A Study on China City Cluster Integrated Ecological Transport Development Strategic Planning, Policy and Integrated Transport Planning Guidelines

Shanghai WSP
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1 INTRODUCTION

1.1 Study Background

China's urbanisation is a unique process in the global process. During 1981-2011, China's urbanisation rate has increased from 20% to 50% (51.3% in 2011), whilst the US took 6 decades to finish the same process. On average, the developed countries have taken 85 years to accomplish this achievement during 1870-1955.

The urbanisation process in China occurred mainly after 1978 when the reform and opening policy was carried out. China’s rural reform generates surplus labours. And the urban economic reform and construction in coastal areas creates large demand of employment. Rural labours began to migrate to urban areas. Meanwhile, the education and rapid development of coastal cities attracts large amount of rural population. The development of town enterprises promotes the expansion and urbanisation of small towns. China’s urbanisation is concentrated in developed east coastal areas. In 1990, China’s urbanisation has expanded to inland areas. After the 1990s, urbanization spread from east and south coast to the inland areas. By the end of 2015, China mainland has a total population of 1.37 billion with an urban population of 770 million which accounts for 56.10% of the total. [4]

After 30 years’ urbanisation process, city clusters with different densities and development levels begin to emerge across China. CCs are the groups consisting of cities with compact geographic distances, strong socio-economic connections and developed transport networks. The concept of CC involves metropolitan and megalopolis, and refers to a region with high urban density.

Specifically, to undertake this study has following backgrounds and significance:

- Boost economic development
- Implement national urbanisation and regional development strategy:
- Support the development of the Motorisation and intercity rapid transport network:
- Support China’s comprehensive transport network planning:
- Address the challenges of resources and environment, global climate change and urban development issue

Based on the above contexts, the Global Environment Facility (GEF) has funded MOT to conduct the study ‘China City Cluster Integrated Transport Development Strategic Planning and Policy Study.

1.2 Study objectives

The aims of this project is to

- Comprehensively consider CCC regional institution, transport institution and further development trend. Based on the principals of low-carbon integrated transport and equalization of public service, the study proposes CCC integrated eco transport development strategic planning and policy suggestions and provides technical guidance of CCC transport planning;
- Propose the overall development orientation, strategic focuses, implementation methods and safeguard measures for CCC integrated eco transport and provide technical references for the of CCC transport strategy & policy making of MOT
- Propose CCC integrated eco transport development policy framework, which can guarantee the achievements of transport development objectives and provide references for the policy making and suggestions of MOT.

This study aims to propose multi-modal integrated transport strategic planning, policy and technical guidelines recommendations for China city-clusters in a pragmatic and low carbon approach. The main objectives of the study are:

- To promote the integration of city cluster integrated transport, coordinate the intercity transport, city cluster transport and urban transport infrastructure & service networks.  
- To optimize city cluster integrated transport structure, and improve the transportation service to meet public travel demand within the city cluster;  
- To promote city cluster integrated transport network optimization to improve the level of service of various modes of transportation and improve the efficiency of passenger travel throughout the service;  
- To promote transportation modal shift, higher share of public transport and lower dependence on private cars;  
- To promote the city development with the public transit-oriented transport;  
- To optimize integrated transportation networks and management, enhance the efficiency, quality and equity of transport service;  
- To promote the development of low-carbon transport, to reduce resources, energy consumption and carbon emissions, to meet the requirements of Eco-transport.

1.3 Main Tasks

CCC integrated eco transport development strategic planning is a comprehensive study involving multiple departments, levels and administrative entities. Based on the objectives, the overall study contains 12 main tasks:
Figure 1.1 – Technical flow chart with tasks
2 CITY CLUSTER AND ITS TRANSPORT OVERVIEW

City cluster transport system is closely related to the formation and development of city clusters, the geographical space and features, economic level, population distribution, urbanization rate and the administrative relationship all will have a significant impact on city cluster transport system planning and construction. Therefore, the city cluster eco-transport planning must provide more systematic analysis of the city cluster transport system.

2.1 Concept of CC

City cluster involves the concepts of megalopolis, global city-region, mega-city region, metropolitan regions and mega regions[6], and also concerns the concepts of super city, extended metropolis regions and super-metropolitan. These concepts are generally similar and refer to the meaning of CC, but varies in terms of detailed contents.

Patrick Geddes, a UK planner, firstly proposes the concept of megalopolis in 1915. Subsequently, the American planner Lewis Mumford concludes the megalopolis is one major process of urban evolution. The most recognised concept of CC is proposed by Jean Gottmann in 1961[6] when there was only one megalopolis region (the Northeast Megalopolis) in the world according to Gottmann.

The concept of CC in China is firstly proposed by Yao Shimou in 1992 and is further studied by Gu Chaolin through a series of academic papers.

Domestic scholarship Yao Shimou proposed the three necessary formulation conditions of CCs:

- CCs should have a number of cities with different scales
- CCs should have one or more large-scale cities as the core
- CCs should have intense connection across component cities

<table>
<thead>
<tr>
<th>Source</th>
<th>Concept</th>
</tr>
</thead>
<tbody>
<tr>
<td>J.Gottmann</td>
<td>City cluster refers to a wider urban area consisting of several metropolitans. City cluster aims to minimize the differences of the city and the rural areas. Normally, the population density of city cluster should reach a certain level.</td>
</tr>
<tr>
<td>ADB</td>
<td>City cluster development is a process of economic and social development through which the built-up areas of a number of human settlements become linked together functionally, structurally, and spatially to form an integrated urban region. City cluster development occurs when the territorial scope of a number of adjoining cities expand until they create an urban corridor or region.</td>
</tr>
<tr>
<td>China Economic System Reform Department, NCDR</td>
<td>City cluster is a spatial form which enables conducting business within a certain distance, by one or several large cities as a leader, many medium and small cities distributed coordination with cities separated by farmland, forest, water and other green spaces, cities connected by convenient and efficient transportation corridor. City cluster will not reduce big city’s scale of economy and agglomeration economy because it has modern transport connections; City cluster can prevent ‘city disease’ (urban sprawl) from single city’s excessive expansion; City cluster can also avoid wasteful land take incurred by dispersed urbanization because it is relatively concentrated.</td>
</tr>
</tbody>
</table>

In general, based on the domestic and international practices, the elements to boost CC development include: national and regional policies to promote CC integration; the function improvement and expansion of regional core cities; the industry and resident migration caused by the increasing production and living cost of core cities; the intercity flow of productive factors and industrial division & cooperation; the suburbanization and expansion of urban areas break by the administrative boundaries across different cities; the construction of intercity transport infrastructure; the improvement of intercity transport equipment; and the reduction of intercity travel cost.

The above elements promote the integration of CC land use, and socio-economic and cultural activities. The development of transport infrastructure and technology shortens the temporal and spatial features of CC travel and is necessary to the growth of city cluster.
The criteria of CCC development stages can be summarized as:
- **Primary** – expansion of core city: the urbanisation rate of the core city exceeds 70% but the urbanisation rate of the whole region is less than 60%.
- **Mid-stage** - CC formation and expansion: the urbanisation rate of the core city exceeds 70% and the urbanisation rate of the whole region is more than 60%. The GDP per capita is more than 60 thousand RMB.
- **Mature** - megalopolis: the urbanisation rate of the core city exceeds 70% and the GDP per capita is over 120-150 thousand RMB.

In international city cluster sphere of influence studies, central city scale, degree of urbanization in surrounding area, population density, commuting rate, population growth rate are common indicators. Commuting rate is most widely used indicator which combines four methods mentioned above.

**Table 2.2 city cluster sphere of influence in different countries**

<table>
<thead>
<tr>
<th>Country</th>
<th>City cluster sphere of influence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Japan</td>
<td>The employment and education population above 15-year-old in residential areas account for over 10%</td>
</tr>
<tr>
<td>The US</td>
<td>Urban area with over 50k population and the urbanisation rate is over 75%; Population density is higher than 50 people/mile with an increase rate of 15%; At least 15% non-farm working labour commute to the core towns or the mutual commuting rate exceeds 20%</td>
</tr>
<tr>
<td>Canada</td>
<td>Urban area with 100k population and the commuting rate is over 40%</td>
</tr>
<tr>
<td>The UK</td>
<td>Area with population over 70k. The employment population in core area exceeds 20k or employment density exceeds 5 persons/acre. The commuting rate from external areas to central areas is higher than 15%</td>
</tr>
</tbody>
</table>

The definition method of city cluster in China can be divided into the following categories in terms of the main body that provides the definition:
- **Naturally defined:** Due to the similarity of the natural and geographical conditions and connectivity of socio-economic ties, the geographical scope of some city clusters have been agreed naturally.
- **Government-led and administratively prompted:** on account of the socio-economic development and urbanization promotion, the government takes administrative means to prompt multiple cities development jointly to form a city cluster.
- **Government-led and scholar supported:** The government issues a strategic planning task for city cluster and provides overall definition for the geographical scope within which scholars specified geographical division. Such method of definition is contains more scientific studies than the above two methods.
- **Academic research:** compared with the previous three methods, this method features the greatest freedom and strongest scientificity, but poorer feasibility without combination with government planning decisions.[24]

The study focus of CC integrated eco transport planning includes the scale and variation of intercity passenger/freight transport demand, intercity comprehensive transport network composition and coverage, intercity transport mode, intercity transport speed, number of intercity corridors, types of transport modes, accessibility of intercity transport.
network, urban spatial connection and eco transport indicators. Transport indexes system can provide quantitative reference to CC scope identification. In terms of the study of CC boundaries, the most important quantitative criterions include whether the commuting ratio from non-core cities to core cities exceeds 15%, number and types of transport corridors, travelling time of different intercity transport modes, the connectivity of urban metro, the construction degree of transport infrastructure and the number of airports, HSR stations and other large integrated hubs.

