristics. The components of evaluation objects, evaluation periods, organisational units, implementation bodies, and information sources are still unclear.

Thirdly, the application of multimodal transportation hub evaluation results has not yet been carried out. There is no comprehensive and systemic multimodal transportation hub evaluation index, and no scientific and perfect evaluation mechanism has been established to support the development of China's MFTHs in terms of hub policy evaluation, hub competitiveness ranking, suggested measures to improve hubs, and related activities. The scope for the application of the existing relevant evaluation index systems is very limited and needs further innovation and expansion.



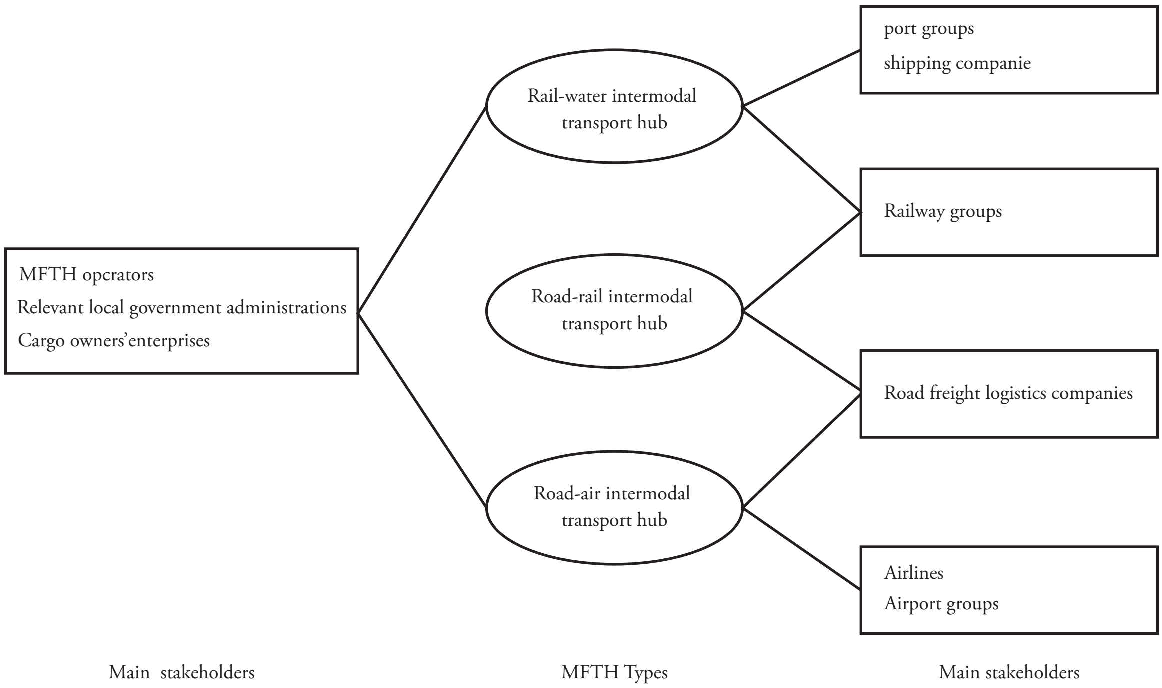
3 Review and Analyse China's MFTH Development

Multimodal transport is important in supporting the restructuring of transport services, improving comprehensive transport systems, and promoting the construction of a modern circulation system. Moreover, multimodal transport is of great significance in supporting the establishment of a new development pattern with domestic circulation as the main focus of action, and domestic and international double circulation then promoting each other. MFTHs are an indispensable part of the transport organisation chain, undertaking multiple functions such as cargo collection and distribution, loading and unloading, warehousing, transit, deconsolidation, delivery, and information services, which determines the efficiency of multimodal transport operations. The establishment of a MFTH system with a reasonable layout, integrated connections, functional combinations, economic efficiency, safety, and greenness is an important foothold for improving multimodal transport development. In recent years, China's central and local government departments have made the construction of MFTHs a key task, and successively issued a series of documents to promote the rapid development of multimodal transport.

3.1 MFTH types

The types of MFTHs include: road-rail, rail-water, road-water, and road-air hubs, amongst others. This study focuses on three types, namely road-rail hubs, rail-water hubs, and road-air hubs. The main stakeholders are shown in Figure 3-1.

Figure 3-1 MFTH Types and Main Stakeholders



3.2 MFTH development status nationwide

3.2.1 Policy documents

Over recent years, Chinese government departments have issued a series of documents to promote MFTH development, starting from January 2017, when the Chinese MOT, together with 17 other ministries, jointly issued the Notice on Further Encouraging Multimodal Transport Work[3]. The document clarified the strategic positioning of multimodal transport for the first time ever from the national level, and further refined the work of promoting multimodal transport in several aspects. In terms of improving the infrastructure network, the policy put forward the idea to rely on logistics corridors, accelerate the formation of the national multimodal transport network backbone for inbound and outbound traffic, and optimise the layout of multimodal transport hierarchies and classification nodes. The policy proposed to strengthen the coordinated development of MFTHs and related industries, and actively expand supporting service functions, such as market trading, warehousing and delivery, distribution and processing, and financial settlements. Moreover, the policy proposed to support the construction of multimodal freight hubs with public attributes, the building of collection and distribution systems of these hubs, the upgrading of transport equipment, and information sharing initiatives, amongst other actions.

In October 2018, the General Office of the State Council issued the Three-Year Action Plan to Promote the Restructuring of Transport Structures (2018-2020)[4], proposing to accelerate the construction of intermodal transportation hubs and equipment upgrades. The document promoted the construction of logistics parks with multimodal transport functions, the acceleration of the planning, construction and upgrading of railroad logistics bases, railroad container handling stations, port logistics hubs, air transhipment centres and express logistics parks, the strengthening of effective connections between different modes of transport, the further expansion of the freight service functions of high-speed railway stations, and the improvement of freight supporting facilities. Furthermore, it proposed to sequentially promote the construction of cargo airports, and expand and improve airport freight service functions.

In December 2018, the National Development and Reform Commission and the Ministry of Transport jointly released the National Logistics Hub Layout and Construction Plan[5], which set out the objectives and completion time frame for their MFTH projects. According to the Plan, by the end of 2020, the following tasks should have been fulfilled: 1. The initial establishment of a multimodal transport system, for the national logistics hubs to been put into operation; 2. To promote and apply standardised intermodal facilities and equipment; 3. Positive progress made in the construction of multimodal transport-related service specifications and operating rules. By the end of 2025, the multimodal transport system will be basically built. Advanced standardised intermodal facilities and equipment will be applied on a large scale. The service specifications and operation rules related to multimodal transport will be basically formed, and the development of “one single system” logistics will be accelerated.

3.2.2 Development characteristics

(1) Continuous improvement in MFTH related infrastructure

Firstly, the layout of MFTH nodes has basically taken shape. Three batches of national MFTH demonstration projects have been accelerated[6]-[7]-[8], with the steadily improved efficiency of multimodal transport transit systems. The MOT has supported the construction of multimodal logistics parks by way of vehicle purchase taxes, resulting in the increasing competitiveness of logistics parks. Over 40 national logistics hubs carrying multimodal transport functions have been basically completed[9]-[10], with increasingly improved functions of production services, transit and distribution, and international ports. Tianjin Port, Qingdao Port, Ningbo-Zhoushan Port, Shenzhen Port, and other ports have sped up the construction of inland dry ports, thus accelerating the formation of two-way mutually beneficial land-sea transport channels. **Secondly, a MFTH collection and distribution system has been initially established.** The MOT, in conjunction with the National Railway Administration and China Railway Group, rendered support to over 100 port consolidation and transportation railroad projects, as well as consolidation and transportation road projects in the Yangtze River Economic Zone. The Development and Reform Commission, the Ministry of Natural Resources, the Railway Bureau and China National Railway Group Limited jointly issued the Guidance on Accelerating the Construction of Special

Railway Lines[11], so as to optimise the construction policy of railroads entering freight hubs and improve trans-modal organisation and connection.

(2) Increasing improvement in MFTH services

The service efficiency of MFTHs has been steadily improved. Qingdao Port launched the free service of "Jiaozhou-Huangdao Tranship Trains" to create efficient and fast sea-rail intermodal transport. China Railway Wuhan Group Co, Ltd. launched the "Daily Express" for the southwest direction of rail-water intermodal transport, compressing the time of goods in transit by 7 days on average[12]. China Railway Shanghai Bureau Group and Ningbo-Zhoushan Port jointly opened a double-decker container train, effectively improving the capacity by 38%[13]. **Additionally, multimodal transportation hubs are also becoming increasingly rich in-service types.** Innovations are blooming for intermodal transport, such as rail-water, road-rail, road-water roll-on, river-sea, land-air, and other related connections. The operation mode of cold chain trains and commodity trains in Dalian Port has basically been established, and specialised multimodal transport channels have been gradually opened. The Chengdu Bureau of China Railway Group, together with Sichuan Airlines and other enterprises, piloted the first air-rail intermodal transport bill within the Bureau's control and completed trial shipments. Zhengzhou and other cities have established trucking flight cooperation modes, thus continually upgrading land-air intermodal transport products.

3.2.3 Existing problems

Although the development of China's MFTHs have made some progress, the system is still in its infancy as a whole. Compared with MFTH development in developed countries, there is still a big gap in their development in China, which is mainly manifested in four aspects.

Firstly, multimodal transport hubs rely on poorly connected infrastructure. Multimodal logistics hubs and backbone networks have not yet formed. In terms of railroads, highways, waterways, civil aviation and other infrastructure, the degree of planning and construction convergence is still not high. It is difficult to transform the connectivity of existing transport infrastructure. Some rail-water intermodal transport hubs also need short-distance highway connections, and the cost of the transit of goods in multimodal transport accounts for a high proportion of overall logistics costs.

Secondly, there are still not many leading enterprises related to the operation of MFTHs. There is a serious lack of multimodal transport operators who have the ability to integrate various transportation resources and assume full transportation responsibilities. The role of leading enterprises has not been fully utilised, and the concentration of the multimodal transport market is still low.

Thirdly, the degree of information exchange and sharing concerning the operation of MFTHs is not high. There is not a standard system for the exchange of multimodal transport information, and any interconnection and sharing mechanisms between departments, methods, enterprises, and regions are not yet complete. As a result, there is a low level of information resource integration and comprehensive development and utilisation. The phenomenon of "information islands" is still widespread. Public information platforms concerning multimodal transport construction are delayed, and there is a problem of long-term discussions not resulting in decisions, and decisions being made with no operability. It is thus difficult to effectively support the rapid development of multimodal transport.

Fourthly, after the completion of MFTHs, government departments lack service evaluation systems for the hubs, which is not conducive to the healthy and sustainable development of multimodal transport. Government departments lack tracking in terms of hub operation efficiency, management efficiency, and service quality. Therefore, it is difficult to grasp the latest industry dynamics and market demands, and provide decision-making support for future planning and construction. There is an urgent need to establish China's MFTH service assessment mechanism by drawing on advanced experiences at home and abroad, and to conduct practical applications and subsequent empirical analysis in typical hubs to fill the research gap in this field in China and promote high-quality and sustainable MFTH development across the country.

3.3 Development status of MFTH in key regions

3.3.1 The Yangtze River Economic Belt

(1) Policy Documents

According to the National Logistics Hub Layout and Construction Plan[5], jointly released by the National Development and Reform Commission and the MOT, a policy concerning "relying on national logistics hubs to accelerate the development of multimodal transport" has been proposed. There are 44 national logistics hub-bearing cities in the Yangtze River Economic Belt (see Figure 3-2).

■ Figure 3-2 National logistics hub-bearing cities in the Yangtze River Economic Belt

Source: TPRI

In August 2018, the MOT issued the Three-Year Action Plan to Deepen the Development of Multimodal Transport in the Yangtze River Economic Belt[14], proposing to build an organically connected and competitive rail-water intermodal transport system, basically forming a river-to-sea direct transportation system for the Yangtze River trunk line, and the Yangtze River Delta region to Ningbo-Zhoushan Port and Shanghai Yangshan Port. The implementation of the policy has further improved the water transport infrastructure system by featuring direct access to trunk and branch lines, access to rivers and seas, and regional networks. The multimodal transport service system has preliminary established a reasonable layout, optimised structure, improved function, and interconnectivity in the Yangtze River Economic Belt.

(2) Development characteristics

The Yangtze River Economic Belt is a relatively fast developing region for China's rail-water (inland waterway) intermodal transport systems.

With the improvement of the Yangtze River's main and tributary navigation channels, rail-water intermodal transport (inland rivers) along the Yangtze River has developed rapidly. At present, Nanjing, Wuhan, Chongqing, and other ports along the Yangtze River Economic Belt, speed up the building of rail-water intermodal transport hub systems, strengthen cooperation between ports, railroads, and shipping enterprises, and accelerate the realisation of the construction of railroads into the ports. Furthermore, the above-mentioned ports are building an advantageous brand line of container rail-water intermodal transportation, encouraging the development of five-scheduled train transport options, giving financial subsidies for rail-water intermodal transport, and further increasing the proportion of rail-water intermodal transport[15].

(3) Existing problems

At present, the operation and development of MFTHs in the Yangtze River Economic Belt still face some problems and obstacles. First, the cross-regional, cross-industry, multi-body coordination mechanism needs to be improved. The Yangtze River Economic Belt involves 11 provinces and cities along the Yangtze River, covering a wide range of space, and involving many departments. There is a lack of effective unified coordination mechanisms, resulting in duplication of constructions, failing to give full play to the transport efficiency. Second, problems need to be resolved, such as cross-regional and cross-departmental information duplication and the existence of islands of information. Most of the regions and departments along the Yangtze River Economic Zone have established their own internal information systems, resulting in the need for enterprises to repeatedly enter information. Furthermore, some of the information cannot be interconnected, which not only reduces the overall operational efficiency of multimodal freight hubs, but also increases the cost of multimodal logistics.

3.3.2 Beijing-Tianjin-Hebei Region

(1) Policy documents

Eight cities in the Beijing-Tianjin-Hebei region were selected to participate in the National Logistics Hub Layout and Construction Plan[5] (see Figure 3-3).

At present, there are no documents issued at the state or provincial levels related to multimodal transport hubs in the Beijing-Tianjin-Hebei region. However, Hebei Province and the city of Tianjin have respectively issued documents concerning MFTHs in their regions.

