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The Study and Modeling for the Construction and Application of a Comprehensive Transport Hub

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Abstract: This study describes the concept and significance of the construction of comprehensive transport hub in national transportation. The core character that a comprehensive transport hub must have and the content of the integration construction are illustrated. The concept and the assessment index of the maturity for comprehensive hub is put forwarded. The evaluation for comprehensive transport hub is discussed in aspect of maturity. The function and the effect that the comprehensive transport hub must possess are analyzed elaborately. The construction method is indicated in the meanwhile. At the end of the study, how to build a comprehensive transport hub is described by adopting a practical example. Referencing the conclusions of the study, the construction of comprehensive transport hub can be guided, the building level of the comprehensive transport hub can be evaluated, the comprehensive service level can be enhanced, the cost of transportation can be reduced and the transport resources can be optimized.

Key words: Comprehensive transport hub, multimodal transportation, assessment index, maturity, integration construction

INTRODUCTION

Comprehensive transport hub is the cross and cohesion for facilities which consists of more than two types of transportation (Wang, 2002). It handles the transfer and transmission of the passengers and freight transportation under the needs of the complex. The comprehensive transport hub generally includes all kinds of facilities such as the station, port, airport and shipping lines, transportation of loading and unloading, departure port, transfer, transport, repair, maintenance, security, navigation and supplies. Comprehensive transport hub is the national comprehensive systems of transportation which become as an important compose part of coordinated operation, organization of combined transport. In recent years, the boosting impact of comprehensive transport hub on national economic development became more and more remarkable along with the rapid development of China's transportation.

THE CONCEPT AND SIGNIFICANCE OF THE COMPREHENSIVE TRANSPORT HUB

The comprehensive transport hub can become various transportation and construction center by using various modes of transportation and related transportation routes of connecting link. Also it can integrate the urban and regional transportation to become

an important transportation center resource and the catalytic medium of the upper and lower industry.

The structure and the principle of the comprehensive transport hub: There is a comparison between the construction of a transportation system with and without a comprehensive transport hub in Fig. 1 and 2.

If there is no comprehensive transport hub (Fig. 1), the transportation among each site can only be completed by the nonstop form of point to point. In addition, there are only flows of passengers and goods from the start point and the destination. The scale effect can be not formed for the small transportation volume under this mode. It wastes the transportation capability and the land source with the high cost of transportation. In the meanwhile, dispersive line network can cause scattered flow of human being and goods, management and services. This will not be good for forming professional coordination and distribution of responsibility. And make the facilities, industry, services system construction at a low level. Even it can cause vicious competition and economic bubble by repeated construction. Thus, the transportation system without a comprehensive transport hub cannot meet the requirement for modern economic developing.

In contrast, if a comprehensive transport hub is established (Fig. 2), then it will form the traffic system of point-the hub-point. Each site can arrive any other places

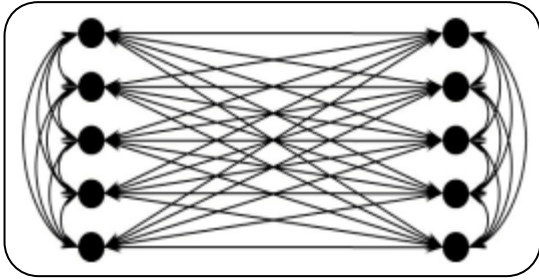


Fig. 1: Transportation system without a comprehensive transport hub

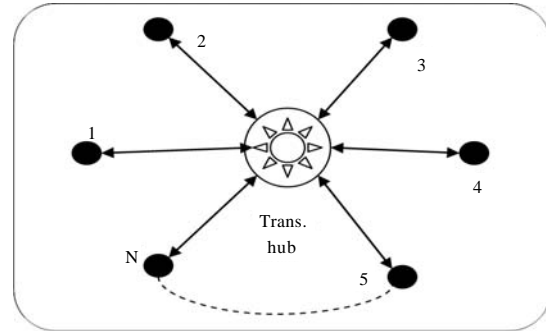


Fig. 3: Comprehensive transport hub with N radiation traffic lines

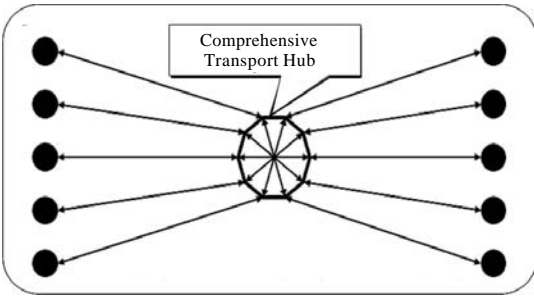


Fig. 2: Transportation system with a comprehensive transport hub

within the area only by linking and transferring through the established contact to the transport hub. By this way, complicated transportation network is greatly simplified and the consumption of the land resources and energy will be decreased significantly. The same investment can benefit larger scale of construction of line network. More diverse choice of line, time and destination can be provided to flows of passengers and goods which pass through the transport hub due to the connection between the line networks and the hub. The line network is optimized when simplified. And the arriving capability is enhanced in each site. In addition, there are many options which include different mode and operation of transportation with different technical characteristics. The flows of passengers and goods can choose most appropriate transportation process in according to their own demands in order to achieve the best balance of time cost, space cost and the expected benefits.