The analysis of CC characteristics involves social and economic conditions. The classification of CC types involves the basic characteristics of CCs. For CC integrated eco transport planning, besides socio-economic development and urbanisation rate, the most important factor is the CC spatial pattern. The CC spatial development pattern largely decides the development model of comprehensive transport network (the traditional ‘ring + radial’ pattern, networked pattern, hub-and-spoke pattern or a combination). The structure of the CC comprehensive transport network is the key indicator to define the development stage and can affect long-term CC transport infrastructure planning. The major spatial development patterns can be classified into single-core development pattern and multi-core development pattern.

- The single core pattern is a major city cluster development pattern. The city cluster with New York as the centre in the northeast of the United States and Japan’s Pacific coastal city cluster with the centre of Tokyo are typical single core pattern examples. These two central cities are typical mega cities with radiating and functions affecting other cities in the cluster which leads the rapid economic development of the whole city cluster. Paris and London are other examples.
- The Northwest Europe typical city cluster and the great lakes city cluster of North America are typical examples of multicentre pattern. Such pattern is with more balanced development for all core cities. Core cities are balanced in functional orientation and the development is coordinated rather than lead by the main core city.

### 2.2 City Cluster Transport Development Characteristics

#### 2.2.1 CC Transport System

Transportation is important element for city cluster development. In city cluster formation and development stages, the importance of transport system is not only for its development type but also its attractiveness for passengers which are regarded as a leading factor of city cluster regional space development mode.

- The first layer is the regional major transport hub, which acts as the transport core of a city cluster. The radiation function of this kind of hub even affects a wider area of CCs and can affect other CCs nearby and even other regions and countries. For instance, Shanghai Pudong Airport and Yangshan Airport serve a scope much wider than Yangtze River Delta and Tianjin Harbour serves the area much wider than Beijing-Tianjin-Hebei.
- The second layer is the upper level transport network consisting of multiple transport arteries. The upper level transport network corresponds to the spatial development corridor of a city cluster and acts as the major transport corridor to connect to the main transport hubs and the component cities of the city cluster.
- The third layer is the lower level transport network which is formed based on the first and second layer.

Due to limited understanding of city cluster transport system layers, especially for the first layer, the planning and design of city cluster transport system lacks of consideration for different layer. This is a limitation to improve city cluster transport service and development.

- **Stage 1 Insufficient transport infrastructure**;
- **Stage 3 CC integrated transport network primarily forms and sustainably develops**;
- **Stage 4 Mature CC integrated transport system**.

From the perspective of regional scales, the whole city cluster transport structure can be divided into three types: regional external transport, interurban transport and urban transport.

- The central city transport is a focus on urban passenger transport, especially for the transport hubs. In addition to the urban transport, intercity transport is crucial for the formation and development of city cluster.
- Intercity freight transport is a key element for CCC development. Intercity freight transport is centred at regional freight hubs which organise external freight transport.

The trunk lines connect transport hubs in the city cluster. The form of transportation generally has at least two characteristics, namely higher-speed and larger-capacity, including the highway, railway, express bus, and aviation. The selection of specific transport mode should be based on comprehensive technical and financial analysis.

For high-value goods, HSR or air freight transport can be used. Water and pipe freight are suitable to normal and bulky goods, and rail and road are also appropriate freight modes. However, CCC intercity freight transport is constrained due to institutional issues. The monopoly of rail limits rail freight development and the rail freight amount is much lower than road freight.

### 2.3 Concept of CCC Integrated Eco Transport

This section will illustrate the concept of ‘eco transport’.

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There are two similar expressions for eco transport – ecological transportation and eco-mobility. The expression of ecological transportation is relatively informal and mainly refers to green travel modes such as walking and cycling.

The expression of eco-mobility is used more frequently. Eco-Mobility is a term used to describe travel through integrated, socially inclusive, and environmentally friendly transport options, including and integrating walking, cycling, and wheel chairs. By enabling citizens and organizations to access goods, services, and information in a sustainable manner, it supports citizens’ quality of life, increases travel choices, and promotes social cohesion [29].

Integrated eco transport follows the concept of nature, human and economic ecology and aims to construct comprehensive transport systems consisting of transport network, equipment and environment. In general, it is a systematic study to plan and to manage transport and environment to control environmental impacts within proper degrees to enable transport the ability of the transportation of people, good and information, as well as support and guide socio economic development, and improve the surrounding environment. Eco transport should have the features of adaption, advancement and evolution [30].

The definition provides clear illustration of the eco-friendly concept in the transport domain. The concept of ‘ecological’ is defined by the ecological economists Costanza [30] who states that the supply of the eco system is limited and irreplaceable. The research of Berkeley [32] and Register [33] also highlights the concept of ecological limitation of eco city. Wu Liangyong [30] states that the concept of sustainable development should consider the ecological limitation, and the definition of ‘eco city’ describes the connotation of ecological limitation [35]. Hence, the ‘ecological limitation’ is an important consideration to achieve eco development.

CC eco transport system should be environmental friendly and can reduce its adverse environmental impact under the ecological limitation in the whole city cluster region. The eco CC transport planning should seriously consider the ecological limitation [36].

For Individual traveller, the intercity travel frequency is relatively low and the travel distance generally above 50km. The concept of eco-mobility is usually used for short/medium distance travel, which does not relate well to the concept of CC integrated eco transport.

In conclusion, CC eco transport highlights the environmental friendly concept and controls the impacts of CC passenger/freight transport under the ecological limitation.
3 CHINA URBANIZATION AND CCC

In the last decade there has been an additional 100 Million urban residents at a 4% annual urban growth rate, which is 5 times greater than the national population growth rate. However, only 50% of this growth is migration, the other 50% is due to city expansion and redefining urban administrative boundaries.[37]

Ning Yuemin[38] states that during 2000-2010, the population of China main land has increased by 74 million. In the same time period, the urban population growth in 13 CCCs is as high as 64.59 million which accounts for 87% of the national total population growth. The national population growth and internal migrating starts to concentrate in CC areas.

Since the CC strategy is proposed in the National 11th Five Year Planning, the spatial scope of CCCs is becoming gradually clearer. In 2007, the ‘National Major Functional Area Planning’ proposes to construct a strategic urbanisation layout with ‘two horizontal lines and three longitudinal lines’ and has defined 21 CCCs. The ‘National New Urbanisation Planning 2014-2020’ further supports the CCC development progress. In Nov 2015, NDRC and MOT issues ‘Integrated Transport Network Planning in Urbanized Areas’ which guides the integrated transport planning of 21 CCCs including, Yangtze River Delta, Pearl River Delta, Middle Yangtze River, Chengyu, Haixia West Coast, Shandong Peninsula, Ha'erbin-Changchun, Middle/central Liaoning, Central Henan, East Longhai Sea, Guanzhon -Tianshui, North Gulf, Taiyuan, Middle Yunnan, Middle Huizhou, Hubaoeyu, Lanzhou-Xining, Tianshan North Hill, Ningxia Yellow River, Middle/south Tibet CC, covering 215 cities. The Urbanized Areas includes 21 city cluster approved by the central government.

China city clusters are still in a developing stage and the city cluster formation and characteristics vary. City cluster transport features are different from region to region due to the differences in economic growth, industry structure, terrain and city cluster urban form. CCC can be categorized by general location: eastern, central and western since this largely relates to the differences in economic status, population and urbanization levels as well as terrain and urban formation. It should be noted that the development status for China city clusters are diverse with significant regional difference. The differences can be found in the aspects of regional urbanization level, economic development status, spatial scale, population density, economic accumulation degree, transport network, the development level of multi modal transport and transport demand. 8 city clusters are selected from 21 CCCs to compile detailed case study. Among 8 selected city clusters, field study have been conducted for 3 of them to collect more up-to-date information on city cluster transport, management and policies which can help to better understand city cluster development status.

3.1.1 Eastern City Cluster Transport Features

Most eastern China city clusters are with a multi-core city structure or with a circle form. In terms of transport, the key features are: (no 1-9)

- Eastern city clusters are with larger population and economic scale. Most core cities in eastern CCC are national level cities with strong regional influences. In terms of transport hubs, the airports and logistic centres in eastern city cluster have a wider sphere of influence on both eastern and central China. Most hubs are with strategic importance and are key nodes in city cluster transport network.
- A multi-modal transport system is developing including integrated transport services with IC card for public transport and integrated highway charging are good examples. But the integration between different modes is still lacking. It should be noted that at this stage the highway network is more developed than intercity rail network in eastern CCCs.
- Regional land use development extends beyond the administration boundaries. There is a growing trend that regional transport follows urban transport characteristics with more commuting trips, tidal transport flows and peak demands. Prioritized urban public transport development begins to further extend to intercity transport and longer distance travel.
- Freight demand is with high growth rate due to the increase in international trade and developed shipping service. For eastern CCCs, the transfer from primary and secondary industry to tertiary industry leads to less aggregated based freight and growing demand for express freight services.
- The planning and design of existing passenger hubs and logistic centres do not consider the demand at city cluster level. The poor location of existing transport hubs accelerates congestion in the city. With further city cluster development, the hubs will attract more external traffic and through traffic. Upgrade existing passenger hubs and logistic centres with extended functions is needed.
- City cluster transport development leads to environmental issues. With a more developed road network, private car will become the dominant mode for intercity trips. In addition to passenger transport, freight by road has a larger share than rail. It is a crucial stage to change existing transport structure towards a more sustainable and environmental friendly pattern.
- Transport networks affect urban form and land use pattern. With a more developed road network, future trends will lead to be car depended development if no measures are taken. It is vital to density and expand the rail network and adopt more intense land use development along railroads.