In 2019, 13 departments including the Department of Transport of Hebei Province jointly issued the Implementation Opinions on Further Promoting the Development of Multimodal Transport in Hebei Province[16], putting forward to coordinate MFTH layout, support the introduction of special railway lines in large integrated logistics parks, and unblock the micro-circulation system for transportation. Moreover, the policy proposes to speed up the construction of the branch line of the port-dredging railroad in the Jingtang port area of Tangshan Port, Caofeidian port area and Huanghua port comprehensive port area, actively promote the preliminary work of the upgrading and expansion project of the Hanhuang railroad, improve the supporting road facilities in and out of the station such as the railroad logistics base, smooth the connection between the hub station and the urban trunk road, and improve branch connection capacity.

■ **Figure 3-3 National logistics hub-bearing cities in the Beijing-Tianjin-Hebei region**

Source: TPRI

In December 2018, Tianjin issued the Implementation Plan for Promoting the Adjustment of Transport Structure in Tianjin[17], proposing to promote the construction of intermodal hubs and upgrade equipment. The policy proposes to promote the construction of specialised parks and yards such as the Tianjin Port Container Logistics Centre and Xingang North Railway Container Centre Station to improve loading and unloading, warehousing, transportation, inspection, bonding, distribution, trade, and other service functions. Moreover, the policy promotes relevant research concerning the second line bundle of the New Port North Railway Container Centre Station and further railway construction relevant to the New Port North Railway. In addition, the policy proposes to improve customs supervision and other business functions of the Newport North Railway Container Terminal, give full play to the role of the port's sea-rail hub, and create a multimodal transport supervision centre.

(2) Development characteristics

The Beijing-Tianjin-Hebei region is a relatively fast-developing region for China's rail-water (coastal) intermodal transport. For example, as an important gateway to the Beijing-Tianjin-Hebei region, Tianjin Port has been rapidly developing rail-water (coastal) multimodal transport systems in recent years. Relying on the policy advantages of Tianjin in building the core area of international shipping in northern China and the Pilot Free Trade Zone, Tianjin Port has made every effort to build a two-way logistics network by sea and land. Five regional marketing centres and 25 inland "waterless ports" have been set up in Beijing, Hebei, Henan, Shanxi, Inner Mongolia, Ningxia, Xinjiang and other hinterlands, and more than 10 sea-rail intermodal transport channels have been opened[18]. In 2017, the Tianjin Port China-Mongolia-Russia Economic Corridor Container Multimodal Transport Demonstration Project led by Tianjin Port (Group) Co., Ltd. was selected into the second batch of multimodal transport demonstration projects by the MOT, as a representative and exemplary multimodal transport freight hub in the Beijing-Tianjin-Hebei region.

(3) Existing Problems

Infrastructure construction is lagging. For example, the problems of Tianjin Port are mainly reflected in its backward operation mode and a lack of communication on the port's operation and needs for infrastructure construction. The backward mode of operation is mainly manifested in the old equipment of the railroad operation line, which fails to meet the demand of modern sea-rail transportation. The lag of information and communication refers to untimely information exchange between the railroad department and the port, resulting in poor operational connectivity.

3.3.3 The Greater Bay Area

(1) Policy documents

Five cities in the Greater Bay Area were selected into the National Logistics Hub Layout and Construction Plan[5] (see Figure 3-4).

■ Figure 3-4 National logistics hub-bearing cities in the Greater Bay Area

Source: TPRI

At present, there are no documents issued at the state or provincial levels related to multimodal transport hubs in the Greater Bay Area. However, Guangdong Province has issued documents concerning MFTHs in its province. In 2019, Guangdong Province issued the Implementation Plan for Promoting the Adjustment of Transportation Structure in Guangdong Province[19], proposing to develop multimodal transport and promote MFTH construction. The policy proposes to further implement multimodal demonstration projects and promote the construction of national demonstration projects such as the "ASEAN-Guangdong-Europe" public-rail-sea-river multimodal transportation and "7+5" multimodal node network multimodal transportation in Guangdong, Hong Kong and Macao Bay Area. Furthermore, the policy puts forward the acceleration of the improvement of rail-water intermodal transport information exchanges, relying on the Guangzhou Port, Shenzhen Port, Zhuhai Port, Zhanjiang Port and other key ports to achieve the organisation of scheduling, operational plans and supervision services and other dynamic information exchanges in real time.

(2) Development characteristics

The Greater Bay Area is a relatively fast developing region of China's rail-water (coastal) intermodal transport systems. For example, Zhuhai Port is one of the five major ports in the "7+5" multimodal nodes identified in the national third batch of multimodal transportation demonstration projects, namely "Build a "7+5" multimodal node network in Guangdong-Hong Kong-Macao Greater Bay Area". It is one of the five major ports in the project and is a representative and exemplary multimodal freight hub in the Greater Bay Area region. The multimodal logistics centre established by Zhuhai Port Group in cooperation with China Valley Shipping Group will provide unified and efficient sea-rail intermodal transport services for Zhuhai, the Pearl River-West River hinterland, Hainan, Southwest China and Beibu Gulf. It will also provide storage and delivery services for bulk commodity customers facing the Pearl River-Xijiang Economic Zone and southwest provinces of China for bulk spot commodities such as energy, grain, sugar and non-ferrous metals.

(3) Existing problems

The development of various transportation modes supported by the hubs needs to be further coordinated and integrated. The transportation infrastructure in the Greater Bay Area is relatively complete, and the logistics nodes have strong functions, but the development of various transportation modes is not coordinated. Highways, waterways, and railways form their own systems; the coordinated development of integrated transportation systems is insufficient, and there is a lack of effective connections among various transportation modes.

Table 3-1 Relevant MFTH policies, strategies, policies, and measures at the national and local levels

Subjects		Strategies	Roadmap	Policies	Measures
National level		Relying on the national logistics hub to accelerate the development of multimodal transport[5].	By 2025, the modern multimodal transport network with "mainline transport + regional distribution" as the main feature will be basically established, multimodal transport organisation will be widely used, and the efficiency of intermodal transport changeover will be significantly improved[5].	Strengthen the connectivity and organisational synergy between multimodal transport trunk lines and feeder lines, innovate multimodal transport standard formation and application connection mechanism, promote multimodal transport "one single system", etc.[3][5].	Coordinate the resolution of cross-industry, cross-sector, cross-sector planning, standards, policies and other matters, by way of the national inter-ministerial joint meeting mechanism of modern logistics work; require all regions to effectively strengthen organisational leadership, clarify the main body of responsibility, strengthen synergy and cooperation[3].
Regional level	the Yangtze River Economic Belt	Efforts to give full play to the comparative advantages of water transport and the efficiency of the combination of multimodal transport, vigorously enhance and improve the function of the Yangtze River Golden Waterway, for the development of the Yangtze River Economic Zone to provide a smoother, green and efficient transport security[14].	By 2020, it is proposed to build an organically connected and competitive rail-water intermodal transport system. The multimodal transport service system is preliminary established with a reasonable layout, optimised structure, improved function, and interconnectivity in the Yangtze River Economic Belt[14].	Focus on making up the shortcomings of intermodal transport infrastructure, strengthening the innovation of intermodal transport service model, and improving the level of multimodal transport equipment, etc.[14].	The provincial transport authorities along the river are responsible to develop relevant implementation programme and then submit IT to MOT. Multimodal transport development is included in the key work of the annual assessment [14].
Local level	Hebei Province	Build Hebei Province into a national multimodal transport demonstration province[16].	Beginning in 2019, the goal is to build more than 35 multimodal transport routes from Hebei Province to the northeast, northwest, southeast coast, and Europe through 3 to 5 years of hard work[16].	Build an efficient and connected infrastructure network, innovate multimodal transport service models, create a fair and efficient market environment, carry out the construction of multimodal transport pilot demonstration projects[16].	Provide certain financial support to multimodal transport demonstration projects that comply with relevant provincial-level special funding policies[16].
	Tianjin	Promote the restructuring of transportation through the development of multimodal transportation[17].	—	Promote the construction of intermodal hubs and equipment upgrading, and promote the construction of specialised parks and yards such as the Tianjin Port Container Logistics Centre and the New Port North Railway Container Centre Station[17].	—
	Guangdong Province	Promote the restructuring of transportation through the development of multimodal transport[19].	By 2020, the multimodal freight volume will increase by about 20% compared to 2017, and the rapid development of container rail-water intermodal transport in key ports will reach 450,000 TEUs (Twenty-foot Equivalent Unit), an increase of more than 150% compared to 2017[19].	Strengthen the construction of multimodal transport infrastructure, promote the standardisation of multimodal transport services and equipment, and further implement multimodal transport demonstration projects[19].	Implement financial tax and fee support policies and increase support for key projects such as the construction of dedicated railroad lines and the innovative development of multimodal transport[19].

4 Formulate the Evaluation Method for MFTHs in China

4.1 Evaluation principles

In order to scientifically evaluate the effect of the construction of intermodal transport freight hubs, the index system for this task is designed according to the principles of scientific grounding, comprehensiveness, independence, operability, hierarchy, and dynamics. The first element of this design is the scientific principle. The index system can reasonably reflect the construction effect of intermodal transport freight hubs, reflect the combination of theories and practices, and adopt scientific methods to reflect the actual situation. The second is the principle of comprehensiveness. The indexes can systematically and comprehensively consider the hub infrastructure, service capacity, operation level, social benefits and safety, green and low-carbon and other factors. The third is the principle of independence, which selects indexes with relatively independent concepts to avoid overlapping concepts between indexes. The fourth is the principle of operability, which fully considers the feasibility of index value measurement and data collection, uses objective indexes and current statistical indexes as much as possible when determining indexes, and avoids putting significant workloads on evaluation organisations and evaluation objects. The fifth is the principle of hierarchy. The construction of the index system should have hierarchy, and the high level is the generalisation and comprehensive embodiment of the low-level index system. The sixth is the dynamic principle. The index system shall be able to adapt to the development and changes of external factors such as social economy, and shall be adjusted regularly.

4.2 Evaluation objectives and mechanisms

The potential evaluation objects of the evaluation system cover all multimodal transport hubs. Specific annual evaluation objects are conducted by the operation or management body of the intermodal transport hub. Operators of all freight hub with two or more transportation modes can become the evaluation objects of the current year.

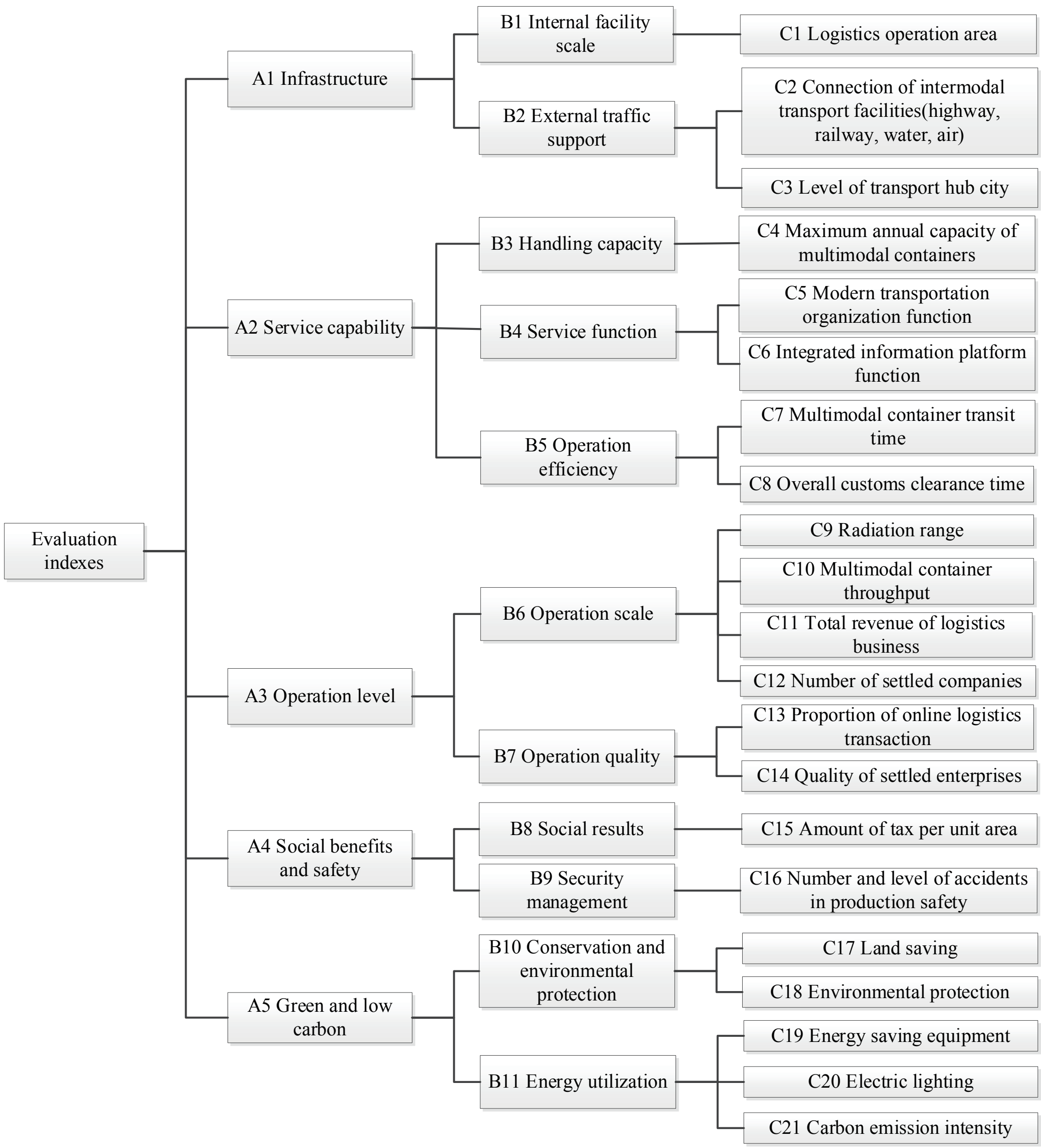
This evaluation work uses scientific appraisal methods to evaluate the service level of the appraised object. It is organised by China's MOT and entrusted scientific research institutions carry out it once a year. This work will comprehensively summarise the situation of the evaluation object in terms of infrastructure, service capacity and level, operation level, social benefits and safety, green and low carbon status, and scientifically quantify the service and management level of intermodal transport freight hubs, and then put forward policy optimisation suggestions.