In a comprehensive transport hub with N radiation transport lines, a complete network hub can be constituted by seamless links of every line, transport and arbitrary thread. A complete transport network hub is constituted by $N * (N-1)$ connecting traffic flows. If each of the N lines has M shifts of the transport services, the ideal network is a completely connectivity by MMN^*

($N-1$) of divisions and transmissions. The comprehensive transport hub can improve the space connectivity, expands the transportation market. It expands N markets to N^* ($N-1$) markets. At the same time, the comprehensive transport hub can enrich the passengers' travel choices. The passengers' choices will be expanded from MN options to MMN^* ($N-1$) options. It is shown in Fig. 3.

The comprehensive hub network can make transport enterprises provide different services (Yuan *et al.*, 2001). On the one hand, extended service projects can develop the value-added products that will obtain high value-added income, on the other hand the extended transport service products and its market penetration and universality will satisfied all the potential transport demands.

The core content of construction a comprehensive transport hub: The reason for developing of comprehensive transport hub is the demand of transfer or transshipment. The foundation of comprehensive transport hub is the operation of cross connecting transportation.

We need transshipment because a single transportation mode always can not access the destination directly. And the optimal transportation objective of the passengers and the owners of the goods can be achieved by various types of transportation or transfer and reloading.

These optimal objectives include the minimum cost, the shortest distance, the shortest time, the most suitable departure and arrive time, the lowest pollution discharging, etc. These produce a special demand of service which for passengers and goods of transportation.

The connecting transportation is an organization of business that includes the connected routes, the modes, the task and the price of the transportation.

It is a basic demand that to integrate the various types of transportation or the multiple lines in according to unified link up. The production planning must also be draw up and operated uniformly.

The objective of the transfer reloading service is to achieve seamless connecting in overall process. The way to fulfill this aim is to providing individualized connecting services to the passengers and the goods.

The main operation of comprehensive transport hub is the integration construction, including transportation integration, transfer reloading service integration, information processing integration, financial settlement integration and hub facilities integration.

Information processing integration is to establishing a joint platform for comprehensive transport hub, transportation enterprise, carrier, shipper forwarders, freight and passengers. It provides transportation reservation, booking tickets, transport process monitoring, information release and statistics of the relevant information service etc.

Financial settlement integration for transport enterprises provides integrated transport fares and income distribution of the financial settlement services. Hub facilities integration is a synthesis of transfer and reloading facilities according to "zero distance transfer" and "seamless connecting" of humanization and the rules of efficiency.

The power for promoting the comprehensive transport hub is the economic effect of scale economy, the economy of scope and the agglomeration economy (Chen *et al.*, 2004).

Economy of scale reflects the intensive utilization of land, the big scale delivery vehicles, the high grade mode of transportation, the high load of transportation and the high rates of arrive and departure.

Agglomeration economy reflects the convenient transportation, logistics gathering and business gathering lead to trade, finance, real estate, information and related manufacturing industry cluster.

Economy of large scope reflects the combined transportation increasing, category and combination scheme for market growth, economic effects from the marginal cost reducing and marginal gains increasing.

THE FUNCTION OF THE COMPREHENSIVE TRANSPORT HUB

As a principal hub node of the national transport network, the comprehensive transport hub undertakes several transport modes. It possess six important functions which includes transport organization, transfer and reloading, storage of loading and unloading, multi-model transportation, information circulation and assist

service. It has an important impact for high efficient operation at the local site:

- The transport organization management is the soul of the comprehensive transport hub. It bears the important mission for organizing, managing, dispatching and commanding. The aim for transport management is to make the owners of the vehicles, owners of goods, passengers and enterprises acquire optimum benefit by providing service, efficiently organizing the transportation for all society and enhancing efficient of transportation
- The transfer and reloading will provide the passengers with convenient service between the different lines and between the different transport modes by using the excellent transport position so as to achieve "zero distance transfer" among each transport modes. The function of reloading will provide the cargo transferring with convenient condition between different transport modes and between transport lines by reasonable organizing for multi-model transportation so as to achieve "seamless connecting" among each transport modes
- The function of loading, reloading and storage will provide cargos with convenient service for transferring, reloading, processing, storing, packaging, selling by using automatic facilities and prefect organization managing of comprehensive transport hub
- The function of multimodal transportation will achieve the conversion between the different transport modes by using the convenient transfer condition of comprehensive transport hub. It possesses the uniform and simple characteristics. Also it can reduce middle procedures, shorten the time of cargo transportation, lower the goods losing accident, improve the quality of transportation, reduce the cost of transportation, save the expenses of transportation, enhance the organizing level and realize the reasonable transportation
- The function of information communication will satisfy the demands of passengers for traveling and transferring by using modern information communication technology, computer technology (such as EDI technology, GPS, GIS, Bar Code etc.) and internet technology. It also provide the place which the comprehensive hub is located with information service by network tickets booking, remote ticket selling between different cities, network ticket booking between railways and airlines, information inquiring, information analyzing, information processing, ticket processing, cargo tracking and information deservig

- The function of production and life assistant will provide passengers and stewards with necessary assistant service for board, lodging, shopping, entertainment, communication. It also offers transport vehicles with the service for detecting, maintaining, repairing, refueling and washing

EVALUATION OF COMPREHENSIVE TRANSPORTATION HUB

How to evaluate a comprehensive transportation hub?

- If a station is a transport hub or not mainly depends on that whether there are the needs for transfer reloading and the business for connecting multi-mode transportation
- If a city is a hub city or not mainly depends on that whether there are the needs for transfer reloading and the service for connecting multimodal transportation
- If a stations and city is a comprehensive hub or not fundamentally depends on that whether there are various modes of transfer reloading and the business for successive and multimodal transportation
- The transfer reloading between various transportation modes is identification of comprehensive transport hub for the feature of marketing demand
- The transfer reloading is a seed for a comprehensive transportation hub. The connecting transportation is a foundation for a comprehensive transportation hub
- The successive and multimodal transportation between various transport modes is identification of comprehensive transport hub for the feature of production supply
- Only when the conditions for demands and supply exist in the meantime, the station and the city can be called comprehensive transport hub

The foundation of comprehensive transport hub: Successive and multimodal transportation is the foundation of comprehensive transport hub. To complete the successive and multimodal transportation must establish an operation organization by a single transport enterprise or the transportation enterprise alliance firstly. Then this organization will integrate the effective resources and build up a zero distance outfit, seamless transfer transportation network. It also will integrate any mode of transport of individual transport divisions and lines set into an organic one so as to facilitate passengers, baggage and goods from a departure site to destination through one or more transfer station.

This organization is a modern transportation business form that linked with lines, transshipment transport divisions, transfer service and transportation of price (Zhang, 2009). It can maximize the advantages of various transportation enterprise, transportation mode, divisions and lines. For passenger and cargo it can offer more options, convenient and economical service. Also it will enlarge the transportation market.

Maturity of the comprehensive transport hub: Indubitably, the station with transfer can be called transport hub, but only the station with successive and multimodal transportation can be called comprehensive transport hub. Obviously, the quantity of transfer for passengers and goods must attain a certain “degree of concentrate” and successive and multimodal transportation must attain a certain “intension of integration” so as the station yet can be definitely called “comprehensive hub” without controversy.

The “degree of concentrate” of the transfer service for the passengers and the goods and the “intension of integration” of the successive and multimodal transportation will be totally called the maturity of the comprehensive hub. It is shown in Table 1.

The maturity of the comprehensive can be divided into three types: the low maturity, the middle maturity and the high maturity. The specific criterion for the maturity of integration as following: demands for transfer, transportation integration (which includes all service in one ticket, directly baggage transportation, connecting multi-line price), information integration (which includes remote booking, monitoring the procedure of transportation, information releasing, data statistics), service integration (which includes guiding identification, specialized service of transfer, individualized service), finance integration (which includes price accounting, pay and collect accounting, finance service), fundamental infrastructure integration (which includes zero distance transfer, seamless transfer).

The comprehensive transport hub with low maturity has the demands for transfer, the passengers who will transfer are on the ratio for 4-20%. On the hand of information integration, it can support remote booking and has guiding identification in the hub.

The comprehensive transport hub with middle maturity can realize all service in one ticket, directly baggage transportation, information release and statistics. Passengers who will transfer are on the ratio of 20-40%. Also it can realize the functions of individualized service for transfer, mutual-mode transport price account, zero distance transfer and seamless connecting.