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The overall transport demand increase is nearing the limits of transport supply of exiting transport infrastructures. High transport demand growth and relatively limited transport corridors due to low availability of land resources are regarded as the bottleneck for future intercity rail development in eastern China.

3.1.2 Central City Cluster Transport Features

Central China is in a rapid developing stage. Compared to eastern China, the terrain is more complex. Most central China city cluster are single centre or twin centre city clusters. Key transport features of central China city clusters include the following:

- Central China has higher population density than western China. For city clusters in central area, the central cities are normally regional centres. The transport hubs in central city clusters are regarded as regional or even strategic transport nodes along key corridors.
- The existing transport framework can support multi modal development. Integrated transport development in central China is now in the initial stage. Highway and rail development is at a lower level compared to eastern China. The difference between highway and rail development in central China is smaller and rail and road are the two main modes for intercity passenger transport.
- The growth in through traffic is greater than regional traffic. The strategic corridors are with increasing pressure.
- In terms of passenger transport modes, road and rail have similar shares. Due to higher the primacy ratio, central cities are attracting more regional traffic. This increases intercity trips from/to centre cities is greater than other cities.
- In terms of freight transport modes, road and rail have similar shares, Heavy industry shifted from eastern China to form new industry clusters in central areas. Aggregate freight demand has grown rapidly due to industry function integration with the eastern CCCs.
- Transport development brings in some environmental issues although the development intensity is lower than eastern China. Central China has a smaller intercity transport demand but larger through traffic demand along strategic corridors when compared to eastern China. In some regions, the through traffic has a negative impact on the environment.
- The central area has different transport strategic corridors connecting the eastern and western part of China. It is favourable for integrated transport development, especially for rail, to guide future land use development and shaping urban form.
- Although the concept of transport integration in central CCC has been proposed, detailed demand analysis and studies on feasible integration approaches is lacking.

3.1.3 Western City Cluster Transport Features

Western China has lower population densities and the city clusters in western China are in the initial developing stage. Most of them are single centre city cluster and the centre is the provincial capital. Key transport features of western China city clusters include:

- City clusters development in western China largely relies on the government. Western CCC has a single central city which is with strong regional influence.
- The transport hubs in western CCCs are regional hubs and some are the key nodes in national strategic transport network.
- Existing transport infrastructure construction is insufficient. Some cities in western China have been nominated for national transport IC project, but there is no plan for western CCC integrated transport development.
- Long distance detours for through traffic is becoming a common issue based on the existing transport network in western area.
- Even if transport infrastructure is in great need, the construction and maintenance cost is high compared to available funding. Funding is an key issue for transport infrastructure construction and transport demand may be much smaller than the capacity of constructed infrastructures.
- Eco-transport development is in great need for western China with poorer ecological conditions.
- Integrated transport planning and urban planning is in need to coordinate the regional development, especially for the city cluster with few corridors and hubs.
- The government plays a leading role in western CCC development, especially for proposing city cluster transport planning, designating institutional arrangements and transport policy making.

3.1.4 Common Features of City Cluster Transport

Although city cluster transport features are different from region to region, common features can be found for integrated eco-transport:

- The transport hubs and logistic centres in city cluster central cities are key nodes in regional transport network.
- Existing city cluster transport network is the basis for intercity transport development. The development of different transport modes is not integrated. Road and rail are two major modes for passenger and freight transport with similar demand. But from the supply side, rail supply is insufficient.
- City cluster development extends beyond traditional administration boundaries. City cluster transport is with more urban transport features. Although business and leisure are two key travel purposes for intercity trips, a higher share of commuting trips is found. It is reported that for Suzhou North HSR station, 33% of the trips are commuting trips.
- Intercity transport demand is growing and passenger travel distance is increasing. The passenger and freight transport mode share are different in different city clusters. The impact from Intercity passenger transport during holidays is more significant.
- Through traffic growth with existing traffic organization and transport network causes congestion along some corridors.

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Intercity transport congestions issue is with a larger sphere of influence in space and time. It is a new challenge for city cluster transport planning, transport management and operation and emergency handling.

- City cluster transport development should focus on integrated transport. Rational corridor and hub layout and design is crucial for integrated transport development. Environmental protection and is one of the key contents in integrated eco-transport development.
- Policy guidance and institutional arrangement is necessary to safeguard robust city cluster transport development, operation and management.
4 International City Cluster Eco-Transport Development Experience and Lessons Learnt

Subject Report 2 of this study includes 11 international city cluster case studies selected from Asia and Europe. The case studies reviews transport development overview with necessary analysis and summarises successful experiences and lessons learnt. It can help to promote China city cluster development with efficient city cluster management policies in the near future.

Based on 5 international city cluster case studies, 3 international city cluster transport patterns are summarized including: Tokyo Metropolitan Area Mode- rail transit oriented passenger transport mode; London and Paris Metropolitan Mode - rail and road oriented passenger transport mode, New York Metropolitan Mode - private car oriented transport mode. In the report, 3 transport modes are analysed in detail including key modes for passenger transport and freight transport, characteristics of integrated transport network, transport hub features, spatial relationship between integrated transport network and city cluster, city cluster Transport Demand Management (TMD) and the sustainability of city cluster transport financing. These are key references to guide designating China city cluster strategies and transport mode selection.

4.1 International CC Transport System Development (International City Cluster Transport Modes 4.1)

Transport development mode selection refers to a strategically determining process of the transport overall development direction. A region cannot be developed without support and guidance by rational transport development mode. A variety of transport development modes with their own characteristics have been formed during the development process of international metropolitan area. For the passenger transport development mode there are three different categories as follows.

- The private transport-oriented, represented by US with developed highway network
- The private transport and public transport, represented by London and Paris.
- The public transport-oriented, represented by the Greater Tokyo and Seoul Metropolitan Area with advanced railway transport network.

4.1.1 Analysis of the Characteristics of Passenger Transport Development Mode

The following table as below for the main characteristics of each transport development mode in terms of structure and network.

It can be conducted that the development mode of freight transport differs from that of the passenger, even within the same city cluster. For example, in the US private transport dominates passenger transport, while both railway and highway are the main mode for freight transport; In the Greater Tokyo, railway and highway dominates passenger transport and freight respectively.

The operating costs borne by government for each transport development mode are different due to the focused transport mode. For the Greater Tokyo, public transport share is relatively higher due to the successful promotion of metro transport leading policy. Tokyo is one of the world’s few cities where metro operating has produces profits, while the world metro companies suffer from financial losses generally and need subsidies from government, since railway, especially urban rail construction requires for higher capital investment. From fiscal 1996 to fiscal 2006, each year Tokyo Metro is profitable without government subsidies. The total pre-tax profit of Tokyo Metro in 2006 was 79.5 billion yen. The profits of urban rail emerge from collaboration of institution, management, advanced technology, subsidies, rational fare system, and harmonious development of railways and urban construction.

In Japan, 50% of the costs of metro construction are shared by state government and local governments (25% for each), and the metro is unsubsidized for operation. In the United States and the European Union, all the metro construction costs are borne by government, and 20%-80% of the operating costs are subsidized by government, too. Due to the high demand for capital, PPP has been introduced into many cities for metro construction and operation. Since 2013, the State Council began to advocate PPP and has launched PPP pilot projects of which rail transport is the focus.

PPP was taken by Britain government as being effective to help relieve financial pressure and applied in London metro establishment. But the PPP came to an unexpected end after 7 years. There are many reasons, and the main three are:
Rail as a low-carbon transport mode of large capacity, without reliable passenger traffic, the income will hardly support high operating costs, bringing too much pressure on government finances. Thus, the city clusters at different stages of development and cities within city cluster need to, according to their own level of economic development, adopt the appropriate transport mode at different stages of development.

### 4.2 Summary and Lessons Learnt

Based on the case international city cluster case study, it can be summarized that the development of city cluster...
relates to the location of the region, social-economic development, transport framework and governance structure. City cluster transport patterns can be diverse worldwide. By choosing proper transport pattern, the transport system can better support city cluster development. Lessons learnt from city cluster transport system development are summarized in Table 4.2.