Evaluation work mainly relies on three channels to obtain data. First, the evaluation agency needs to establish an intermodal transport hub evaluation system, and then the evaluation objects report relevant data on the evaluation system as required. Second, data is taken from transportation statistics. Third, data is taken from national logistics park survey reports and other authoritative industry analysis reports. To ensure the authenticity and accuracy of the reported data, it is first necessary to prepare a technical guide for data filling, and clarify the calculation and filling methods of each indicator data. Second, evaluation objects are required to provide necessary supporting materials. Third, the assessment agency shall verify all or part of the data through field surveys, the use of remote sensing image analysis, expert consultations, and other means, to test the authenticity of the data. In the instance that it is verified that the hub participating in the evaluation has committed false reporting and/or fraud, the hub will be disqualified from participating in the evaluation for two years.

4.3 Evaluation index systems

The management evaluation index system of intermodal transport freight hubs evaluates the operation management and service levels of hubs, and is divided into three levels of evaluation indexes. There are 5 first-class evaluation indexes, including infrastructure, service capacity, operation levels, social benefits and safety, and green and low-carbon status. Additionally, 11 second-class evaluation indexes are set, including internal facility scales, external traffic support, loading and unloading capacity, service functions, operation efficiency, operation scale, operation quality, social benefits, safety management, conservation and environmental protection, and energy utilisation. There are then 21 three-level evaluation indexes, which are outlined in the management evaluation index system of intermodal freight hubs as shown in Figure 4-1.

■ **Figure 4-1 Management Evaluation Index System of Intermodal Transport Freight Hubs**



4.4 Weight of indexes

The evaluation method adopts the expert scoring method to determine the index weight. Guided by the perspectives of the "Notice on Further Encouraging the Development of Intermodal Transport" issued by the MOT and other documents, and combined with the actual situation and target orientation of intermodal transport freight hubs in China, each expert scientifically and objectively compares the importance of each index and determines the weight of each index according to their practical experience. The final weight of each index is shown in Table 4-1. The process of weight setting is mainly based on the following considerations:

Firstly, fully tapping the potential of intermodal transport hubs for energy conservation and emission reduction and taking the road of sustainable green development shall be the most important direction of hub development in the future. The development of intermodal transport is a practical action to implement the major decisions and arrangements of the CPC Central Committee and the State Council on adjusting transport structures and winning the blue-sky defense war. Drawing on the successful experience of developed countries, intermodal transport hubs should adhere to the construction concept of green ecology, high efficiency, and intensification, and embody green development in all links of hub construction and operation. Therefore, in order to strengthen the environmental benefits of intermodal transport hubs, its weight is set at a value of 0.3 in this study.

Secondly, more attention should be paid to improving the service capacity of multimodal transport hubs in the future, which is important for hubs to maintain market competitiveness and obtain economic benefits. Improving the service capacity of the hubs includes improving the equipment level of intermodal transports, standardising the operation standards of intermodal transports, improving the technology of intermodal transports, and related actions. This will not only guarantee the efficient operation of the hubs, but also serve as an attraction point for the hubs to participate in market competition and attract market players. In this study, their weight is set at a value of 0.25.

Thirdly, improving infrastructure construction for intermodal transport hubs and ensuring the smooth connection of various modes of transport is the basis for functional cargo transportation. At this stage, an intermodal transport hub is not limited to having basic reloading functions, but is also committed to becoming a link between network facilities and integrated services, a carrier for the efficient flow of resource elements, and a platform for the integrated development of transportation and industry systems. Intermodal transport freight hubs are gradually developing in the direction of large-scale, comprehensive, networked, and intelligent services. However, most hubs in China have not yet formed an integration of intermodal transport capacities, multiple transport modes cannot yet achieve an efficient connection, the ecosystem for the development of intermodal transport hubs is far from forming, and the effect of agglomeration and intensification cannot be brought into play. Therefore, paying attention to the infrastructure construction of intermodal transport hubs is still the top priority in the future. This study gives this element maximum weight, with a value of 0.2.

Operation levels and quality affect the economic benefits of intermodal transport hubs. Whether the hubs can survive in the market for a long time is closely related to their proper operation. Adopting appropriate operation modes and improving the operation level of hubs is conducive to the optimal allocation of resources. In this study, its weight is set as having a value of 0.15.

Finally, as parks with the attribute of public infrastructures, intermodal transport hubs should bear certain social responsibility, pay attention to the realisation of social benefits, and ensure public safety. Especially under the guidance of high-quality transportation developments, the importance of social benefits and safety in hub construction cannot be ignored. This study gives these elements a value of a weight of 0.1.

Vigorously promoting intermodal transport is key in developing green and low-carbon transportation in China at this stage. It can improve the energy efficiency of the whole society, reduce greenhouse gas emissions, reduce social logistics costs, and comprehensively improve transportation efficiency. As an important carrier for the realisation of intermodal transport, intermodal transport hubs should be in line with the development trend of green and low-carbon transportation, focusing on land intensification, environmental protection and energy saving levels, energy utilisation efficiency, carbon intensity and other aspects of the hubs, which also demonstrate the original intention of setting green and low-carbon indicators in this study.

Table 4-1 Evaluation Index Weight of Intermodal Transport Freight Hub Management

First-level index			Second-level index			Third-level index		
Serial No.	Index name	Index weight	Serial No.	Index name	Index weight	Serial No.	Index name	Index weight
A1	Infrastructure	0.2	B1	Scale of internal facilities	0.04	C1	Logistics operation area	0.04
			B2	External traffic support	0.16	C2	Connection of intermodal transport facilities (highway, railway, water, and air transports)	0.10
						C3	Level of transportation hub city	0.06
A2	Service capability	0.25	B3	Handling capacity	0.05	C4	Maximum annual capacity of multimodal containers	0.05
			B4	Service function	0.12	C5	Modern transport organisation function	0.06
						C6	Integrated information platform function	0.06
			B5	Operation efficiency	0.08	C7	Multimodal container transit time	0.04
						C8	Overall customs clearance time	0.04
A3	Operation level	0.15	B6	Operation scale	0.11	C9	Radiation range	0.05
						C10	Multimodal Container throughput	0.02
						C11	Total revenue from logistics operations	0.02
						C12	Number of settled companies	0.02
			B7	Operation quality	0.04	C13	Proportion of online logistics transaction	0.02
						C14	Quality of settled enterprises	0.02
A4	Social benefit and safety	0.1	B8	Social benefit	0.05	C15	Amount of tax per unit area	0.05
			B9	Security management	0.05	C16	Number and level of accidents in production safety	0.05
A5	Green and low carbon	0.3	B10	Conservation and environmental protection	0.10	C17	Land saving	0.05
						C18	Environmental protection	0.05
			B11	Energy utilisation	0.20	C19	Energy saving equipment	0.07
						C20	Electrical lighting	0.03
						C21	Carbon emission intensity	0.10

4.5 Index significance and evaluation methods

In order to evaluate the level of each intermodal transport freight hub, the evaluation score of the three-level evaluation index is divided into six grades from Grade 0 to Grade 5. The higher the score is, the stronger the service or competitiveness of the hub in this index. The comprehensive score of a hub is weighted according to the evaluation score of each three-level evaluation index. The higher the score is, the stronger the comprehensive service and competitiveness of the hub. The significance and evaluation method of each three-level evaluation index are as follows:

C1 Logistics Operation Areas

(1) Index significance: The logistics operation area includes wharfs, railway loading and unloading lines, roads, warehouses, storage yards, canopies, circulation and processing sites, truck parking lots, loading, and unloading sites, information service lands and related areas, excluding living and business supporting lands.

(2) Reasons for Selection: The logistics operation area is not only an important embodiment of the intensive use of land and scale benefits in the construction of logistics parks, but also a necessary guarantee for the logistics intensity of park operations. The Basic Requirements for Classification and Planning of Logistics Parks (GB/T 21334-2017) clearly stipulates that the proportion of logistics operation areas of a single park shall be greater than 50%, and makes recommended requirements for the logistics intensity of different types of logistics parks. Therefore, this index is selected as the reflection of the hub infrastructure scale.

(3) Index Calculation: According to the distribution scope of logistics operation areas of national intermodal transport freight hubs and the research results of the Fifth Investigation Report (2018) on National Logistics Parks (base), the index calculation method is determined as follows:

- Covering an area of 5 square kilometres or more: 5 scores;
- Covering an area of 3~5 square kilometres: 4 scores;
- Covering an area of 1~3 square kilometres: 3 scores;
- Covering an area of 0.5~ 1 square kilometres: 2 scores;
- Covering an area of 0.3~0.5 square kilometres: 1 score;
- No score for the rest.

C2 Connection of Intermodal Transport Facilities (highway, railway, water and air transports)

(1) Index significance: The number and connection distances of external traffic connection facilities (highway, railway, water and air transports) of the hub during the assessment period.

(2) Reason for Selection: The core requirements of intermodal transport are a) Improving connections amongst ports, railways, airports and highways; b) Improving the transport capacity of port dredging railways and highways, and; c) improving the efficiency of intermodal transports. Just like developed countries in Europe and America, not only does the infrastructure of intermodal transport need to be developed, but also the intermodal transport collection and distribution systems composed of special lines, hubs and terminal nodes need to be relatively perfect. It is obvious that the intermodal transport hubs in China are not yet connected. Strengthening the connection of intermodal transport facilities is an important aspect of hub evaluations.

(3) Index Calculation: According to the functional positioning of intermodal transport freight hubs and referring to the Basic Requirements for Classification and Planning of Logistics Parks (GBT 21334-2017), the index calculation method is determined as follows:

- The hub has at least 3 kinds of effective connection facilities (highway, railway, water, and air transports), of which the railway loading and unloading line (special line) is connected to the park, and the berth is located within the hub: 5 scores.
- The hub has at least 3 kinds of effective connection facilities (highway, railway, water and air transports), of which the railway loading and unloading line (special line) is connected to the park, or the berth is located within the hub: 4 scores.
- The hub has at least 3 kinds of effective connection facilities (highway, railway, water, and air transports): 3 scores.
- The hub has at least 2 effective connection facilities (highway, railway, water, and air transports), of which the railway loading and unloading line (special line) is

connected to the park, and the berth is located within the hub: 2 scores.

- The hub has at least 2 kinds of effective connection facilities (highway, railway, water, and air transports): 1 score.
- No score for the rest.

C3 Level of Transportation Hub Cities

(1) Index Significance: Refer to relevant national and provincial planning documents for the level of the city where the hub is located.

(2) Reasons for Selection: The role of the level of each transportation hub city in promoting the infrastructure level of intermodal transport hub is mainly reflected in two aspects. First, transportation is the core component of logistics activities. The improvement of comprehensive transportation systems determines the collection and distribution level of intermodal transport hubs, which is the basic premise of efficient operation of the hubs. Second, the State encourages and promotes hub construction by taking the logistics hub carrying city as the unit, and considers intermodal transport hubs in the city, which is conducive to the optimal allocation of logistics resources and the coordinated development of hubs. The level of each transportation hub city can then be an important consideration for the development of intermodal transport hubs.

(3) Index Calculation: According to the positioning and division of cities in relevant national and provincial planning documents, the index calculation method is determined as follows:

- The hub city is an international, comprehensive transportation hub: 5 scores.
- The hub city is a national, comprehensive transportation hub and a national logistics hub: 4 scores.
- The hub city is a national comprehensive transportation hub or a national logistics hub: 3 scores.
- The hub city is an important regional comprehensive transportation hub: 2 scores.
- The hub city is an ordinary regional comprehensive transportation hub: 1 score.
- No score for the rest.

Classification basis of hub cities:

International comprehensive transportation hubs are positioned as the core transportation hub of the province, supporting a province's foreign personnel and economic exchanges, and are an important gateway to the global market and the major economic zones in China. Relying on their comprehensive transportation hub advantages such as traffic location, economic and industrial status and highway, railway and air passenger transport/freight stations, they undertake international and national personnel and cargo distribution and transit and control processes, mainly processing the international and domestic long-distance trunk transportation of passengers and cargo, and are the most important personnel and cargo gathering centres in the province and the highest level hub nodes in the provincial transportation system. The determination of international comprehensive transportation hub cities is based on the Outline of National Comprehensive Three-dimensional Transportation Network Planning.

National comprehensive transportation hubs are positioned as the main transportation hub of the province, with complete highway, railway, aviation, and other hub facilities as well as strong transportation location advantages and economic and industrial advantages. Each mainly serves as an avenue for the distribution and transit of personnel and freight throughout China, and is the main transportation node in supporting inter-provincial personnel economic exchanges. These hubs play an important supporting and driving role in the economic development of the whole province. The determination of national comprehensive transportation hub cities is based on the Outline of National Comprehensive Three-dimensional Transportation Network Planning.

Important regional comprehensive transportation hubs are positioned as important transportation hubs of the province, with relatively complete highway, railway, and other hub facilities as well as certain transportation location advantages and economic and industrial advantages. Each mainly serves as an avenue for the distribution and transit of personnel and freight between surrounding provinces and various regions in the province, and play a certain supporting and driving role in the economic development of the province. The determination of important regional comprehensive transportation hub cities is based on the relevant plans issued by government agencies at or above the provincial level.

Ordinary regional comprehensive transportation hubs are positioned as an ordinary transportation hub within the whole province, with certain highway, railway (or aviation) and other hub facilities. Combined with the needs of local economic and industrial development, they meet the needs of local and surrounding cities for personnel exchange and industrial development, and mainly serve demands for medium and short-distance passenger and freight transportation, production efforts and normal life movements between surrounding cities and the hub's city. The determination of regional comprehensive transportation hub cities is based on the relevant plans issued by government agencies at or above the provincial level.

A national logistics hub is the infrastructure core of the logistics system. It is a comprehensive logistics hub with a wider radiation area, stronger agglomeration effect, better service function and higher operation efficiency. These hubs play the role of key nodes, and serve as important platform and backbone hubs in the national logistics network. The determination of the carrying city of the national logistics hub is based on the Layout and Construction Planning of National Logistics Hubs.

C4 Maximum annual capacity of multimodal containers

(1) Index Significance: The maximum number of multimodal containers that the hub can transfer each year during the assessment period. Unit: standard container per year (TEU per year).

(2) Reasons for Selection: Multimodal transport is encouraged to adopt container transport to facilitate shifts between different modes of transport. The maximum annual multimodal container handling capacity can fully reflect the multimodal service capacity of a hub.

(3) Index Calculation:
Based on expert consultations and research of relevant enterprises, the calculation method of the index is determined as follows:

- Multimodal containers with a maximum annual handling capacity of more than 3 million TEUs: 5 scores.
- Multimodal container handling capacity of 1 million-3 million TEUs per year: 4 scores.
- Maximum annual handling capacity of multimodal containers of 300,000-1 million TEUs: 3 scores.
- Maximum annual handling capacity of multimodal containers of 100,000-300,000 TEUs: 2 scores.
- Multimodal container handling capacity of 50,000-100,000 TEUs per year: 1 score.
- No score for the rest.