The passengers from the comprehensive transport hub with high maturity who will transfer are on the ratio of

Table 1: Maturity of the comprehensive hub

Grade of maturity				
Essential Features	Particular features	Low	Middle	High
Transfer demands integration	The ratio of passengers and goods which need transfer	4%-20%	20%-40%	40%Transport
	All service in one ticket		✓	✓
	Directly baggage transportation		✓	✓
Information integration	Connecting multi-line price			✓
	Remote Booking	✓	✓	✓
	Monitoring the procedure of transportation			✓
Service integration	Information releasing, data statistics		✓	✓
	Guiding identification, specialized service of transfer	✓	✓	✓
	Individualized service		✓	✓
Finance integration	Price accounting		✓	✓
	Pay and collect accounting			✓
	financing service			✓
Fundamental infrastructure integration	Zero distance transfer		✓	✓
	Seamless transfer		✓	✓

above 40%. This high maturity comprehensive transport hub can realize the function of connecting multi-line price, monitoring the procedure of transportation subjectively, personality service, payment account for transport enterprise and agency, providing transport enterprise and agency with financial and investment service, collect and remit.

Obviously, the strength of the connecting for the hub depends on the quantity of the transfers and the amount of the connecting transport lines. The quality of the connecting depends on the developing level of integration for the hub facility, transportation, information, service and finance accounting. Only the hub with high maturity is the comprehensive hub indeed.

CONSTRUCTING A COMPREHENSIVE PASSENGER TRANSPORT HUB

The construction of comprehensive passenger transport hub will be discussed at the following paragraph.

The factors and conditions that must be first considered in constructing comprehensive transport hub includes multiple politics, developing level and scales of the economy, culture, natural conditions, geography locations, original foundation and developing conditions of transport network and infrastructure. The construction of comprehensive passenger transport hub must satisfy the demands from different passengers to complete the uniform planning for multi-type transportation and harmonize developing. The three aspects of facilities distribution, transfer design and transport organization will be planned which facing passengers stream for collecting and dispersing of comprehensive transport hub. Finally it will accomplish “hierarchy locating, multi-dimensional transferring, organizations partitioning, public transportation taking precedence, considering people as a base”.

There need to be a comprehensive transport system with multi-types facilities which has been balanced developed to satisfy the requirement for smoothing of the transportation.

The facilities of the roads and the public passenger transportation must be developed balanced firstly. The transport system must satisfy the moving of the vehicles, also must considerate the efficiency of the passenger transportation in the meanwhile. The public transport facilities will be building in large scale at the palace where will have quantity of passengers. And the track transportation will be developed powerfully. The traffic stream must be reduced.

A transport linking system must be built as a core. The multi-mode transportation, the personal transportation and the public transportation, the urban and the external transportation must be linked effectively by using the transport linking system so as to express the entirety benefit. It will provide the bus passengers with convenient transfer conditions by using the compact set station. By using the traffic facilities in compact linking routes in the comprehensive transport hub city road, rail connection, railway station and highway facilities and external station etc, it will improve the passenger travel efficiency and reduce the cost of travel.

There usually used to build some high-grade transport highways and railways for connecting the surrounding cities and the passenger transport hub. It will provide a convenient transferring and arriving for passengers from surrounding cities. There also could be a connecting for the roads, railways and public transportation.

The construction of passenger transport hub is not a simple link in a traditional way. It is a modern comprehensive transport hub with the function of successive and multimodal transportation based on the linkage transport integration, service integration and information processing outfit integration, financial

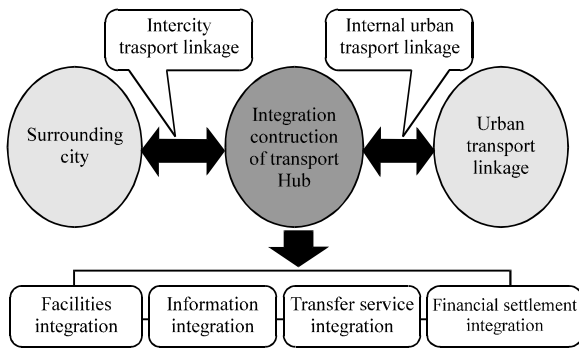


Fig. 4: The construction of passenger transport hub

settlement integration and hub facilities integration. Integrated transport hub can improve the transportation efficiency and ability. Also it will provide people with more convenient travel. It can be seen in Fig. 4.

CONCLUSION

The comprehensive transport hub is a comprehensive system which can provide excellent services with the feature of safe, quick, convenient, comfortable, economy to the users of transportation for passengers and goods. Its essence is to provide a higher level and more general passenger and cargo transportation services with the more economical cost, more efficient and convenient services and smaller environmental loss. The large-scale

transportation mode and the high grade for the universality of the transportation service can be realized only rely on the comprehensive transport hub. The aim of providing a safe, quick, convenient, comfortable, economy and excellent service can be achieved only by forming a modern comprehensive transportation system.

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