Table 4.2 International city cluster transport development experience

<table>
<thead>
<tr>
<th>City cluster</th>
<th>City cluster Transport System</th>
<th>Lessons learnt</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tokyo Metropolitan</td>
<td>Shipping and air are the dominant, a part of road transport</td>
<td>Rail transit development to lead city cluster development</td>
</tr>
<tr>
<td></td>
<td>Rail transit dominant with a part of road transport</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Public transport: rail transit and regular bus</td>
<td></td>
</tr>
<tr>
<td>Greater London Metropolitan</td>
<td>Shipping and rail are the dominant, a part of road transport</td>
<td>Transport planning is based on metropolitan development demand.</td>
</tr>
<tr>
<td></td>
<td>Railway/rail transit and highway</td>
<td>Accessibility of public transport, transport demand</td>
</tr>
<tr>
<td></td>
<td>Public transport: underground/DLR/over ground and regular bus</td>
<td>along the corridors and growth poles are studies with qualitative analysis</td>
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<tr>
<td></td>
<td></td>
<td>based on the proposed spatial development strategy. The analysis result is used</td>
</tr>
<tr>
<td></td>
<td></td>
<td>for transport structure selection and rail transit network planning</td>
</tr>
<tr>
<td>Northeast Megalopolis (Bos-Wash)</td>
<td>Shipping and air dominant</td>
<td>Metropolitan Planning Organization (MPO) is the coordination institution</td>
</tr>
<tr>
<td></td>
<td>highway and regional rail</td>
<td>between different government departments which safeguards the effective and</td>
</tr>
<tr>
<td></td>
<td>underground/rail/bus/taxi/ferry</td>
<td>efficient transport planning and its implementation</td>
</tr>
<tr>
<td>Seoul Metropolitan</td>
<td>shipping/air/rail and road</td>
<td>The massive transit system integrates technology innovation,</td>
</tr>
<tr>
<td></td>
<td>Highway/coach</td>
<td>infrastructure construction, public transport organization and management,</td>
</tr>
<tr>
<td></td>
<td>Integrated public transport system</td>
<td>institutional arrangement.</td>
</tr>
<tr>
<td>Randstad CC</td>
<td>Shipping is the dominant mode. Air/rail/road are other external transport modes.</td>
<td>The dispersed multi-core structure guides a healthy city cluster development</td>
</tr>
<tr>
<td></td>
<td>highway</td>
<td>with good external transport connections. Randstad CC transport system</td>
</tr>
<tr>
<td></td>
<td>Convenient public transport system</td>
<td>development is coordinated with National Strategic Transport Planning</td>
</tr>
<tr>
<td></td>
<td></td>
<td>and Regional Master Planning.</td>
</tr>
</tbody>
</table>

Based on the overview and detailed case study of international city clusters, lessons learnt are summarized for CCC integrated eco-transport development: (number 1-7)

- City cluster in urbanization: in urbanization process, as population/industry/resources concentrating on cities, the expanded urbanized area will have a larger sphere of influence. Core cities are usually the growth poles with strong radiating fact to the whole city cluster.
- Institutional arrangement for government-market coordination: in different countries, the institutional arrangements for city cluster planning and management might be different. The coordination agency can be national/local governmental departments, non-governmental organizations, or specialized city cluster management agencies.
- Urban issue prevention: urban issues such as congestion and urban sprawl can be mitigated by provide increasing urban infrastructure to coping with rapid growth of population and more frequent business.
- Mass transit development will be a trend for CCC: for intercity travel, the trip train is more complicated than intra-urban trips with more transfers among different travel modes. The increase in intercity commuting trips is significant. Intercity transport system connects corridors and key nodes in central cities, sub centres and satellite towns. Mass transit development has been well adopted in city cluster transport system worldwide which is the trend that China will follow.
- Multi-modal freight and sustainable logistics: freight transport, especially freight by road is one of the key factor for noise, congestion and emission. In recent years, sustainable logistics and multi-modal freight are developing aiming at improve freight efficiency and mitigate the negative environmental impact. It can be achieved by many approaches including using cleaner fuel, enhancement in freight corridor construction, logistic organization, market management and cooperation reorganization for sustainable logistics development.
- Governmental guidance on eco-transport development is vital: in addition to technical reform such as new energy use, ITS, the government plays a vital role in CCC eco-transport development. Transportation and land use coordinated development, transport prioritized strategy, Transport Demand Management (TDM) and public consultation cannot be achieved without the policy support and safeguards from the government. Effective eco-transport development covers a wide range of contents such as improving public transport service, fare reduction, charging tactics for car use, re-assignment of road space, personalized travel plan and land use policies. The implementation of the measures in those aspects can help to build a more sustainable and eco-friendly transport system for CCCs.
- SEA in transport planning: this enables the detailed transport project evaluation on potential environmental impacts, including GHG emission, land use, and indirect impacts such as transport safety and biodiversity. SEA is a key reference for decision makers and planners.
5 CCC Transport Demand Forecast and Characteristics of City Cluster Transport Demand

The trends in inter-urban transport growth, the mode, trip length and vehicle technology directly impact GHG emissions and the type of policies/infrastructure needed to mitigate present and future negative environmental impacts. A clear understanding of the strategic transport demand can be gained by international benchmarking, the current global trends and forecasting by the international energy community, and the current experience in China at the national, regional and CCC level.

The chapter compares Strategic Transport Demand Analysis for China under different scenarios and forecast the unconstrained regional transport demand for selected CCC or provinces including Yangtze River Delta CC, Hubei Province and Shaanxi Province. Characteristics of intercity transport demand are summarized based on domestic and international studies.

A summary of inter-city travel definition worldwide is shown in Table 5-1

<table>
<thead>
<tr>
<th>Country/Region</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Japan</td>
<td>travel between 47 prefectures in Japan</td>
</tr>
<tr>
<td>USA</td>
<td>trip distance is 80km (50 miles) or above</td>
</tr>
<tr>
<td>German</td>
<td>for planning: trip distance is 80km or above; for survey: trip distance is 80km or above</td>
</tr>
<tr>
<td>EU</td>
<td>European Tourism Indicators System (ETIS) studies long distance trips between traffic zones based on (Nomenclature of Territorial Units for Statistics) NUTS3.</td>
</tr>
</tbody>
</table>

In China, there is no standard definition for intercity trips. It is recommended to that all trips between different jurisdictions are intercity trips.

Currently, Inter-city passenger travel plays a minor role in travel surveys because it includes only a small share of the overall trips generated by the main urban areas. However, the share of passenger distance can be high due to the longer distances travelled by intercity trips, and the climate relevance and impact on society is significant because of the dominance of air and car mode for intercity travel. Coupled with the fact that in most countries, car and air travel modes show highest passenger shares and the highest growth rates for longer distance trips, then it is expected that the impact of intercity travel in transport global warming is even greater than 33-50% when just based on the total trip distance.\(^{[54]}\)

An interesting phenomenon is that whilst the number of daily trips (including NMT) is almost constant in many countries (c. 3-4 trips per day), the trip lengths and total distance travelled per year differ substantially by country or region. It is suggested based on the forecast\(^{[55]}\) that in 2020, the average travel distance is estimated at 40,000 km per year in the USA, 30,000 km in Europe and 11,000km for Asia..

In terms of contribution to carbon footprint, globally intercity car and air modes show the highest share of traffic and highest growth rates, and under the Business As Usual (BAU) scenario or trend, the impact of inter city traffic could be much higher than expected. According to the International Energy Agency (IEA), the growth in urban transport CO\(_2\) by 2050 is moderate for both Organization of Economic Cooperation and Development (OECD) and non-OECD countries, whilst there is considerable growth in inter-city travel CO\(_2\) emissions, most noticeably in non-OECD countries (including China and India). The share of intercity CO\(_2\) emission is set to grow from 50% to 70% from 2010 to 2050, and an almost doubling in total CO\(_2\) from transport is expected by 2050.

Rapidly increasing travel distances in non OECD countries will boost car/air travel especially if rail is a considered as a minor mode. Railway is generally considered to be a low emission mode per passenger km and can have significant benefits to the environment. Railways can provide a competitive mode to air travel distances of 75-1000km and for shorter inter-city trips can provide a faster option to the car. Given the development of urban rail within the City cluster cities, then intercity rail is becoming a vital option to connect the city cluster cities and realise the social and environmental benefits.

Generally, that national passenger transport demand is with significant growth in the last 15 years at 5%-10% annual growth. Road is the dominant mode for passenger transport which is followed by rail. The proportion of passengers by air and ship are small.

Road is the dominant passenger transport mode and the growth rate of passenger transport demand is between 5% to 10%. Ship is the dominant freight transport mode, the freight tonne annual growth rate is between 5% to 12%. In
general, national transport demand growth is aligned with GDP growth.

Generally, national freight tonnage is with moderate growth typically 5%-10% in the last 15 years. Road is the dominant mode. Freight tonnage by ship is with continuous increase but rail tonnage is quite stable in recent years. In terms of tonne km, ship is dominant mode due to the longer ship distance by inner water or by sea. Considering the shorter freight travel distance by road, there is a significant decrease in tonne km share by road. The national tonne km is increasing at 10%-15% per annual which shows the close relationship with the real GDP growth and freight demand.

The analysis of historical passenger trips and passenger km is made for Yangtze River Delta CC, Hubei Province and Shaanxi Province. Key findings at regional levels are

- **YRD CC**: Road is the key mode for passenger transport. Air plays a vital role in passenger transport which signifies the national importance of Shanghai as a developing airport hub. Passenger km by air is more than rail since 2004 despite recent development of HSR. Recent passenger transport growth rates of 5%-10% are in line with the regional GDP growth. In terms of passenger travelled distance, YRD has highest mobility level compared to Hubei, Shaanxi Province and national level

- **Hubei Province**: Rail and road are the leading passenger transport modes. Air travel take a small proportion. Passenger transport demand growth is 10% to 15% annually which is similar to the GDP growth for Hubei Province. Passenger mobility level is close to national level but lower than YRD CC.