C5 Modern Transportation Organisation Functions

(1) Index Significance: The diversified service capacity of hub transportation organisation during the assessment period.

(2) Reason for selection: Scientific and reasonable transportation organisation modes are the basic condition for efficient and economic freight transportation, an important means to optimise the allocation of transportation resources and the basic guarantee for the development of intermodal transports. The development of advanced transportation organisation modes in China is slow, and the intermodal transport rate of containers is low. In recent years, China has actively promoted the pilot of Drop and pull transport, intermodal transport demonstration projects and urban green freight distribution demonstration projects, aiming to promote the innovative development of advanced transportation organisation modes. The modern transportation organisation function is a necessary means for the development of intermodal transport hubs.

(3) Index Calculation: Supporting modern transportation modes such as drop-and-pull transport and hump transport; supporting the cold chain logistics transport; opening international routes (or flights): 5 scores.

- Supporting modern transportation modes such as drop-and-pull transport and hump transport; supporting the cold chain logistics transport; opening international routes (or flights); if two of them are satisfied, 3 scores will be given.
- Supporting modern transportation modes such as drop-and-pull transport and hump transport; supporting the cold chain logistics transport; opening international routes (or flights); if one of them is satisfied, 1 score will be given.
- No score for the rest.

C6 Integrated Information Platform Functions

(1) Index Significance: The service function that the hub integrated information service platform can meet during the assessment period.

(2) Reason for Selection: Information platforms are the basis for realising information transmissions between the cargo owner and the carrier and improving overall service quality. The platforms provide support to ensure information sharing amongst enterprises, carry out vehicle cargo matching and improve transportation efficiency. These platforms strengthen information transmissions between the government and enterprises, and eliminate information barriers. The construction of an intermodal transport hub should improve the service function of comprehensive information platforms, focusing on strengthening the information interconnection between carriers, and making the platform service effectively cover all links and the whole process of intermodal transport organisation, supplying the supply chain with data, and promoting the leapfrog development of intermodal transports.

(3) Index Calculation: Integrated hub information platforms that can realise basic data exchanges between different transportation modes, can also realise basic data exchanges between different departments, and can realise only one freight document for multimodal transportation: 5 scores.

- If a hub meets two of the above conditions: 3 scores.
- If a hub meets one the above conditions: 1 score.
- No score for the rest.

C7 Multimodal Container Transit Times

(1) Index Significance: The average time for multimodal containers to transit from arrival at the hub to changing to another mode of transportation during the assessment period. Unit: hour.

(2) Reason for Selection: The conversion efficiency between different modes of transport directly affects the smooth progress of logistics. In China, the means of container transport has been encouraged in multimodal transport, which facilitates the conversion between different modes of transport. Multimodal container transfer time also reflects the service capacity of multimodal transport hub to a large extent.

(3) Index Calculation: Based on expert consultation and research of relevant enterprises, the calculation method of the index is determined as follows:

- Multimodal container transfer time of less than 0.5 hour: 5 scores.
- Multimodal container transfer time of 0.5-2 hours: 4 scores.
- Multimodal container transfer time of 2-4 hours: 3 scores.
- Multimodal container transfer time of 4-12 hours: 2 scores.
- Multimodal container transfer time of 12-36 hours: 1 score.
- No score for the rest.

C8 Overall customs clearance time

(1) Index Significance: During the assessment period, the average time from the arrival of goods at the hub port to the allowable lifting of goods, including the time-consumed by multiple links of actions such as arrival, loading and unloading, stacking, tally, declaration, inspection, release and lifting of goods. Unit: hour.

(2) Reason for Selection: The customs clearance time is an important embodiment of the operation efficiency of export-oriented freight hubs. Freight hubs should be encouraged to promote and implement "One-Station" customs clearance, make overall use of port supervision facilities, optimise the integrated workflow of customs clearance and inspection, accelerate the construction of "Single Window" systems and improve the capacity and level of customs clearance support.

(3) Index Calculation: Combined with the distribution scope of each hub level and the principle of timeliness, the index calculation method is determined as follows, according to the monitoring of China's overall customs clearance time by the General Administration of customs[6], and the circular of the state port administration office on the overall customs clearance time of the whole country and provinces (regions and cities) in December 2020, and over the whole of 2020 in China.

[6] In December 2020, the overall customs clearance time of imports and exports in China was 34.91 hours and 1.78 hours respectively.

- The overall customs clearance time is less than 24 hours: 5 scores.
- The overall customs clearance time is 24~36 hours: 4 scores.
- The overall customs clearance time is 36~48 hours: 3 scores.
- The overall customs clearance time is 48~60 hours: 2 scores.
- The overall customs clearance time is 60~72 hours: 1 score.
- If the overall customs clearance time is more than 72 hours or does not have a customs clearance function, no score will be given.

C9 Radiation Range

(1) Index Significance: The coverage of the trains (lines) organised and operated by the hub during the assessment period.

(2) Reason for Selection: The radiation range of intermodal transport hubs reflects the operation service radius and resource agglomeration capacity of the hub. A national logistics hub is defined as a comprehensive logistics hub with a wider radiation area, stronger agglomeration effect, better service function and higher operation efficiency. It can be seen that the radiation range is an important embodiment of the operation scale and level of intermodal transport hubs.

(3) Index Calculation: According to the overall operation of trains in intermodal transport hubs in China, the index calculation method is determined as follows:

- The trains (lines) organised by the hub covers some major cities in the world: 5 scores.
- The trains (lines) organised by the hub cover some major cities in Asia: 4 scores.
- The trains (lines) organised by the hub cover some major cities in China: 3 scores.
- The trains (lines) organised by the hub cover major cities in the province: 1 score.
- No score for the rest.

C10 Multimodal Container throughputs

(1) Index Significance: The sum of transportation volume of transport units entering and leaving the intermodal transport hub during the assessment period. Unit: $\times 10^5$ TEU (taking one container as an example).

(2) Reason for Selection: The throughput of an intermodal transport unit is a direct reflection of the operation scale of intermodal transport hubs. It is worth noting that intermodal transport encourages using standardised transport units as transport units. Therefore, the throughput of a transportation unit rather than the freight throughput is selected as the measurement index of the operation scale.

(3) Index Calculation: According to the distribution range of national port container throughput and inland port container throughput, the index calculation method is determined as follows:

- The intermodal container throughput exceeds 5×10^5 TEU/year: 5 scores.
- The intermodal container throughput is 3×10^5~5×10^5 TEU/year: 4 scores.
- The intermodal container throughput is 1×10^5~3×10^5 TEU/year: 3 scores.
- The intermodal container throughput is 0.5×10^5~1×10^5 TEU/year: 2 scores.
- The intermodal container throughput is 0.2×10^5~0.5×10^5 TEU/year: 1 score.
- No score for the rest.

C11 Total revenue from logistics operations

(1) Index Significance: During the assessment period, this is the sum of the income obtained by the hub through logistics business activities, including logistics business income such as transportation, storage, loading and unloading, handling, packaging, circulation, and processing, distribution, and information services. Unit: ×108 yuan.

(2) Reason for Selection: The total revenue of logistics businesses is an intuitive reflection of the market scale and operation of intermodal transport hubs, and is also convenient for statistics.

(3) Index Calculation: According to the distribution range of logistics business income of each hub and referring to the Statistical Analysis Report on Logistics Park Operation (2015), the index calculation method is determined as follows:

- The average annual operating income is more than 40×10^8 yuan: 5 scores.
- The average annual operating income is 15×10^8~40×10^8

yuan: 4 scores.
- The average annual operating income is 6×10^8~15×10^8 yuan: 3 scores.
- The average annual operating income is 1×10^8~6×10^8 yuan: 2 scores.
- The average annual operating income reaches 0.5×10^8~1×10^8 yuan: 1 score.
- No score for the rest.

C12 Number of settled companies

(1) Indicator Significance: The total number of companies settled in the park during the assessment period.

(2) Reason for Selection: The market subject is the premise of logistics activities, and the scale of the market subject determines the business scale of the intermodal transport hub to a certain extent.

(3) Index Calculation: According to the distribution of the number of enterprises settled in each hub, the index calculation method is determined as follows:

- The number of settled companies is more than 300: 5 scores.
- The number of settled companies is 200~300: 4 scores.
- The number of settled companies is 100~200: 3 scores.
- The number of settled companies is 50~100: 2 scores.
- The number of settled companies is 20~50: 1 score.
- No score for the rest.

C13 Proportion of Online Logistics Transactions

(1) Indicator Significance: The ratio of the sum of logistics service transactions realised through the hub integrated information service platform (including own IT systems/platforms) in proportion to the total logistics service transactions of the hub during the assessment period.

(2) Reason for Selection: Using the hub integrated information service platform to provide enterprises with one-stop public information services such as infrastructure, tracking and positioning, line capacity, qualification, certification and recognition, inspection and quarantine, customs clearance and inspection, credit evaluation and related actions, is the development direction of intelligent and informed intermodal transport hubs. The proportion of online logistics transaction volume can reflect the information service capacity and the high-quality development level of the hubs.

(3) Index Calculation: According to the proportion distribution of online logistics transaction volume of each hub, the index calculation method is determined as follows:

- The online logistics transaction volume accounts for more than 50% of the total transaction volume: 5 scores.
- The online logistics transaction volume accounts for 30%~50% of the total transaction volume: 4 scores.
- The online logistics transaction volume accounts for 10%~30% of the total transaction volume: 3 scores.
- The online logistics transaction volume accounts for 5%~10% of the total transaction volume: 2 scores.
- The online logistics transaction volume accounts for 1%~5% of the total transaction volume: 4 scores.
- No score for the rest.

C14 Quality of Settled Enterprises

(1) Index Significance: During the assessment period, it is the scale, strength and type of enterprises settled in the park, including the number of 3A ~ 5A logistics enterprises, the number of world's top 500 enterprises, the number of trading enterprises, the number of processing and manufacturing enterprises, the number of information platform enterprises and the number of financial and insurance enterprises.

(2) Reason for Selection: Cultivating intermodal transport operators and backbone leading enterprises is an important guarantee for the efficient and seamless connection of intermodal transports. Accelerating the introduction of well-known domestic and foreign logistics enterprises and focusing on attracting large-scale well-known intermodal transport operators is very important for the development of intermodal transport hubs. Just as the Memphis freight hub, dominated by FedEx, has become an important freight hub in the world, the quality of settled enterprises will deeply affect the operation quality of the hub.

(3) Index Calculation: The identification of 3A ~ 5A logistics enterprises is based on the Classification and Evaluation Index of Logistics Enterprises (GB / T 19680-2013). The national standard divides logistics enterprises into three categories including transportation logistics enterprises, warehousing logistics enterprises and comprehensive service logistics enterprises. There are clear standards for each type of A-level enterprise. For example, transportation logistics enterprises are divided into five levels such as A ~ 5A according to six aspects, including business status, assets, facilities and equipment, management and service, personnel management and informatisation level. Accordingly, the calculation method of this index is as follows:

- The number of 3A ~ 5A level logistics enterprises accounts for more than 70% of the settled logistics enterprises, and the number of the world's top 500 enterprises is more than 3. Settled enterprises include commercial enterprises, express enterprises, e-commerce enterprises, processing and manufacturing enterprises, information platform enterprises, financial and insurance enterprises, and related businesses: 5 scores.
- The number of 3A-5A logistics enterprises accounts for more than 60% of the settled logistics enterprises, and the number of the world's top 500 enterprises is more than 1. Settled enterprises include commercial enterprises, express enterprises, e-commerce enterprises, processing and manufacturing enterprises, information platform enterprises, financial and insurance enterprises, and related businesses: 4 scores.
- When the number of 3A ~ 5A logistics enterprises accounts for more than 50% of the settled logistics enterprises. Settled enterprises include commercial enterprises, express enterprises, e-commerce enterprises, processing and manufacturing enterprises, information platform enterprises, and related businesses: 3 scores.
- When the number of 3A ~ 5A logistics enterprises accounts for more than 40% of the settled logistics enterprises. Settled enterprises include commercial enterprises, express enterprises, e-commerce enterprises, processing and manufacturing enterprises, and related businesses: 2 scores.
- The number of 3A ~ 5A logistics enterprises accounts for more than 30% of the settled logistics enterprises: 1 score.
- No score for the rest.

C15 Amount of tax per unit area

(1) Index Significance: The ratio of the total annual tax revenue of the park to the actual floor area of the park during the assessment period. Unit: ×105 yuan (×105 m2·year)

(2) Reason for Selection: In the process of operation, intermodal transport hubs shall pay the corresponding urban maintenance and construction tax and education surcharge according to local tax standards, and abide by the legal principle of tax. The tax amount per unit area determines the contribution of the intermodal transport hub to the local finance system and the realisation of social benefits.

(3) Index Calculation: According to the distribution of tax per unit area of each hub and referring to the Statistical Analysis Report on Logistics Park Operation (2015), the index calculation method is determined as follows:

- The tax amount per unit area is more than 100×10^5 yuan/ ($\times10^5$ m^2·year): 5 scores.
- The tax amount per unit area is 60×10^5~100×10^5 yuan/ ($\times10^5$ m2·year): 4 scores.
- The tax amount per unit area is 30×10^5~60×10^5 yuan/ ($\times10^5$ m2·year): 3 scores.
- The tax amount per unit area is 10×10^5~30×10^5 yuan/ ($\times10^5$ m2·year): 2 scores.
- The tax amount per unit area is 5×10^5~10×10^5 yuan/ ($\times10^5$ m2·year): 1 score.
- No score for the rest.

C16 Number and level of accidents in production safety

(1) Index Significance: The number of work safety accidents in the park during the assessment period.

(2) Reason for Selection: The number of safety production accidents is the direct embodiment of the safety management level of intermodal transport hubs. The hubs and settled business operators shall take the main responsibility for safe production systems, timely investigate potential safety hazards and avoid safety production accidents.

(3) Index Calculation: The classification standard of work safety accidents refers to the Bylaw Governing Reporting, Investigation and Handling of Production Safety Accidents, and the index calculation method is determined as follows:

- No safety production accident has occurred: 5 scores.
- 1 general accident at most: 3 scores.
- 2 general accidents at most: 1 score.
- No score for the rest.

C17 Land Conservation

(1) Index Significance: The degree of space utilisation of intermodal transport hubs during the assessment period.