- **Shaanxi Province**: With few waterway and shipping resources, road and rail are the two major modes for passenger transport. Due to its geological characteristics, Shaanxi highway network density is relatively low but railway network is quite developed. Passenger transport by rail is attractive. The passenger mobility level is the lowest compared to YRD CC, Hubei Province.

### Table 5.2 Unconstrained Transport Demand Forecast Summary

<table>
<thead>
<tr>
<th>Year</th>
<th>NATIONAL Passenger km/head</th>
<th>YRD CC Passenger km/head</th>
<th>HUBEI Passenger km/head</th>
<th>SHAANXI Passenger km/head</th>
</tr>
</thead>
<tbody>
<tr>
<td>2000</td>
<td>1,988</td>
<td>5,365</td>
<td>785</td>
<td>2,505</td>
</tr>
<tr>
<td>2005</td>
<td>2,365</td>
<td>6,005</td>
<td>846</td>
<td>2,738</td>
</tr>
<tr>
<td>2010</td>
<td>3,427</td>
<td>7,877</td>
<td>1,053</td>
<td>3,295</td>
</tr>
<tr>
<td>2015</td>
<td>4,902</td>
<td>10,091</td>
<td>1,360</td>
<td>4,430</td>
</tr>
<tr>
<td>2020</td>
<td>7,722</td>
<td>14,365</td>
<td>1,669</td>
<td>7,098</td>
</tr>
<tr>
<td>2025</td>
<td>11,673</td>
<td>20,096</td>
<td>1,989</td>
<td>11,062</td>
</tr>
<tr>
<td>2030</td>
<td>16,130</td>
<td>27,037</td>
<td>2,309</td>
<td>16,709</td>
</tr>
<tr>
<td>2035</td>
<td>20,531</td>
<td>34,374</td>
<td>2,629</td>
<td>21,306</td>
</tr>
<tr>
<td>2040</td>
<td>24,038</td>
<td>42,176</td>
<td>2,950</td>
<td>25,806</td>
</tr>
<tr>
<td>2045</td>
<td>26,160</td>
<td>46,203</td>
<td>3,200</td>
<td>28,107</td>
</tr>
<tr>
<td>2050</td>
<td>26,657</td>
<td>47,705</td>
<td>3,250</td>
<td>28,508</td>
</tr>
</tbody>
</table>

According to the passenger transport forecast, passenger km/head for road, rail and air is with significant increase. In terms of mode split, due to the rapid growth in motorized trips, road is still the dominant passenger transport mode with a share greater than 60% while rail is with a stable share around 20%. Road share gradually shifts to air due to longer distance travel.

### Table 5.3 Passenger km per head Summary (Ship excluded)

<table>
<thead>
<tr>
<th>Year</th>
<th>NATIONAL Passenger km/head</th>
<th>YRD CC Passenger km/head</th>
<th>HUBEI Passenger km/head</th>
<th>SHAANXI Passenger km/head</th>
</tr>
</thead>
<tbody>
<tr>
<td>2000</td>
<td>1,245</td>
<td>611</td>
<td>308</td>
<td>431</td>
</tr>
<tr>
<td>2005</td>
<td>1,533</td>
<td>810</td>
<td>461</td>
<td>572</td>
</tr>
<tr>
<td>2010</td>
<td>2,331</td>
<td>1,363</td>
<td>788</td>
<td>2,352</td>
</tr>
<tr>
<td>2015</td>
<td>4,196</td>
<td>2,605</td>
<td>1,032</td>
<td>4,238</td>
</tr>
<tr>
<td>2020</td>
<td>7,877</td>
<td>4,950</td>
<td>1,353</td>
<td>7,908</td>
</tr>
<tr>
<td>2025</td>
<td>12,365</td>
<td>8,642</td>
<td>1,688</td>
<td>12,390</td>
</tr>
<tr>
<td>2030</td>
<td>17,878</td>
<td>12,462</td>
<td>2,023</td>
<td>17,898</td>
</tr>
<tr>
<td>2035</td>
<td>22,456</td>
<td>16,362</td>
<td>2,366</td>
<td>22,467</td>
</tr>
<tr>
<td>2040</td>
<td>25,933</td>
<td>20,362</td>
<td>2,679</td>
<td>25,951</td>
</tr>
<tr>
<td>2045</td>
<td>26,260</td>
<td>20,658</td>
<td>2,740</td>
<td>26,278</td>
</tr>
<tr>
<td>2050</td>
<td>26,700</td>
<td>21,016</td>
<td>2,810</td>
<td>26,716</td>
</tr>
</tbody>
</table>

2050 China Energy and CO2 Emission Report and Energy Technology Perspectives 2012 – Pathways to a Clean Energy System [IEA report](http://www.iea.org/) forecast future national transport demand. The comparison summary of two forecasts and unconstrained forecast is shown below:
Table 5.4 National Transport Demand Growth Summary

<table>
<thead>
<tr>
<th>Year</th>
<th>Passenger Transport</th>
<th>Freight Transport</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Unconstrained CEACER</td>
<td>IEA (LC/ELC scenario)</td>
</tr>
<tr>
<td>2005</td>
<td>2,365</td>
<td>3,446</td>
</tr>
<tr>
<td>2010</td>
<td>3,923</td>
<td>5,099</td>
</tr>
<tr>
<td>2020</td>
<td>7,830</td>
<td>8,631</td>
</tr>
<tr>
<td>2030</td>
<td>11,633</td>
<td>13,868</td>
</tr>
<tr>
<td>2040</td>
<td>16,130</td>
<td>20,641</td>
</tr>
<tr>
<td>2050</td>
<td>19,755</td>
<td>28,312</td>
</tr>
</tbody>
</table>

*Existing data is highlighted.

In general, city cluster transport planning deals with Type C/D/E trips and a part of Type B trips (on city cluster corridors). But urban transport planning deals with Type A trips which is seldom considered in city cluster transport planning. However, it is important that all types of trips are considered and how to connect external and internal transport supply is a key issue.

In most domestic city transport master plans, Type C/D trips are regarded as external transport demand which is the main transport demand for city clusters. Inter-city passenger travel takes only a small share of the overall trips generated by the main urban areas. In some cities, only around 2-5% of passenger trips are intercity (i.e. external to the main urban area). Consider the longer travel distance, inter-city trips might have greater impact on the environment and energy consumption.

By analysing city cluster transport demand characteristics, future trends for intercity trips will be:

- **Journey purpose**: current major journey purpose for China inter-city trips are leisure, tourism, family and friend visiting. The study on journey purpose change of US long distance trips indicates that the share of personal business and household business is stable but there is a decreasing trend for friend visiting with increased leisure and business trips. It can be estimated that the share of business and leisure trips in China will increase in the future.
- **Seasonal variation**: intercity travel is with a more significant seasonal variation than intra city travel. From the long-term perspective, for CCC passenger transport demand, the weekday/weekend variation will remain but seasonal variation will be less significant due to stable work-living structure for urban migrants and residents.
- **Traveller characteristics**: for intra city trips, the occupation and income level for travellers are quite stable. For city clusters in different developing stages, the occupation and income level for inter city travellers could be diverse.
- **Time distribution**: The time distribution of future intercity trips could be different from current time distribution due to the change of trip journey purpose and traveller characteristics. With higher urbanization rate, the increase in inter city commuting trips will gradually show its time distribution features.
- **Trip length**: there will be a growing trend for intercity trip length and it might be different for trips with different purposes
- **Travel mode**: Passenger travel mode is affected by transport supply, cost and service level
- **Characteristics of city cluster freight transport**: industry structure is a key fact to change freight transport in the future
6 CCC Integrated Eco-transport Strategy and Development Framework Study

The city cluster integrated eco-transport strategy will guide future transport development including transport supply structure, choice of transport infrastructure and the city cluster transport system which relates to operations, service level, construction cost and phasing, as well as the overall accessibility of the service. The issues and challenges of CC transport development will impact the transport operation quality, construction & operation quality, transport convenience degree, financial sustainability and environmental quality, as well as the competitiveness across the country.

City cluster integrated eco-transport strategies are crucial to achieve proposed city cluster development targets can guide transport infrastructure construction to meet strategic transport demand.

6.1 Existing CC Transport Issues

At present, the development degrees of CCCs are imbalanced. But similar issues exist and the analysis of these issues can provide important references to CC transport development.

6.1.1 City cluster transport network issues

Existing city cluster transport network issues are identified for the overall supply structure, coverage rate, integrate degree, various modes network and their service.

1) Imbalanced supply structure: Rail development is insufficient, especially for inter-city rail and suburban rail.
   - Historical passenger km by rail is lower than by road and the different is expected to be greater in the future. In some eastern city clusters, passenger km by air is even greater than rail. For freight, road is still the dominant mode except some western CCCs.
   - Passenger transport dominated by road is due to road transport policies in 1980s, which encouraged using toll charge to pay back road construction loans. Monopolistic rail construction and operation eliminated private investment to develop rail. As a result, road transport development exceeded rail and become the dominant mode for intercity travel.
   - The sharp increase of aviation encourages the funding and financing process of domestic airports and boosts the air infrastructure construction.
   - The rapid development of road construction made the road become the leader of inter-city passenger transport. Its passenger turnover amount (excluded vehicle transport, only long-distance passenger transport) had a significant increase from 30% to 54% during 1978-2000. In the same period, the rail sustained passenger turnover amount reduced from 63% to 37% and it further decreased to 34% in 2008.
   - Rapid development of road transport owns to the development of private cars. The fully opened market for road construction may further encourage private car use which is not a sustainable development approach.

2) City cluster transport network with limited coverage: Most of cities are relying on the hub and major channel construction in their inner transport network. It is lack of efficient network connection in minor channel and hub. In eastern city cluster, it is lack of coverage area of high speed transport network. In central-western city cluster, the high-speed transport network construction is not completed yet.

3) Lack of Integration of different transport networks: It is lack of integration in resource, information and service between the outbound transport service in aviation, rail, road and the city cluster inbound transport service, even it is lack of efficient integration, such as the Public Transport Card, Highway Charging Card. The service level to the passenger is also needed to be improved; the development of integrated transport modes in freight is not full that is lack of efficient service infrastructure and policy guidance.

4) The city cluster channel demand rapid increases and it is rush to have efficient solutions: Especially in the eastern city cluster, there are frequent congestions in some parts of major channels that need expansion; The minor channels need to be constructed and the crossing channels need to be optimized.

5) Road: Road is the leading transport mode in city cluster. In eastern city cluster, the congestion, lack of reliability and road safety has become the problems for road transport network, such as the congestion in Beijing-Xizang Highway and Shanghai-Nanning Highway. Due to the low density of city cluster transport network, it is easy to cause congestion as the planning is lack of systematic network analysis and reliability test. This problem is prominent in some city clusters. Another prominent problem is the road safety. The safety in road transport is more prominent than other transport modes.
6) **Rail:** The rapid development of high speed rail has a significant impact on energy conservation and emission reduction. Compared to road transport, the rail supply in city cluster is insufficient. Existing marketization revolution of rail construction and operation management system cannot fully meet the requirements setting to support city cluster transport development.

7) **Aviation:** Some airports in CCCs are with very low usage rate. Aviation service integration and regional airport planning coordination is insufficient. Due to the large government investment of airport construction, it is vital to choose the suitable construction phasing to improve resource using and releasing government financial pressure.

8) **Shipping:** The majority of eastern city clusters are suitable to develop shipping but there is no focus on integrated shipping planning currently. Due to the rail development is led by the government, it is difficult to integrate rail and shipping. Yangshan port is a good case in point, a good many of ports in Yangtze River Delta lack of freight rail connection.

9) **Challenges for freight transport:** Due to the upgrade of city cluster industry and replacement of industrial land, there are significant changes in demand freight types, scales and locations in some city clusters. This brings challenges to city cluster freight transport planning decision.

10) **The city cluster transport service level needs to be improved:** The infrastructure planning construction, operational organization fail to efficiently connect with inter-city transportation. It is also lack of diversity, timeliness and reliability in transportation service. The administrative obstacle and market separation exist in the fields of operation safety, administrative management and marker monitoring so that it is hard to provide convenient inter-city transport service.

11) **Insufficient transport information sharing:** Information sharing platform construction is in behind. It is lack of information sharing mechanism between cities and transport modes for real time information publishing and searching.

### 6.1.2 City cluster transport hub issues

The existing CC transport hubs have the issues of:

- City cluster transport network hub is not well connected: It is not coordinated between integrated transport hub layout and that of urbanization space. It is lack transport hub connection platform for major cities and the connections coordinating inter-city, intra-city transport.
- The hub service for city cluster is needed to be improved: This prominently shows in the lack of inter-city rail connection in passenger and freight transportation, such as Pudong International Airport in Yangtze River Delta city cluster and Yangshan Port. Currently, national policy suggests that if hub of central city in city cluster has a distance larger than 30 km to the central city, they should be connected by inter-city rail. But generally, whether the inter-city rail service is provided will be mainly determined by the overall demand of other cities in city cluster to the central city hub, but not the distance.
- Pudong International Airport has a distance of 30km to the central area in Shanghai. Pudong International Airport throughputs 50 million passengers per year. If taking the pick-up and delivery travel, the overall traffic flow will be higher in the airport. Among them, part of the travel is made from the vehicle or other road transport modes from Yangtze River Delta area. These travels will need to drive roughly 70-100km on Shanghai road and highway network. Because of this, the traffic congestion and pollutant emission become more serious. If the airport can be accessed by inter-city rail, part of the road travel can be transferred to the inter-city rail.
- The main inbound and outbound transport mode in Yangshan Port and Waigao Bridge Port are waterway transit and road transport. They cannot accessed by rail and the transport system led by road transport cause the traffic congestion and pollution in the north side of Outer Ring Road of Shanghai and further exacerbate the transport infrastructure pressure in Shanghai-Nanning Highway and other highways along the river. It is hard to meet the requirements of increase outbound freight transport in Yangtze River Delta.
- Outbound and inbound inter-city transport to core hub influences the urban transport: Due to the irrational spatial layout of core hub of city cluster central city, or it is lack of efficient connections among different inter-city transport modes, it causes extra transport pressure to the central city causing congestion and pollution emission.

### 6.1.3 Lack of coordination in city cluster land development and transport construction

There is a lack of coordination in city cluster land development and transport construction. Meanwhile, alongside the boundaries between cities, the land development is not well coordinated which further generates transport funding issues. Including: city cluster transport environmental issues, lack of quantitative analysis in city cluster transport infrastructure planning and construction, the coordination mechanism between city cluster transport planning and construction is not fully established, the investment and financing of city cluster transport infrastructure is still needed to be explored.
6.2 Future challenges

Based on the future transport demand forecast and socio-economic development trend in the future, the following CC transport challenges are identified:

1) **Sustainable city cluster development framework**: It is unsustainable maintaining current city cluster transport development mode in the future: with rapid transport demand increase, the inter-city transport infrastructure construction is vital to meet such demand. If the road transport maintains the dominant, the traffic congestion, pollution and parking issues will be more severe in the future. Future development strategy of city cluster integrated eco-transport development should turn to the sustainable city cluster transport development mode.

2) **City cluster transport development goals and objectives**: Designating city cluster transport development goals and targets should consider the overall supply structure, passenger and freight demand by modes and select proper CO2 emission and energy consumption indicators. Those indicators are vital for implementing integrated eco-transport planning strategy, achieving city cluster sustainable development and energy conservation goals and assessing integrated eco-transport planning implementation.

3) **City cluster transport services**: Considering the aging population issue in China, future city cluster transport service should consider the travel demand by the elderly. The change in journey purpose will also affect the supply and service mode planning for various transport modes.

4) **Spatial development with TOD**: City cluster spatial development should coordinate with Transit Orient Development approach. The city clusters will attract more residents and new land use development and jobs are needed. It is one of the future challenges of integrated eco-transport planning on the introducing transit oriented development approach in land use development in achieving integrated eco-transport development.

5) **Air challenges**: For air, by 2050, inter-city aviation demand is predicted to increase 5-10 times than 2010. The significant demand increase needs to be considered by improving and expanding existing airports in the city cluster. It is also necessary to plan and construct the branch airport to increase the airport density. Considering the high cost of airport construction, it is another challenge for the future city cluster transport.

6) **Shipping challenges**: For shipping, the majority of city cluster have no integration in waterway and shipping resources. Shipping integration will become one of significant challenges for future city cluster transport development.

7) **Road challenges**: For road transport, congestion will become the prominent problem in future city clusters if no constrains is taken. Another prominent problem is the road safety. The safety in road transport is more prominent than other transport modes. The growth in private car use is another factor leading rapid development of road transport. The open market for road construction can attract more private funds and further promote the development of vehicle transport. This brings challenges to the planning and management of road construction.

8) **Rail challenges**: Problems on city cluster rail network: City cluster rail will obtain significant development in the future. The large amount of inter-city rail cannot follow the existing rail management system to construct and operate. In the future, it is necessary to innovate the system of rail construction, operation and maintenance to protect the rights and benefits of the investors and satisfy the requirement of inter-city transport; It is also a great challenge on how to integrate the new inter-city rail with the national high speed rail and other rail network to fully perform the benefit of city cluster rail network infrastructure.

9) **Institutional coordination**: City cluster transport construction system will face various new challenges in the future. The institutional coordination for eastern, central and western city clusters could be different considering the difference in development status.

10) **Service integration**: The large-scale construction of CC transport supply network brings the challenge of integrating the service network of different transport modes. A proper integration of service can help reduce travel cost and provide convenient intercity travel service.

6.3 CITY CLUSTER TRANSPORT DEVELOPMENT WITH NATIONAL STRATEGIES

6.3.1 CCC Transport Development Strategic Objectives

The ‘China New Urbanisation Planning 2014-2020’ proposes standard population coverage ratio of comprehensive
transport network in CCCs: By 2010, normal rail covers all the cities with 200 thousand populations and above, and rapid rail covers cities with 500 thousand populations or above. National road network covers all the counties and expressway network covers cities with population of 200 thousand or above. The ‘Comprehensive Transport Network Mid/Long Term Planning’ and ‘Urbanisation Integrated Transport Planning’ also propose specific objectives. The ‘Comprehensive Transport Network Mid/Long Term Planning’ issued in 2007 proposed that by 2020, construct a modern and reliable modern comprehensive transport network with clear layout, structure, high convenience and safety.

- By 2020, the mileage of comprehensive transport network should achieve 3.38 million km (excluding airlines, sea lines, and village roads)
- The mileage of road network should achieve over 3 million km (excluding village roads) with 650 thousand km highways of 2nd class or above and over 100 thousand km expressways. The total mileage of rail network will achieve over 120 thousand km with the double-line ratio and electrification ratio of 50% and 60%. The mileage of urban rail transit should achieve 2,500km. The mileage of inland waterway should achieve 130 thousand km, with 19 thousand km national waterways and 24 thousand waterways of 5th class and above.
- The throughput of sea harbours should achieve 6.5 billion tons and the containers throughput should achieve 240 million. For coal transport, sea and inland water harbour should have a total throughput of over 1.2 billion. For iron transport, the throughput should be above 350 million.