(2) Reasons for Selection: Intermodal transport hubs should adhere to the concept of intensive development, pay attention to intensive land use and comprehensive development, promote the optimal allocation of various resources, and improve the organisation and intensive level of logistics hubs by improving the intensive utilisation rate of logistics facilities and various logistics resources.

(3) Index Calculation: With reference to the Technical Requirements for Assessment of Green Transportation Facilities, the calculation method of the index is determined as follows:

- The intensive design is adopted with more than two designs such as a multi-storied warehouse design, elevated warehouse, and container yard: 5 scores.
- More than one intensive design: 3 scores.
- No score for the rest.

C18 Environmental Protection

(1) Index Significance: Treatment of water pollution, acoustic environment pollution and garbage in the park during the assessment period.

(2) Reason for Selection: The degree of environmental pollution control is an important embodiment of an environment-friendly hub. An intermodal hub adhering to the concept of green and low-carbon development should pay close attention to the red line of environmental protection and reduce the environmental cost of production.

(3) Index Calculation: With reference to the Technical Requirements for Assessment of Green Transportation Facilities, the calculation method of the index is determined as follows:

- It meets the following three conditions: there is no excessive discharge of wastewater in the site, the noise meets the provisions of GB3096, the effective classified collection and treatment of garbage, and the garbage collection station has sealing measures to reduce the escape of odour: 5 scores.
- It meets two of the above conditions: 3 scores.
- It meets one of the above conditions: 1 score.
- No score for the rest.

C19 Energy Saving Equipment

(1) Index Significance: The energy-saving technical level of ventilation and air conditioning, vehicle handling, loading, and unloading energy-saving equipment in the park during the assessment period.

(2) Reason for Selection: The use of international, advanced, low-carbon environmental protection technologies such as energy-saving logistics equipment, low-carbon and environmental protection building materials and designs will help to improve the low-carbon level of intermodal transport hubs. Therefore, intermodal transport hubs should be encouraged to strengthen the application of low-carbon logistics equipment and technology.

(3) Index Calculation: With reference to the Technical Requirements for Evaluation of Green Transportation Facilities, the calculation method of the index is determined as follows:

- It meets the following conditions: 1. VAC equipment adopts renewable or clean energy heating systems, heat pump cooling technology, etc.; 2. Natural ventilation is preferred in the warehouse, energy-saving air conditioning equipment is used in constant temperature warehouses and cold storage, or other intelligent energy-saving measures are taken; 3. Configure new energy vehicles, such as new energy container trucks, electric forklifts, electric tractors, etc. with a proportion of no less than 50%; For the application of oil to gas energy-saving technology, the utilisation rate is ≥ 30% (when it meets all above conditions): 5 scores.
- It meets three of the above conditions: 3 scores.
- It meets two of the above conditions: 2 scores.
- It meets one of the above conditions: 1 score.
- No score for the rest.

C20 Electrical Lighting

(1) Index Significance: Energy-saving levels of lamps and electrical devices in the park and the use of intelligent controls during the assessment period.

(2) Reason for Selection: The use of energy-saving lighting systems is also an important aspect of energy conservation and environmental protection of intermodal transport hubs.

(3) Index Calculation: With reference to the Technical Requirements for Evaluation of Green Transportation Facilities, the calculation method of the index is determined as follows:

- It meets the following conditions: 1. The utilisation rate of LED light sources is more than 90%; 2. The distribution transformer shall reach the energy efficiency level of class I in GB 20052; 3. The water pump and fan meet the energy-saving evaluation value requirements of gb19762 and gb19761 respectively; 4. The indoor public lighting system adopts zoning, timing and infrared induction energy-saving control measures; 5. The road lighting system can automatically start and stop according to 5 conditions such as outdoor illumination and set time: 5 scores.
- It meets four of the above conditions: 4 scores.
- It meets three of the above conditions: 3 scores.
- It meets two of the above conditions: 2 scores.
- It meets one of the above conditions: 1 score.
- No score for the rest.

C21 Carbon emission intensity

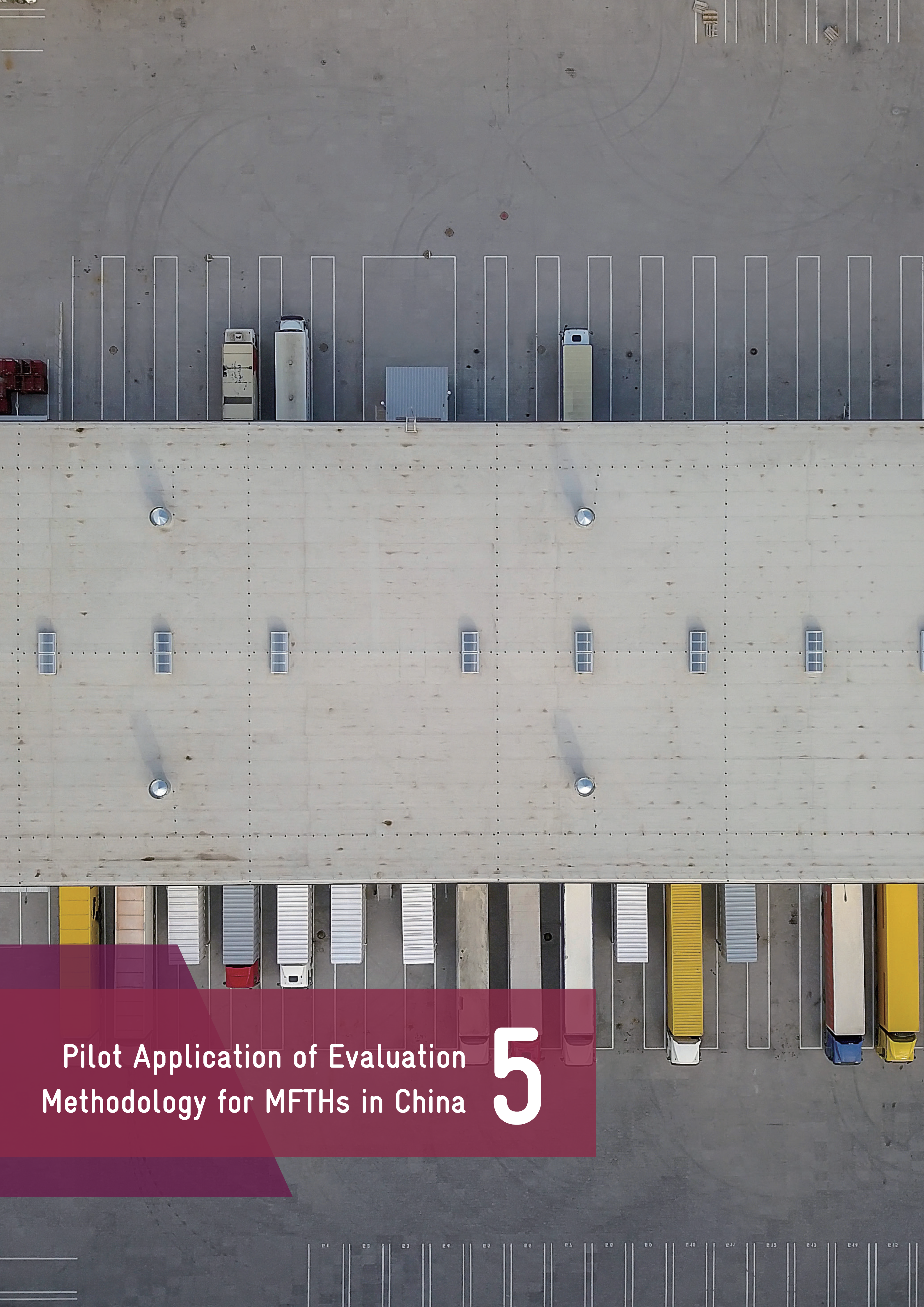
(1) Index Significance: The ratio of hub carbon emissions to cargo throughput during the assessment period. Unit: ton/10,000 yuan. Where: hub carbon emissions = various types of energy consumption × emission factors.

Emission factor = average low calorific value × carbon content per unit calorific value × carbon oxidation rate × mass conversion coefficient from carbon-to-carbon dioxide (44/12).

(2) Reason for Selection: Carbon intensity is an important indicator for the development of low-carbon modes for intermodal transport hubs. Reducing carbon emissions produced by intermodal transport hubs is also a manifestation of improving energy efficiency.

(3) Index Calculation:
According to the reference value of carbon intensity in developed countries and the development objectives of carbon intensity proposed by various provinces and cities in China, the calculation method of the index is determined as follows:

- The carbon intensity is less than 3: 5 scores.
- The carbon intensity is 3~4: 4 scores.
- The carbon intensity is 4~5: 3 scores.
- The carbon intensity is 5~6: 2 scores.
- The carbon intensity is 6~7: 1 score.
- No score for the rest.



5 Pilot Application of Evaluation Methodology for MFTHs in China

In order to test the practicability of the evaluation method proposed in this study, it was applied to four typical MFTHs. According to the evaluation process and the results of the method's pilot applications, the evaluation method was verified and then improved, and the evaluation status of pilot MFTHs was summarised.

5.1 Selection of pilot MFTHs

The selected pilot hubs were chosen so that they covered the main multimodal transport modes in China. This study selected three types of MFTHs, namely, road-rail hubs, railway-waterway hubs, and road-air hubs. However, one of the purposes of carrying out the MFTH evaluation was that a number of leading MFTHs with excellent service quality, standardised management and an obvious demonstration of quality and ability to take a leading role could be taken as benchmarks for the industry's development, so as to provide model references for promoting high-quality MFTHs. Priority should therefore be given to the pilot hubs of the national multi-modal transport demonstration project. Through comparison and selection, this study selected four pilot hubs, including the Lanzhou New Area Commerce Trade and Logistics Park (road-rail hub), Henan Airport Logistics Hub (road-air hub), Wuhan Yangluo International Port Logistics Park (rail-water hub) and the Sea Railway Centre of Ningbo Zhoushan Port (rail-water hub).

5.2 Data collection for multimodal freight hub evaluation indicators

According to the MFTH evaluation index system established above, most evaluation indicators require analysis and calculation. Therefore, in order to obtain relevant information about the evaluated MFTHs quickly and easily, and simplify the collection and analysis of MFTH index data, MFTH evaluation forms have been prepared in a way that is convenient for the front-line staff of enterprises to fill out, as shown in the enclosed table at the end of this report. This form has been sent to MFTHs for the collection of basic information.

5.3 Data availability for pilot hub indicators

The evaluation of multimodal transport hubs is based on level 3 indicators, of which there are 21 in total, according to the previously established multimodal transport hub evaluation index system. Each of the four pilot hubs needs to collect data for 21 indicators, for a total of 84 indicators to have data to be collected. In fact, three hubs can provide data for 66 indicators, with an indicator data availability rate of 79% in total (the ratio of the number of data actually collected to the number of data to be collected). Judging from the data availability rate of each indicator, after soliciting expert opinions, the research team noted that if the indicator data availability rate is no less than 50%, then the indicator is retained, for it is relatively easy to obtain information to assess it. However, if the indicator data availability rate is less than 50%, the indicator is considered difficult to obtain and needs to be replaced or improved. Among the 21 indicators for level 3, 10 indicators are available from all four pilot hubs, and the indicator data availability rate is 100%; 7 indicators are available from three pilot hubs, and the indicator data availability rate is 75%; 2 indicators are available from two pilot hubs, and the indicator data availability rate is 50%; 1 indicator is available from only one pilot hub, and the indicator data availability rate is 25%; and 1 indicator is not available from any pilot hubs, with a 0% availability of indicator data. The main reason for the unavailability of this final indicator is that hub companies did not have a way to obtain the relevant statistics to fulfil it, as detailed in Table 5-1.

Table 5-1 The availability of indicator data at pilot hubs

Indicator number	Name of indicator	Availability of data for indicators		Main reasons for non-availability of data
		Number of pilot hubs with data available for this indicator	Percentage of total pilot hubs	
C1	Logistics operating area	3	75%	—
C2	Connection of intermodal transport facilities (highway, rail, water, air)	4	100%	—
C3	Level of transport hub city	4	100%	—
C4	Maximum annual capacity of multimodal containers	3	75%	Air-led hubs have cargo handling capacity only, with no container handling data.
C5	Modern transport organisation function	4	100%	—
C6	Integrated information platform function	4	100%	—
C7	Multimodal container transit time	3	75%	Air-led hubs have cargo handling capacity only, with no container handling data.
C8	Overall customs clearance time	4	100%	—
C9	Radiation range	4	100%	—
C10	Multimodal Container throughput	3	75%	Air-led hubs have cargo handling capacity only, with no container handling data.
C11	Total revenue from logistics operations	2	50%	No relevant statistics
C12	Number of settled companies	4	100%	—
C13	Proportion of online logistics transaction	2	50%	No relevant statistics
C14	Quality of settled enterprises	3	75%	No relevant statistics
C15	Amount of tax per unit area	0	0%	No relevant statistics
C16	Number and level of accidents in production safety	4	100%	—
C17	Land saving	3	75%	No relevant statistics
C18	Environmental protection	4	100%	—
C19	Energy saving equipment	4	100%	—
C20	Electric Lighting	3	75%	—
C21	Carbon emission intensity	1	25%	No relevant statistics

5.4 Modifications to the evaluation index system

Based on the acquisition of the pilot hub indicator data and the relevant suggestions from the pilot hub management enterprises, the MFTH evaluation indicator system as established above was appropriately modified.

5.4.1 Increase in indicators

Based on feedback from the pilot hubs, the indicator “expansion of service functions” was added.

Index significance: The financial, governmental affairs, catering and other supporting service functions expanded by the hub on the basis of logistics services, during the assessment period.

Reason for increase: Three of four pilot hubs suggested adding this indicator. With the development of multimodal transport and integrated logistics services, MFTHs, as nodes of the global integrated transport network, are also becoming more extensive in their functions and are developing a full range of value-added services, serving as centres where commodity flows, capital flows, technology flows and talent flows converge. The expansion of service functions can reflect the development stage of hub expansion from providing basic freight logistics services to also being used for high-end services such as finance and government services.

Index calculation: Hubs must meet the following requirements: 1. Support two or more financial logistics services including warehouse receipt pledges, bill of lading pledges, bonded warehouses, agent procurement, advance payment for goods, agent collection for goods, insurance financing and related services; 2. Support two or more of the government and business service capabilities of industry and commerce, tax, insurance, national inspection, finance, and related services, and; 3. Support three or more of other basic supporting services capacities, such as parking, accommodation, catering, refuelling (offering gas or charging options), property, repair, shopping, entertainment and related services

- Meeting all 3 of the above conditions: 5 scores.
- Meeting 2 of the above conditions: 3 scores.
- Meeting 1 of the above conditions: 1 score.
- No score for the rest.