The ‘Urbanisation Integrated Transport Planning’ in 2015 proposes to further extend national major transport corridor to connect to the 21 main urbanisation areas. The objectives of comprehensive transport development in urban areas include:

- Beijing-Tianjin-Hebei, Pearl River Delta and Yangtze River Delta develop mature intercity transport network
- 1 hour travelling circle across nearby core cities and other node cities
- Basically form intercity transport network in other urbanisation areas
- 1-2 hours travelling circle across the majority of core cities and surrounding node cities
- The mileage of intercity rail should achieve 36 thousand km, including 8 thousand new-constructed rail and covering 98% node cities and 60% counties.
- Construct or reconstruct 13 thousand km expressways
- By 2030, the intercity transport network should be formed in all urban areas, with 1 hour travelling circle across core cities and node cities.

6.3.2 CCC Integrated Eco transport Development Strategy

CC integrated eco transport overall development strategy include:

- Integrate with national and regional policies and reflect the detailed requirements of national policies and development strategies.
- Actively develop CC transport infrastructure and satisfy the general requirement of CC transport to meet the demand of future socio-economic development and urbanisation.
- Use environment quality and energy saving objectives to strictly control the environmental impact of CC transport system. The transport model based on environmental constraints and energy conservation and emission reduction aims is needed to calculate and monitor the development trend of CC transport supply structure. Conduct transport SEA during the infrastructure planning, construction and operation stages to guarantee the achievement of eco transport objectives
- Develop intercity rail and peri-urban rail in east CCCs and strictly control road construction space in east CCCs; Support the development of intercity rail and promote the construction of integrated transport network in west CCCs.
- Optimise CC hub spatial layout and promote CC integrated transport hub service and collecting & distributing system
- Promote transport informatisation to promote the efficiency of transport planning decision.
- Implement the CC spatial development AOD strategy

6.3.3 CC transport network development strategy

**General strategies:** promote the construction of integrated transport network based on CC’s demands of external transport, through traffic, intercity transport and peri-urban transport; optimise comprehensive transport corridors and regional transport arteries, to improve connectivity and integration; develop intercity rail and peri-urban rail for CCs with proper development conditions and travel demands; For freight transport, focus on the development of water and rail freight; improve the external transport of small cities/towns; use transport network to guide urban layout and propose rail, road, air, water transport development strategies based on the local conditions.

In addition, other strategies are proposed including

- Road transport network development strategy:
- Rail transport network development strategy:
- Air transport network development strategy: Water transport network development strategy:
- Integrated passenger transport development strategy: Integrated freight transport development strategy:
- Propose intercity corridors classes and technical standards.

6.3.4 CCC transport hub development strategy
**General strategy:** Conduct the 42 major transport hub planning projects involved in ‘Middle/Long Term Planning of Comprehensive Transport Network’. Construct integrated passenger transport hub involving rail, road and air transport, and integrated freight transport hub involving rail, road, water and air freight. Conduct layout optimisation and function improvement.

Specific transport hub strategies include:
- Passenger hub integration strategy:
- Freight transport hub integration strategy:
- Improve passenger/freight transport service through technology innovation:
- Integrate hub construction and operation strategy:

### 6.3.5 CCC integrated eco transport environmental strategy

The planning, construction, operation and management of CCC transport facilities should meet environmental requirements. However, the current environmental impact study of transport projects only focuses on the construction process. The environmental strategy contains:
- transport planning stage: SEA or PEA
- infrastructure construction or operation stage: EIA (for construction/operation/and post stages)
- operation stage (transport department): integrated eco-transport evaluation

In the planning stage, estimate air pollution and energy consumption conditions of freight/passenger transport based on the predicted travel demand and the characteristics of transport equipment.

In the operation stage, monitor the travel demand, energy consumption and emission of passenger/freight transport, to examine whether the environmental protection objective can be achieved and find out further solutions.

### 6.3.6 CCC spatial development strategy with high transport accessibility

The existing national CCC transport policies state that the planning of logistics parks should be based on the locations and characteristics of freight hubs. Similar to the TOD model, all these policies aim to improve the accessibility of freight/passenger transport and increase the land value of surrounding areas.

CC transport oriented spatial development models include the following types:
- Transit oriented development (TOD)
- Freight accessibility oriented development
- Comprehensive transport network oriented development

To increase accessibility, CCC spatial and land development should take advantage of the following transport nodes and corridors including airport, harbour, HSR station, railway station, Intercity rail station, peri-urban rail station, areas along intercity rail, coach station, freight station, highway interchange nodes and expressway ramp entrance/exit.

### 6.3.7 CCC transport informatisation strategy

In the conventional national policy and planning, CCC transport informatisation is only a supporting measure. In fact, transport informatisation involves broad contents transport survey, planning, ITS facility, information platform, transport facility monitoring, data collection, infrastructure maintenance, transport demand management and emergency addressing.
- CCC transport informatisation and transport planning:
- CCC transport informatisation and transport operation efficiency.

### 6.4 CC Integrated Eco-transport Development pattern Suggestions

According to the analysis of the international city cluster transport development mode, it is suggested to focus on the points with regard to China city cluster integrated transport development mode design including identifying the transportation development mode, transport network indicator, integrated transport hub design, freight network and service, implementation of TDM measures, land-use and transportation integration, ecological transport and financial sustainability.

In general, the appropriate city cluster transport development mode means to under the premise of meeting transport demand, with targeted reducing impact of transport on environment, considering the affordability determine the appropriate transport supply scale and layout, applying management measure, favorable policies, urban planning, etc. improve transport efficiency, and establish a safe, efficient, convenient, comfortable and ecological city cluster integrated transport system.

Table 6.1 Recommendation on China CC Transport Development Mode
## Type of Economic Conditions

<table>
<thead>
<tr>
<th>Main Features</th>
<th>Eastern CC</th>
<th>Middle CC</th>
<th>Western CC</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>high level of economic development</strong>, <strong>high population density</strong>, cities are closely connected, well-developed road network, road and water dominate in passenger and freight transport; traffic congestion occurs in hub area and central area of core city; has many world-class national ports</td>
<td>relatively high level of economic development, confronting industrial transformation; core city expands rapidly, closely connected with surrounding cities; great through traffic; similar share of highway and railway in passenger and freight transport</td>
<td>Overall low level of economic development, low population density, relatively loose links between cities, great through traffic for certain core cities; weak transport infrastructure</td>
<td></td>
</tr>
</tbody>
</table>

| Predominant Transport Development Mode | Railway dominates in passenger transport and external freight transport; develop water-water transport and water-rail transport; the percentage of rail freight transport reduced to under 50% | for short term road and rail dominate in passenger transport, for long term rail dominates; rail dominated in freight transport for short/long term | Road dominates in passenger transport for long term, for short term develop passenger-freight mixed rail to be promote to passenger rail in long term; for freight transport both road and rail need to be developed. |

| Transport Network Indicator | Railway density over 4-5 times than highway | Railway density over 2-3 times than highway | Improve highway network and conditions, provide rapid metro service between core cities |

| Hub Design | Develop multiple mode passenger/freight hub | Develop multiple mode passenger/freight hub | Extend inter-city rail and freight rail to city centre and major industrial park/logistic park respectively |

| Freight Network and Service | Ensure water-rail transport at major harbour, where possible develop road-rail transport | Ensure water-rail transport at major harbour, for resource-based city clusters develop special freight railway and road-rail transport | Promote highway transport marketing, develop water-rail transport at major harbour and special freight railway for resource-based city clusters |

| TDM | Parking management (supply and charge) Restriction on car ownership and use congestion charge | Parking management (supply and charge) Restriction on car ownership and use | Parking management (supply and charge) |

| Transport Network Integration | Integrate various transport network, develop multi-mode passenger/freight transport and hub, integrate information service and ITS | | |

| Transport and Land Use Integration | Apply mobility-oriented land development mode, where possible introduce intercity rail to city centre and implement TOD around rail station plan freight hub or industry park at highly accessible nodes | | |

| Ecological Transport | EIA; Improve rail supply, reduce private transport and highway freight transport; Promote land use around hub, avoid low density development; Apply appropriate TDM measure to promote green, low carbon transport. | | |

| Financial Sustainability | The objective is: government investment in intercity transportation facilities does not exceed 50%, passenger and freight transport operations keeps profitable and does not need government subsidies. City clusters need to following their own economic situation and traffic demand apply suitable development mode to avoid over-advanced construction. | | |

## 7 CCC Integrated Eco and Low Carbon Transport Modes
The achievement of CC integrated eco transport development goals largely depends on the implementation status of CC low-carbon and ecological transport modes. This chapter will comprehensively consider the existing transport characteristics of CCCs and propose transport development model suitable to economic and ecological conditions, based on the transport demand characteristics in the future. The CC rational passenger/freight transport structure is the most effective way to minimise transport pollution and carbon emission. More details of transport structure modelling can refer to Section 4.2 (Chapter 4) in China City Cluster Integrated Eco Transport Planning Guidelines.