5.4.2 Replacement of indicators

Based on pilot findings, it was recommended to replace the indicator of “the amount of tax per unit area” with the indicator of “the value of goods transported per unit area”.

Index significance: The ratio of the annual value of transported goods completed in the hub to the actual floor space of the hub during the assessment period. Unit: Ten thousand Yuan/ (ten thousand square metres•year).

Reason for replacement: Data availability for the indicator“the amount of tax per unit area” was 0% and none of the pilot hub management enterprises could provide any information relating to this indicator. Management enterprises from two pilot hubs suggested replacing this indicator with “the value of goods transported per unit area”, thus reflecting the contribution of the hub to economic and social development. Moreover, two of the pilot hubs have provided additional data for this new indicator.

Index calculation:
The value of transported goods completed per unit area is over 600 million yuan/(10,000 square metres•year) : 5 scores.

- The value of transported goods completed per unit area is 300-600 million yuan/(10,000 square metres•year) : 4 scores.
- The value of transported goods completed per unit area is 150-300 million yuan/(10,000 square metres•year) : 3 scores.
- The value of transported goods completed per unit area is 50-150 million yuan/(10,000 square metres•year): 2 scores.
- The value of transported goods completed per unit area is 10-50 million yuan/(10,000 square metres•year): 1 score.

5.4.3 Indicator improvement

(1) Improvement of selected indicators for aviation hubs

The three indicators of “maximum annual capacity of multimodal containers”, “multimodal container transit time" and "multimodal container throughput" are not suitable for aviation-led MFTHs. Since aviation hubs generally do not collect container-related data, their relevant indicators are improved into "Maximum annual capacity of multimodal containers (or cargo)", "multimodal container (or cargo) transit time" and "multimodal container (cargo) throughput". Among them, aviation-led MFTHs evaluate cargo-related indicators, while other hubs still evaluate container-related indicators. The scoring standards of cargo related indicators refer to container standards and are converted according to the rule that 1 TEU equals 10 tons.

(2) Improvement of the index calculation method

It is necessary to improve the indicator calculation method of "carbon emission intensity", because the data availability rate for this category is low (it was found to be only 25% in the pilot evaluation process). However, this indicator is important for measuring the low-carbon development of MFTHs, so it should be retained. The evaluation of this indicator requires the government to guide MFTHs to gradually strengthen the gathering of data for relevant statistics. According to the feedback and suggestions of the pilot hubs, before the gathering of data for relevant statistics is improved, recent levels of "carbon emission intensity" can be reflected by the average transport distance of the multimodal cargo, that is, the average transport distance of the cargo from arriving at the hub to changing to another mode of transport, because the "carbon emission intensity" mainly reflects the energy consumption of the hub. The key to reducing hub energy consumption is to optimise hub transportation organisation and shorten the transhipment distance of multimodal cargo. Therefore, the average transit distance of multimodal transport goods can be used in the near future to represent "carbon emission intensity". According to expert consultations and surveys of relevant enterprises, the calculation method of the indicator is determined as follows:

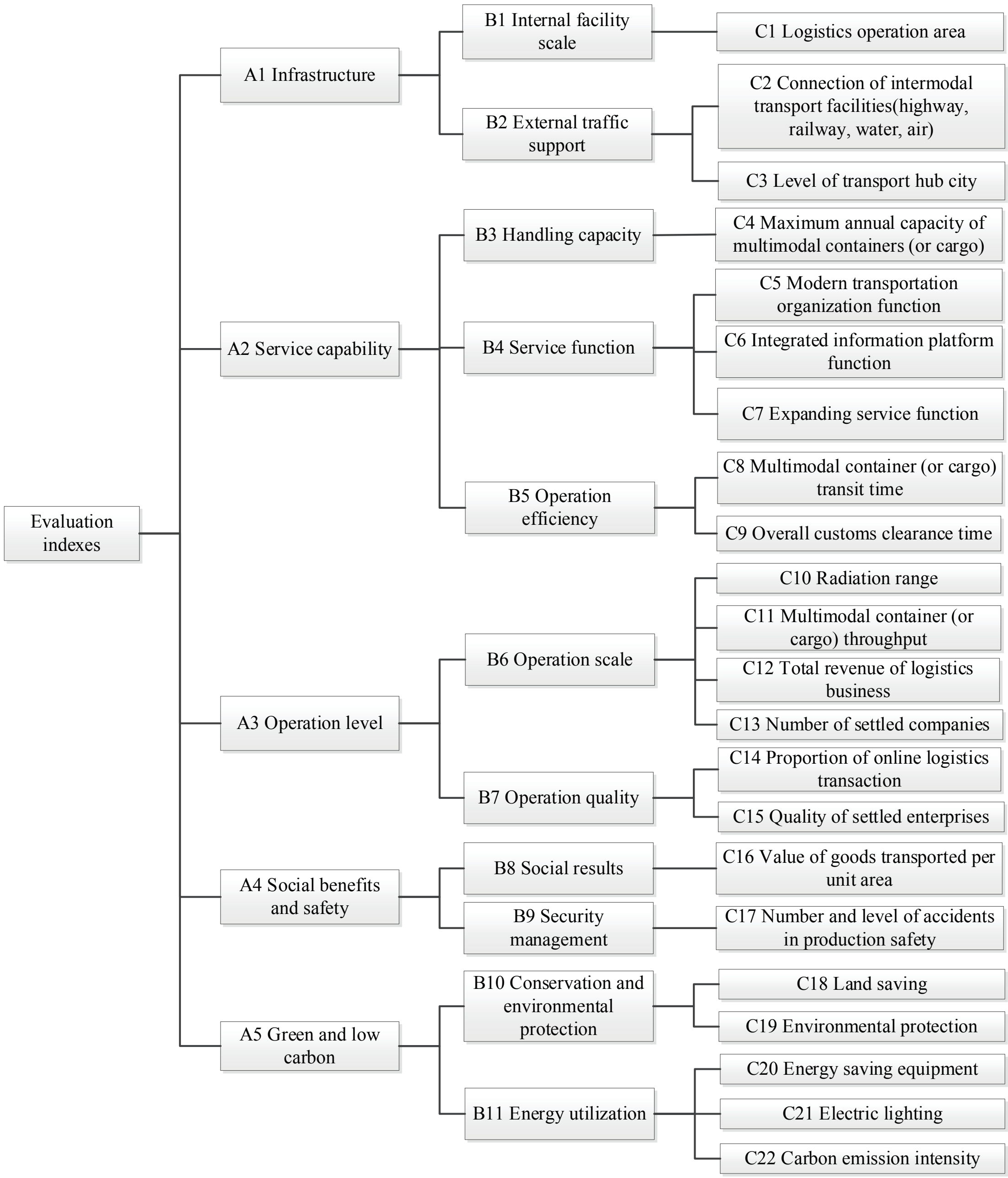
- The average transhipment distance of multimodal goods is less than 0.1 km: 5 scores.
- The average transhipment distance of multimodal cargo is 0.1 km to 0.3 km: 4 scores.
- The average transhipment distance of multimodal cargo is 0.3 km to 0.5 km: 3 scores.
- The average transhipment distance of multimodal cargo is 0.5 km to 1 km: 2 scores.
- The average transhipment distance of multimodal cargo is 1 km to 2 km: 1 score.
- No score for the rest.

The evaluation index system has been modified as shown in Table 5-2 and Figure 5-1.

Table 5-2 Modified multimodal transport hub evaluation index systems after pilot application

First-level indicators			Second-level indicators			Third-level indicators		
Serial No.	Index name	Index weight	Serial No.	Index name	Index weight	Serial No.	Index name	Index weight
A1	Infrastructure	0.2	B1	Scale of internal facilities	0.04	C1	Logistics operating area	0.04
			B2	External transport support	0.16	C2	Connection of intermodal transport facilities (highway, railway, water, and air)	0.10
						C3	Level of transport hub city	0.06
A2	Service capacity	0.25	B3	Handling capacity	0.05	C4	Maximum annual capacity of multimodal containers (or cargo)	0.05
			B4	Service function	0.12	C5	Modern transport organisation functions	0.04
						C6	Integrated Information platform function	0.04
						C7	Expanding service function	0.04
			B5	Operation efficiency	0.08	C8	Multimodal container (or cargo) transit time	0.04
						C9	Overall Customs Clearance time	0.04
A3	Operation level	0.15	B6	Scale of Operation	0.11	C10	Radiation range	0.05
						C11	Multimodal container (cargo) throughput	0.02
						C12	Total revenue from Logistics business	0.02
						C13	Number of settled companies	0.02
			B7	Operation quality	0.04	C14	Proportion of online logistics transactions	0.02
						C15	Quality of settled enterprises	0.02
A4	Social benefit and security	0.1	B8	Social benefit	0.05	C16	Value of goods transported per unit area	0.05
			B9	Security Management	0.05	C17	Number and level of accidents in production safety	0.05
A5	Green and low carbon	0.3	B10	Conservation and environmental protection	0.10	C18	Land saving	0.05
						C19	Environmental protection	0.05
			B11	Energy use	0.20	C20	Energy saving equipment	0.07
						C21	Electric lighting	0.03
						C22	Carbon emission intensity	0.10

Figure 5-1 Management Evaluation Index System of Intermodal Transport Freight Hub modified after pilot application



5.5 Analysis of evaluation findings

Tier 1 indicators are a summary and comprehensive reflection of Tier 2 and Tier 3 indicators. The four pilot hubs have been analysed in terms of five Tier 1indicators, namely infrastructure, service capacity, operational level, social benefit and safety, and green and low-carbon standards.

In terms of social benefits and safety, the general score rates (the ratio of the actual score to the theoretical maximum score) of the four pilot hubs are high, with all exceeding 50%, especially in the evaluation of the number and level of safety production accidents indicator. In the evaluation period (2020), no production safety accidents of any grade occurred in the four pilot hubs, and all of them received the highest theoretical score of this indicator. To some extent, this reflects that China's hubs perform well regarding social benefits and safety, especially in the management of production safety.

In terms of infrastructure, the scoring rates of the four pilot hubs are also high, with all exceeding 40%, and the scoring rate of one hub reaching 70%, which to some extent reflects the acceleration of infrastructure construction for China's MFTHs in recent years, and the gradual improvement of distribution systems.

Thirdly, in terms of service capacity and green and low-carbon considerations, the scoring rates of the four pilot hubs are between 30% and 70%, and there are still ample opportunities for the improvement of these levels. Regarding operation levels, the scoring rate of the four pilot hubs is lower than 45%, which reflects, to some extent, the development characteristics of China's MFTHs at present, which tend to emphasise considerations of construction, but ignoring elements relating to their operation. These aspects are the weaknesses that China's MFTHs should focus on for their future development.

6 Recommendations for Policies and Measures

6.1 Suggestions on policies and measures for competent authorities of the transport industry

6.1.1 Suggestions on policies and measures for the MOT

(1) Promote MFTH evaluations and the application of findings

Carry out MFTH evaluations. According to the relevant deployment arrangements of the 14th Five-Year Development Plan for Comprehensive Transportation Services, it is necessary to organise MFTH evaluations nationwide, and promote the application of emerging technologies such as electronic terminals, mobile terminal APPs and digital monitoring platforms, so as to improve data collection efficiency, information verification accuracy, and continuous tracking operability. In addition, it is recommended to conduct in-depth analysis and evaluations of the operational status of MFTHs to find existing problems and carry out a national ranking of evaluation results.

Promote the application of MFTH evaluation results. MFTH evaluation results need to be published to set industry development benchmarks and promote the sharing of, and learning from, the advanced experience of established hubs. Different types of hubs have unique characteristics, so hub ranking and benchmarking needs to be classified so that findings can be effectively compared. According to the hub type, development stage and evaluation results, MFTHs included in the management and evaluation work will be classified and guided according to their contextual needs. Furthermore, in guiding MFTH development, more detailed policy recommendations will be issued to form and improve more targeted and influential evaluation index systems and working methods, which will also continue to improve the scientific and leadership contributions of evaluation work, in order to upgrade MFTHs in terms of their collection and distribution capacity, transhipment and operational management efficiency, and intelligent development.

(2) Accelerate the construction of national main corridors and hubs related to multimodal transport

Improving the infrastructure construction of MFTHs serves as the basis for carrying out multimodal transport of goods. Infrastructure-related indicators are an important part of the MFTH evaluation index system proposed in this study. Among them, the connectivity of multi-modal transport facilities (highway, rail, waterway, and air transport) and the carrying capacity of urban transport hubs mainly depend on the planning and construction of the external public infrastructure of multimodal transport facilities. According to the feedback from relevant enterprises during the evaluation of the pilot hubs, the government primarily needs to coordinate the planning and construction of public infrastructure, so as to promote MFTH development. It is particularly necessary for China to speed up the construction of major multi-modal transport corridors and upgrade the national MFTH capability.

Accelerate the construction of major national multimodal transport corridors. It is necessary to promote the construction of major logistics corridors, and speed up the formation of a backbone network of combined transport facilities spanning the east and west, connecting the north and the south, and connecting China to the world. It is advised to make up for the shortcomings in infrastructure related to trunk railroads and main waterways between different regions and major urban clusters, accelerate the upgrading of highway bottlenecks and busy sections, improve arterial railroad transportation networks in the central and western regions, continue to promote the construction of deep-water waterways such as the Yangtze River, and expand the navigability of the Three Gorges hub[7].

Speed up the upgrading of main national MFTHs. It is necessary to optimise the planning layout of comprehensive transport hub nodes, and take into account the needs of urban development plans, industrial layouts, and regional integration strategies, and promote the establishment of several national and regional multimodal transport service bases with large operational scales, high transfer efficiencies and wide cover radius ranges. Looking at the overall perspective of the strategic positioning of regions and cities, consideration should respectfully

[7] The Three Gorges is the largest hydropower station in the world.

then be given to the layout of facilities, connection of lines and networks, supporting functions required, and transportation organisation and service supplies, so as to accelerate the optimisation of the overall MFTH system and improve its efficiency. It is suggested to optimise the layout of inland dry ports, and improve the intermodal transportation channels and hub networks connecting with coastal and border areas.

(3) Improve regulations and standards concerning multimodal transport

The MFTH evaluation index system proposed in this study involves indicators related to service capacity and the operation of MFTHs. According to the feedback from relevant enterprises during the evaluation process concerning pilot hubs, MFTH service systems involve a variety of transportation modes, which not only require enterprises to improve their service and operation levels, but also requires the government to develop a relevant top-level design that these services function within, in order to create a favourable environment for MFTH development. In particular, it is necessary to improve laws and regulations related to multimodal transport and establish and improve the system of supporting standards and norms that apply to the hubs.

Improve laws and regulations related to multimodal transport. It is recommended to promote the formulation and revision of laws and regulations such as the Transportation Law and Multimodal Transport Law, to guide and standardise the legislative work of local transport administrative departments, to give overall consideration to the basic positioning, service attributes and management responsibilities of MFTHs, and clarify and unify the legal definition of MFTHs. Moreover, it is necessary to systematically sort out the definition of "hub" in laws and regulations, such as the Railway Law, Highway Law, Aviation Law, and Road Transport Regulations, so as to identify overlapping, contradictory and vague terminology and unify the developing foundations of the industry.

Establish and improve supporting standard and specification systems. With regard to MFTH construction, operation, service, safety, and green development, it is recommended to accelerate related research and release a series of standards and specifications, such as a unified classification standards for freight and similar guidelines, so as to solve key problems including poor cross-modal transport connectivity and mismatched technical equipment, together with inconsistent data and information exchange interface standards. It is necessary to speed up the formation of standard systems in terms of infrastructure, packaging and carrying units, special transport vehicles, loading and unloading equipment, as well as data exchange, with standards related to containers as their core.

(4) Improve supporting policies concerning MFTHs

In order to promote the evaluation of MFTHs and the application of related results, supporting policies for MFTHs should be improved. Appropriate funds and policy preferences should be given to bench-marking hubs that actively participate in the MFTH evaluations with good results.

Actively seek financial support for MFTHs. It is suggested to carry out studies to incorporate the operation and management of MFTHs into the scope of financial support from central budget funds, vehicle purchase tax funds and other financial funds. Efforts should be made to promote the MFTH evaluation ranking as an important reference for MFTHs to enjoy policies concerning financial support. It is suggested to promote the transformation of financial subsidies from focusing on hardware facility construction to focusing on other functional elements, such as hub service capabilities, management levels, improved management efficiency and the promotion of low-carbon development. More specifically, it is recommended to give financial policy support to MFTH service management structures that have significantly improved efficiency and well-regulated transport structure levels.

Ensure support funds for MFTHs through multiple channels. Financial institutions are encouraged to increase credit support for MFTH operators that have high rankings in evaluations. The PPP (public-private partnership) model can be adopted to guide private investors to participate in MFTH reconstruction and expansion projects. Related construction funds such as railway and civil aviation funds can also be inclined to be channelled to MFTHs.

Provide sufficient resources for MFTHs. Preferential policies such as priority for land use rights can be provided to MFTHs that have high rankings in evaluations to improve composite land use. Under the premise of complying with laws and regulations on the use of sea areas, sea reclamation management, intensive and economical sea use, and ecological protection, it is advised to support MFTH's use of sea and coastline for collection and distribution systems.

(5) Promote information sharing and exchange

The MFTH evaluation index system proposed in this study includes the functional indicators of the integrated information platform. In the process of pilot hub evaluation, some enterprises have proposed that the establishment and improvement of the information platform requires the country to strengthen macro guidance, establish a mechanism for sharing information resources, and accelerate the opening of public information resources.

Establish an information sharing mechanism. It is necessary to establish a catalogue of information sharing methods across different modes of transportation and accelerate the establishment of a mechanism for promoting the interconnection and sharing of multimodal transport information resources among various departments, governments and enterprises. Leading enterprises and stakeholders of MFTHs are encouraged to coordinate and improve information exchange standards and establish information sharing and exchange channels. It is also of great significance to promote cross-regional multimodal transport information sharing, innovative cooperation models, and promote the efficient matching and timely interaction of information related to cargo resources and transport capacity, together with hub facilities and resources.

Accelerate the opening of public information resources. It is suggested to conduct research and formulate a list of public governmental information resources involving governmental departments in sectors of transportation, customs, entry-exit inspection and quarantine, commerce and related divisions, based on the national and industrial data resource sharing and exchange platforms and the existing information management systems. This list can then be used to share and exchange national and regional multimodal transport information, promote "one-stop" public information services, and provide public service information concerning customs clearance and release, national inspections, dangerous goods clearance, import and export licenses, and other relevant processes. Moreover, relying on the cooperation mechanism of the Northeast Asia Logistics Information Service Network, it is recommended for China to promote information interconnection and the sharing of multimodal transport efforts within and between countries and regions, including Japan, South Korea, ASEAN, Central Asia, and the European Union.

6.1.2 Recommended policies and measures for local transportation authorities

(1) Strengthen overall planning and network connections between regional MFTHs

The connectivity of multimodal transport facilities (concerning highways, railways, waterways, and air transport) and the capacity of urban transportation hubs depends largely on the planning and construction of public infrastructure external to the hubs themselves. It is therefore of great importance to build major national multimodal transport corridors and improve the capacity of main national hubs. Moreover, it is recommended that local competent transport authorities strengthen the overall planning of regional hubs and promote the synergistic development of the hubs in the region, so as to enhance hub capacity, strengthen the rapid collection and distribution efforts within hubs, and improve the connectivity of multimodal transport facilities.

Strengthen the overall planning of regional hubs. At present, the development of China's comprehensive transportation hubs has entered a period of historical opportunity for system optimisation, network interconnections, and quality improvement. On the basis of promoting the integration of different modes of transportation, MFTHs are encouraged to be more integrated, intensive, people-oriented, and multifunctional and strike a dynamic balance between the supply and demand of freight hub services. From regional, urban, and strategic positioning perspectives, local transportation authorities need to consider the overall layout of facilities, network connectivity, support functions, transportation organisation, and service supplies. Efforts should be made to accelerate the optimisation of the entire multimodal transport hub system, guide hubs to become international and national comprehensive transportation hubs, encourage their intensive and large-scale development, and improve the overall efficiency of MFTH systems.

Improve the rapid collection and distribution capacity of hubs. It is suggested to promote the construction of railways and dedicated roads for major coastal and inland river ports, aiming at easing traffic congestion and contradictions in port and city development. Moreover, it is necessary to speed up the connection of high-grade highways with airports and railway stations, and encourage qualified logistics parks to plan and build dedicated railway lines and special collection and distribution channels, in order to achieve the rapid distribution of goods. Furthermore, it is recommended to strengthen the construction of highway collection and distribution stations in railway and air cargo hubs, and optimise "first and last mile" distribution channels.

(2) Foster leading MFTH enterprises

The MFTH evaluation index system proposed in this study includes indicators regarding the number and quality of enterprises settled in the hubs. The improvement of the quantity and quality of the enterprises in these hubs requires local competent transportation authorities to accelerate the cultivation of MFTH enterprises, especially the leading ones, using a certain scale. Local governments should speed up the cultivation of MFTH operators (enterprises) with cross-transport operation and resource allocation capabilities, and constantly work to improve the conditions and use efficiency of MFTH facilities. Furthermore, it is advised to encourage competent railroad, highway, waterway, and air freight enterprises, as well as postal express logistics enterprises, non-truck operating common carriers, non-vessel carriers, shipping brokers and agencies and other logistics enterprises to expand multimodal transport business and transform themselves into multimodal transport operators. Combined with the characteristics of local industries, it is suggested to actively cultivate professional multimodal transport service entities, in areas of commercial vehicles, cold chains, e-commerce express delivery, equipment leasing, station operation and information services, so that diversified service entities are encouraged to settle in MFTHs and expand their professional service scopes.

(3) Improve and implement local supporting policies

In order to promote MFTH evaluation and the application of related results, local transportation authorities need to improve and implement local supporting policies, and give appropriate funds and policy preference to the industry development benchmark hubs that actively participate in hub evaluations and have good evaluation results. Furthermore, it is necessary to strengthen financial support for the construction, operation, and maintenance of MFTHs that rank high in the evaluation, give priority to allocating provincial financial support funds, and coordinate and solve the problem of land use for MFTH reconstruction and expansion. Meanwhile, it's also essential to carry out dynamic monitoring of MFTH development by making full use of the Internet, big data and other technological means, assist in MFTH evaluations, and issue more specific policies and measures that guide MFTH development, based on MFTH evaluation results and local conditions.

(4) Establish local multimodal transport management agencies

According to feedback from relevant enterprises during the evaluation of the pilot hubs, local transport authorities should strengthen their levels of coordination and guidance for MFTH operations, since they involve multiple transport modes and governmental departments. It is suggested to conduct research and establish local multimodal transport management agencies, led by local transport authorities. Local multimodal transport management agencies would be responsible for: 1. Coordinating and undertaking MFTH development planning, business guidance, supervision and management; 2. Comprehensively connecting different modes of transport, such as railway, highway, waterway and civil aviation systems; 3. Effectively communicate and coordinate with other departments (in charge of development and reform, public security, finance, and commerce and trade); 4. Addressing major issues in the operation and management of MFTHs in a timely manner; 5. Promoting the refined management and guidance of MFTHs and; 6. Actively seeking to incorporate MFTH management into the important deliberations of local governments.

6.2 Operational recommendations for MFTH operators

(1) Focus on intensive and efficient development

The evaluation index system proposed in this study includes indicators on MFTH operation efficiency, such as transfer times of multimodal transport containers (or cargo), which requires MFTH operators to improve facility arrangements for the conversion between different transportation modes, improve the modernisation of facilities and equipment, optimise cargo transfer process between different transport modes, realise the centralised and rapid transhipment of goods, and create an efficient multimodal transport operation platform. Aviationoriented integrated freight hubs need to concentrate on the layout of cargo terminals and storage, air express processing centres, postal express processing centres, and other related facilities, while also optimising the streamlining of operations, expanding the depth scale of freight areas, and reserve space for future expansions. Railway-oriented and water-oriented integrated freight hubs need to focus on the overall layout of specialised facilities and related equipment such as container intermodal transport options, and gear needed for loading, unloading, and stockpiling, as well as short barges, so as to improve the efficiency of multimodal transport systems.

(2) Optimise hub transportation organisation

The evaluation index system proposed in this study contains indicators concerning the function of actions taken for the organisation of modern transportation systems. It is suggested that MFTHs should focus on optimising transportation organisation efforts, actively upgrade and expand diversified station facilities (including loading and unloading equipment), as well as promoting innovative practices (such as drop and pull transport, piggyback transport, China Railway Highspeed (CRH) express, double-deck container transport, and online freight platforms). Qualified MFTHs can improve their capabilities to provide diversified services by developing systems relating to cold chain and emergency logistics, together with those relating to handling, storage, and transfer sites for hazardous chemicals and other special cargo. Overseas transfer centres also need to be built, and support needs to be in place for distribution networks and business outlets to extend their service chains and improve the global marketing capabilities. Enterprises settled in MFTHs, the operators of railways and ports, shipping companies, freight forwarders, and customs administrations offices are encouraged to provide one-stop services, so as to reduce the cost and increase the efficiency of MFTH services.

(3) Expand hub functions

The evaluation index system proposed in this study includes indicators relating to the functioning of expanding services. It is suggested that MFTHs should actively expand their service functions beyond transportation, when conditions are mature. The first category of expansion is regarding financial logistics services, including warehouse receipt pledges, bill of lading pledges, bonded warehouses, agent purchases, advance payment for goods, collection on delivery, and factoring. The second category of expansion relates to government and business services, including industrial and commercial affairs, taxation, insurance, customs, national inspections, and financial services. The third category of expansion is regarding supporting services, including parking, accommodation, catering, refuelling (gasoline and battery charging), property, repairs, shopping, and entertainment.

(4) Promote IT application and data sharing

The evaluation index system proposed in this study includes indicators regarding integrated MFTH information platforms. MFTH enterprises need to follow state macro guidance, improve their business management information systems, provide external information service interfaces in accordance with the multimodal transport information exchange standards, release service information on the arrival and departure of goods in an orderly manner, as well as on the status of inbound and outbound stations and flight schedules. MFTH operators are encouraged to promote the application of multimodal transport information exchange standards, and strengthen their information sharing and business cooperation strategies with other enterprises. In addition, MFTH operators are advised to integrate information resources, promote basic data exchange between different transport modes and different departments, and provide one-stop information inquiry, data exchange and conversion services for manufacturers, traders, and carriers. Moreover, it is necessary to promote the application of advanced information technologies such as the mobile Internet and IoT to improve the visual management and intelligent service of the whole multimodal transport process.

(5) Make MFTHs safer and more reliable

The evaluation index system proposed in this study contains indicators for the number and severity of production accidents. MFTH operators should stick to the concept of “Life first, safety first”, and assume the primary responsibility in safe production strategies, improve safety production management systems, and provide professional production safety management personnel and special funds. In view of the technical characteristics of their operational roles, MFTH operators are requested to urge production staff at all levels to strictly implement safe technical operation procedures, and strengthen the standardised management of cross-modal handover safety operations. In addition, they also need to strengthen safety supervision and inspection systems, timely remove potential safety hazards, and coordinate the maintenance of hub facilities and equipment overhauls to avoid major accidents. In addition, efforts should be made to regularly organise training on safety production and improve the level of security prevention through manpower, material resources and technology. Finally, MFTH operators are advised to strengthen life cycle safety management planning, strictly carry out safety risk assessments, formulate emergency response plans, and ensure production safety in all aspects of MFTH systems, including hub planning, construction, operation, management, and maintenance, in order to continuously improve their abilities in promoting safe production strategies and emergency response plans.

(6) Build low-carbon and green MFTHs

The evaluation index system proposed in this study includes a number of green and low-carbon indicators. It is suggested that MFTHs improve land utilisation by making full use of relevant spaces, such as multi-story warehouses, high rack warehouses, and container yards. Moreover, it is necessary to orderly promote the construction of charging stations, supporting power grids, refuelling (gas) stations, hydrogen refuelling stations and other infrastructure for MFTHs, and increase the proportion of new energy and clean energy loading and unloading equipment and transfer vehicles used in MFTHs, as well as promote the use of shore power for ships in ports. Efforts should be made to promote the green upgrading and renovation of existing MFTH facilities. Priority shall be given to the use of renewable or clean energy heating systems and heat pump cooling technologies for Heat, Air Ventilation, and Cooling (HVAC) equipment, natural ventilation for warehouses, and energy-efficient air conditioners for constant temperature and cold storage settings. Other intelligent energy-saving measures also need to also be taken. For example, it is advised to enhance the configuration of energy-saving equipment such as electric forklifts and electric tractors, and continuously improve the energy-saving and intelligent control levels of hub lighting and electrical appliance. Attention must also be paid to the treatment of water pollution, acoustic environmental pollution, garbage, and waste in the hubs. Moreover, it is necessary to optimise the space layout of MFTHs and reduce the average transit distance of cargo, so as to reduce energy consumption and carbon emissions.

6.3 Outlook and recommendations for MFTH evaluation in China

6.3.1 Prospect of MFTH evaluation in China

The Chinese government attaches great importance to the development of multimodal transport, and has incorporated the MFTH evaluation into the related 14th Five-Year Plan. The MOT and the National Development Report Commission (NDRC) have implemented the multimodal transport demonstration project, thus laying a good social foundation for further promoting MFTH evaluation in China in its next phase. All these factors contribute to bright prospects for the evaluation of MFTHs in China.

(1) The government values multimodal transport development and plans to promote MFTH evaluation

The government attaches great importance to the development of multimodal transport. In recent years, the Chinese government has successively issued a series of documents to promote the development of multimodal transport, such as the Notice on Further Encouraging Multimodal Transport Work[3]. In February 2021, the CPC Central Committee and the State Council jointly issued the National Comprehensive Transport Network Planning Outline, clearly proposing to "improve the efficiency of multimodal transport and logistic service", and "promote the construction of multimodal transport logistics parks and special railway lines".

The MOT has included MFTH evaluation in its "14th Five-Year Plan". In November 2021, the MOT issued the 14th Five-Year Plan for Development of Comprehensive Transportation, listing 19 dedicated action plans, the first of which is the improvement of comprehensive transportation hub services. Specifically, it aims to "improve the service of the comprehensive transport hubs for both passengers and freight by establishing an evaluation index system, conduct the service ability evaluation, and continuously improve the level of connection, transfer, collection and distribution capacity, transhipment efficiency, operation management efficiency, together with informatisation and intelligence of comprehensive transportation hubs". The above statement provides an important basis for the promotion of MFTH evaluation in China.

(2) Favourable social foundations to carry out MFTH evaluation

In recent years, the MOT and NDRC have implemented three batches of national multimodal transport demonstration projects. The MOT and NDRC have strengthened supervision and guidance on the implementation of demonstration projects, and have kept related partners and offices informed of the progress and existing problems of demonstration projects of multimodal transport, and initially formed a batch of replicable and promotable experience models for the development of multimodal transport hubs. By participating in the establishment of demonstration projects, MFTH enterprises have improved their service quality and corporate brand image, thus laying a good social foundation for the promotion of MFTH evaluation in China in its next stage. China promotes the evaluation of multimodal freight hubs, which can be applied first to hubs in multimodal demonstration projects and then gradually expanded to other hubs.

6.3.2 Suggestions for MFTH evaluation

(1) Continuously improve the evaluation index system

A scientific and reasonable evaluation index system is a reliable tool to measure the development of MFTHs, which have multiple functions, long chains of systems and processes and diverse elements. It is necessary to continuously adjust and improve the evaluation index system according to the progress of evaluation work and changes in external factors such as socio-economic development. It is also possible to develop a more detailed evaluation index system for different types of MFTHs in the future so that the evaluation can play a better role in guiding and serving MFTH development. In the future, a more detailed evaluation index system can be studied for different types of MFTHs.

(2) Establish a pragmatic and efficient evaluation mechanism

MFTH evaluation is a systematic project, involving a large number of departments and enterprises, a large amount of data, and complex work procedures, which requires the establishment of a pragmatic and efficient evaluation work mechanism. It is therefore recommended to establish and improve the data statistics system and guide MFTHs to pay attention to the statistics of relevant indicators such as carbon emission intensity. In addition, efforts should be made to improve the means of obtaining evaluation data. Information should be collected in various forms such as network surveys, telephone surveys, in-depth interviews, field investigations, symposiums, E-mail questionnaires, and government and association data collection activities, so as to ensure the timeliness and accuracy of the base of MFTH evaluations.

(3) Make full use of industry associations and scientific research institutions to carry out MFTH evaluations

As important bridges between governments and enterprises, industry associations and scientific research institutions are eligible to undertake MFTH evaluation work, which would not only use their great advantages in indicator research, survey organisation and result application, but also give full play to their main role in providing decision support for industry development and promoting the vigorous development of MFTHs.

(4) Focus on the publicity and application of the evaluation results

Evaluation results can be used as a basis to measure the service capabilities of a single hub or the development of the entire transport industry. In addition, the results can also become an important tool for identifying problems, promoting competition among hubs, and promoting the high-quality development of the transport industry. It is recommended to release the Annual Report on the MFTH Development Quality based on the evaluation results, which can summarise the annual development of MFTHs, provide excellent cases for the industry to learn from, look forward to future development directions and trends, and increase the amount of attention that the entire industry receives. Furthermore, competent authorities and MFTH operators are also advised to summarise, replicate, and promote their typical experiences in terms of infrastructure construction, service capacity enhancement, operation improvement, social benefits, safety guarantees, and green and low-carbon development, so as to provide useful, replicable, and effective references for other MFTHs.

References

[1] Notice of the State Council on Printing and Distributing the Medium and Long-term Plan for the Development of Logistics Industry (2014-2020) ([2014] No.42).

[2] Action Plan for the Construction of Logistics Corridors (2016-2020), issued by the Ministry of Transport, and National Development and Reform Commission ([2016] No. 217).

[3] Notice of the Ministry of Transport and Other Eighteen Departments on Further Encouraging Multimodal Transport ([2016] No.232).

[4] Notice of the General Office of the State Council on Printing and Distributing the Three-Year Action Plan for Promoting Transportation Structure (2018-2020) ([2018] No.91).

[5] Notice of the Ministry of Transport of the National Development and Reform Commission on Printing and Distributing the National Logistics Hub Layout and Construction Plan ([2018] No.1886).

[6] Announcement of the First Batch List of Multimodal Transport Demonstration Projects, issued by the General Office of the Ministry of Transport and the General Office of the National Development and Reform Commission on ([2016] No. 79).

[7] News from the website of National Development and Reform Commission: the list of the second batch of multimodal transport demonstration projects (https://www.ndrc.gov.cn/fggz/jjyxtj/xdwl/201711/t20171124_11825 42.html).

[8] Announcement of the Third Batch List of Multimodal Transport Demonstration Projects, issued by the General Office of the Ministry of Transport and the General Office of the National Development and Reform Commission on ([2018] No. 146).

[9] Notice on the Construction of National Logistics Hubs in 2019 ([2019] No. 1475).

[10] Notice on the Construction of National Logistics Hubs in 2020 ([2020] No. 1607).

[11] Guidance on Accelerating the Construction of Special Railway Lines (Development and Reform Foundation [2019] No. 1445).

[12] Sohu News: Wuhan Railway has reduced carbon dioxide emissions by 16,800 tons this year (https://www.sohu.com/a/318763432_459908).

[13] Hourly News: 38% increase in capacity! The first domestic double-decker container sea-rail intermodal train debuts at Zhoushan Port (https://www.thehour.cn/news/221518.html).

[14] The Three-Year Action Plan to Deepen the Development of Multimodal Transport in the Yangtze River Economic Belt ([2018] No. 104).

[15] Jin Lin. The Development of Multimodal Transport in the Yangtze River Economic Belt under the New Situation [J]. Ports of China, 2020 (04):57-60.

[16] The Implementation Opinions on Further Promoting the Development of Multimodal Transport in Hebei Province ([2019] No. 275).

[17] The Implementation Plan for Promoting the Adjustment of Transport Structure in Tianjin ([2018] No. 58).

[18] The State Council Information Office website: Tianjin port “sea and rail transport” helps to accelerate the “Belt and Road” construction (http://www.scio.gov.cn/m/ztk/wh/slxy/31208/ document/1483142/1483142.htm).

[19] The Implementation Plan for Promoting the Adjustment of Transportation Structure in Guangdong Province ([2019] No. 8).

Annex

Evaluation Form of Multimodal Freight Hubs Status

Name of indicator	Reported data	Instructions for filling out the form
1. Logistics operating area	The logistics operation area is _____ square metres.	It includes wharves, railway loading and unloading lines, roads, warehouses, yards, canopies, distribution and processing sites, truck parking lots, loading, and unloading sites, information service sites, etc., excluding living and business support sites.
2. Connection of intermodal transport facilities	The hub has _____kinds of effective transport connectivity, including _____ (please choose among road, rail, waterway, and air). The rail loading and unloading lines or dedicated lines (if available) _____ (have/ have no) access to the logistic park. Moreover, berths (if available) _____ (are/ are not) located within the hub boundaries.	Effective transport mode connectivity means that the hub is within 5 km of highway entrances and exits, rail freight yards, terminals, and airports.
3. Level of transport hub city	The located hub city _____ (is /is not) national-level logistics hub, its positioning is _____ (please select international, national, regional, local, others) integrated transport hub.	
4.Maximum annual capacity of multimodal containers	The maximum number of intermodal containers that can be transported at the hub per year is _____ TEU/year.	It refers to the hub's multimodal container design capacity, not the actual throughput.
5.Modern transport organisation function	(1) It supports modern modes of transport such as drop-and pull transport and bump transport. _____ (Yes/No). (2) It supports cold chain logistics transport. _____ (Yes/No). (3) It operates international routes (or flights). _____ (Yes/No).	
6. Integrated information platform function	(1) The hub integrated information service platform can realise the basic data exchange between different modes of transport. _____ (Yes/No). (2) The hub integrated information service platform can realise the basic data exchange between different departments. _____ (Yes/No). (3) It supports multimodal transport single order system. _____ (Yes/No).	
7. Multimodal container transit time	The average time for a domestic intermodal container to arrive at a hub and change to another mode of transport is _____ hours.	

Name of indicator	Reported data	Instructions for filling out the form
8.Overall customs clearance time	It has a port function. _____ (Yes/No). The average time allowed for cargo removal from arrival port to departure port is _____ hours.	This includes the time-consuming process of arrival, loading and unloading, stowage, handling, declaration, inspection, release, pick-up, and departure of cargo.
9.Radiation range	(1) The hub organises the operation of lines (trains, flights) covering the main cities in the province _____ (fill in at least three, excluding the city where the hub is located, if not fill in "none"). (2) The hub organises the operation of lines (trains, flights) covering major cities in China _____ (fill in at least 3, excluding cities within the province, if not fill in "none"). (3) The hub organises the operation of lines (trains, flights) covering major cities in Asia _____ (fill in at least 3, excluding domestic cities, if not fill in "none"). (4) The hub organises the operation of lines (trains, flights) covering major cities in the world _____ (fill in at least 3, excluding cities in Asia, if not fill in "none").	
10. Multimodal Container throughput	In the previous year, the hub completed an intermodal freight container volume of _____ TEU.	
11. Total revenue from logistics operations	In the previous year, the sum of the revenues generated by the hub through logistics business activities was _____ billion.	It includes revenue from logistics operations such as transportation, storage, loading and unloading, handling, packaging, distribution and processing, and information services.
12.Number of settled companies	The total number of settled companies within the hub is _____.	
13.Quality of settled companies	There are 3A-level and above enterprises _____ in the hub.	Logistics enterprises are identified based on the Classification and Assessment Indicators for Logistics Enterprises (GB/T 19680-2013).
14.Proportion of online logistics transaction	(1) In the previous year, the total transaction value of the hub logistics services were_____ billion RMB. (2) In the previous year, the transaction value of logistics services achieved by the hub through online platforms (including those built by the hub itself) was _____ billion RMB.	
15.Amount of tax per unit area	In the previous year, the hub completed tax collections of _____ billion RMB.	

Name of indicator	Reported data	Instructions for filling out the form
16. Number of production safety accidents	In the previous year, the number of safety accidents in the hub was _____, of which the number of general accidents was _____.	The criteria for identifying and classifying production safety accidents refer to the Regulations on the Reporting and Investigation and Handling of Production Safety Accidents.
17. Land saving	No need to fill in the form.	
18.Environmental protection	(1) There are excess wastewater discharges within the hub_____. (Yes/No). (2) Noise meets the requirements of GB3096. _____ (Yes/No). (3) Effective separation of waste collection and disposal has been implemented, and the waste collection station has airtight measures to reduce the escape of odours, etc._ ____ (Yes/No).	
19.Energy-saving equipment	(1) HVAC equipment uses renewable or clean energy heating systems, and heat pump cooling technologies, etc._____ (Yes/No). (2) Natural ventilation is preferred in warehouses. _____ (Yes/No). Constant temperature storage and cold storage uses energy-saving air conditioning equipment or other intelligent energy-saving measure have been adopted. _____ (Yes/No). (3) The hub is equipped with electric forklift, electric tractor, electric platform conveyor, shuttle vehicle (RGV) or other energy-saving equipment. _____(Yes/No). (4) The oil-to-gas energy saving technologies have been applied, with the utilisation rate ≥ 30%. _____ (Yes/No). (5) New energy supply stations such as charging stations or gas refilling stations have been built at the hub. _____(Yes/No).	
20.Electric lighting	(1) LED light source usage rate reaches 90% or more. _____ (Yes/No). (2) Distribution transformers reach level 1 energy efficiency according to GB 20052. _____ (Yes/No). (3) The pumps and fans meet the energy saving evaluation value requirements of GB19762 and GB19761, respectively. _____ (Yes/No). (4) In terms of indoor public lighting system, energy-saving control measures have been adopted, such as division of different areas, setting the time, and infrared induction. _____(Yes/No). (5) The street lighting system can automatically start and stop according to the outdoor illumination level and the set time. _____ (Yes/No).	

Name of indicator	Reported data	Instructions for filling out the form
21.Utilisation rate of new energy vehicles	New energy vehicle usage rate is _____%.	It refers to the proportion of new energy freight vehicles owned by the park to the number of freight vehicles owned by the park, excluding vehicles owned by others.
22.Carbon emission intensity	(1) In the previous year, the cargo throughput was _____ million tons/year. (2) In the previous year, energy consumption by different types: including electricity _____ kWh, natural gas _____ tons, ... (please add other energy types).	

Note: If an indicator cannot be filled in, please briefly explain the reason, e.g., no relevant statistics or confidential data, etc.

Deutsche Gesellschaft für
Internationale Zusammenarbeit (GIZ) GmbH

Registered offices
Bonn and Eschborn, Germany

GIZ in China
Tayuan Diplomatic Office Building 2-5
14 Liangmahe South Street, Chaoyang District 100600 Beijing, P. R. China

T +86 (0)10 8527 5589
F +86 (0)10 8527 5591
E info@giz.de
I http://www.giz.de/china