Rail is the most sustainable and eco-friendly mode for both passenger and freight transport. The development in rail can help China city clusters to achieve the designated eco-transport goals. Information technology supports city cluster rail freight development. Application of information in bulk rail freight at present enables the mode shift from road to rail for medium and long distance freight. It increases the rail freight efficiency, reduces emission and cuts the cost. Additionally, multimodal freight such as marine-rail freight, inner waterway-rail freight would increase the capacity and ratio of rail use in port distributing and delivering. Multi-modal freight with rail can further help to reduce congestion as the mode shift from road reduces the trunk number on roads.

The recommended travel mode structures for China city cluster eco-transport system are summarized in.

<table>
<thead>
<tr>
<th>category</th>
<th>Passenger Transport</th>
<th>Freight Transport</th>
</tr>
</thead>
<tbody>
<tr>
<td>external</td>
<td>HSR will be the key mode for external transport and short distance air trips will shift to HSR.</td>
<td>Rail will be the main mode for long distance freight. Geological limitation is a key constraint for developing freight transport by ship in the nation. Marine-rail and water-rail multimodal development is in need.</td>
</tr>
<tr>
<td>intercity</td>
<td>Intercity rail will be the dominant travel mode among eastern China city clusters. Intercity rail will also be developed as corridors connecting with central and western city clusters.</td>
<td>road for short distance freight transport (&lt; 80km) and rail for longer distance freight transport</td>
</tr>
<tr>
<td>urban</td>
<td>MTR will become the major travel modes in city cluster central cities and sub centres. Slow mode will be further developed with ground public transport in smaller and medium size cities</td>
<td>Improve the emission standard for urban logistics vehicles and use clean energy vehicles. Improve logistic efficiency by shared delivery, empty loading reduction and by other information technology measures.</td>
</tr>
</tbody>
</table>

Enhancing the fuel economy of vehicles and vehicle fleets is the single best opportunity to curb fossil fuel use and reduce CO2 emissions within the transport sector over the next decade. The improvement of vehicle technology is essential to achieve energy conservation and emission reduction. Achieving the target of energy conservation and emission reduction requires a combination of improved fuel efficiency; new types of vehicles, such as battery electric (BEVs) and plug-in hybrid electric vehicles (PHEVs); and alternative fuels capable of reaching very low CO2 emissions per kilometre (e.g. advanced biofuels).

In China, rail transport undertakes 31% of the total passenger turnover amount and 18.8% of the total freight turnover amount. The rail energy consumption occupies 5.2% of the national total transport energy consumption[83]. Rail is a relatively eco-friendly transport mode, while still has a great improvement space in China. The energy consumption of freight rail vehicles is much higher than passenger rail vehicles. The rail vehicle improvement objectives include increasing efficiency, reducing energy consumption and exploring alternative fuels. Other energy conservation techniques focus on the following aspects:

- **Balanced increase of rail and road transport:** As the total vehicle number and passenger/freight transport demand keeps growing, new transport infrastructure needs to be constructed. It is suggested to coordinate the rail and road transport development especially in CCCs with an integrated concern on construction cost, capacity and applicable conditions.

- **Reduce infrastructure construction through avoid/transfer strategy:** Infrastructure projections were adjusted to reflect road and rail travel changes with Avoid/Shift measures. While vehicle technology and fuel improvements decrease overall energy consumption in the transport sector, the Improve case does not produce any changes in overall vehicle infrastructure demand (not including fuel recharging infrastructure which is considered part of the fuel infrastructure). The cost can be saved by optimizing the layout of transport infrastructure and avoid unnecessary construction, denser land use development.

- **Develop green freight:** In China, the strategies can be applied to develop green freight in China involve cultivate the awareness of green freight for enterprises and consumers; establish efficient freight information platform for green freight development; improve and apply new technologies and improve institution to guide green freight & logistics development.
8 CCC Integrated Eco Transport Assessment and SEA

In general, transport projects include planning, project approval, construction, operation and maintenance, deconstruction stages. For each stage, the assessment of potential environmental impacts is necessary. Although China has developed a comprehensive environment impact assessment system for construction projects, it cannot fully reflect regional environmental impacts under the background of city cluster integrated transport development. It is crucial to implement Strategic Environmental Assessment (SEA) in planning, operation and maintenance stages. Introducing SEA in city cluster eco-transport planning can decision makers to identify whether the environmental capacity can support social and economic development. According to existing city cluster integrated transport development, the SEA should further adopt the concept of eco-transport. The fundamental task of SEA is for ecological protection and pollution prevention. Based on the understanding of city cluster transport features, key tasks of SEA and PEA include:

- Identify the pollutants and emission levels, and the objectives of carbon emission reduction and energy conservation.
- Test whether the condition can meet the requirement of ecological limitation especially for PM2.5
- Identify regions and areas which the planned routes should be keep clear. Natural conservation area, tourism destinations, drinking water conservation area, rare species conservation area, cultural relics protection sites are regarded as environmental sensitive regions.
- Propose set back requirements along the short-term constructed routes. Residential land use should be avoided facing the planned railroad directly and also should meet the noise requirements.
- Identify reservation area and spatial reservation for intercity transport corridors. Propose site selection requirements for maintenance sites, hubs, service area, road network and corridors and reduce land taken.
- Rail route connection to the urban area and speed control suggestion which meets urban area noise standard.

In terms of SEA application, suggestions are proposed including the following 6 aspects:

- Policy & law suggestion: Improve the SEA legislations and regulations, and strengthen the legal status of SEA for the CC integrated transportation planning. Build SEA safeguard system based on the Law of the People's Republic of China on Evaluation of Environmental Effects and national legislation, policies, and regulations issued by environmental protection departments. Improve the authority and effectiveness of SEA related laws and regulations, and strengthen the legal status and influence of SEA.
- Management institutions: In order to improve the monitoring effect on the management regulation level, city cluster should improve regulation protection system of city cluster integrated transport planning strategic environmental assessment on the following basis
  - Improve SEA evaluation system and implementation procedures
  - Cities should implement the vertical management of environmental protection, to avoid the excessive intervention of local governments on city cluster comprehensive transport SEA and approval
  - Establish incentive and punishment mechanisms for CC integrated transport SEA. Establish SEA evaluation indicators, environmental impact assessment to develop transportation incentive and punishment mechanism
- Major subject: The proposed SEA safeguards in this chapter are applicable to both city cluster transport master plan and specific transport plans.
- Implementation process: Transport modelling, as a technical solution, helps to find the appropriate structure for city cluster passenger and freight transport achieving ecological conservation and pollution prevention goals.
- Management effects: From the perspective of city cluster development management, there is no coordinated institutional arrangement for city cluster integrated transport. It is necessary to propose a city cluster SEA institutional arrangement based on PRC Environmental Protection Law.
- Institution guarantee: In order to improve the legislation and regulation framework within which CC planning can include SEA adoption, there are several ways in which SEA can be promoted.
  - Establish and improve the city cluster transportation planning SEA guarantee system.
  - SEA practitioner training and improve the general environmental awareness.
  - Improve SEA methodology and evaluation system.
  - Enhance communication and cooperation and improve public consultation.

Regulation and codes for project EIA is developed but suggestions are proposed for EIA practice at city cluster level:

- Coordinate construction department with management department and EIA department
- Encourage the legislation integration and planning integrated between different administration bodies
- Joint audit and review for construction project EIA


## 9 CCC Integrated Eco-transport Institutional Arrangements

In order to investigate domestic city cluster transportation construction institution, international regional planning institutions have been reviewed. Recommended domestic city cluster transport institution types will be proposed. Current international regional planning and construction institution can be summarized as four modes: Non-governmental organizations, government planning agencies, joint planning agencies between governments and coordination agencies with a single function for coordination between local governments.

According to international best practice presented in previous sections, international transportation institutional arrangements can be divided into two typical types from US and Japan which are applicable to China:

- **Option 1**: The option is the represented by the MPO of United States, established by the federal government (central government) funding as a single city cluster transportation planning agency which manages and coordinates transportation planning and seeks federal government funding. Including the development and maintenance of city cluster transport planning model, preparation of a 20-year transportation plan, develop city cluster five-year transportation construction plan, auditing transport projects that local governments apply for federal funding, approved the payment of the federal government funding and other transportation construction funds, assessing local government transport planning and implementation effects.

- **Option 2**: This mode is represented by Japan with regional management and coordination agency directly under the jurisdiction of the central government, including central government, local government, business, university professors and other members, to carry out all kinds of regional planning, including regional spatial planning, etc., and to assume transportation planning and construction management duties.

### Table 9.1 Domestic city cluster regional planning and construction options and applicability

<table>
<thead>
<tr>
<th>City cluster planning and construction types</th>
<th>Type 1 government planning agencies</th>
<th>Type 2 joint planning agencies between governments</th>
<th>Type 3 Coordination agencies with a single function</th>
</tr>
</thead>
</table>
| **Characteristics**                       | 1. The agency has strong management capabilities  
2. It can effectively play the role of the government macro-control of the city cluster development  
3. The contribution of local governments is restricted | 1. The agency has weaker management capabilities  
2. It can play part of the role of the government macro-control of the city cluster development  
3. The contribution of local government is higher | 1. The agency has quite strong management capabilities  
2. It can efficiently play the role of the government macro-control of the city cluster development  
3. The contribution of local government is restricted in specific areas, but in other areas is unconstrained |
| **Applicability**                         | 1. The relationship between city cluster is complex and the coordination of different infrastructure planning and construction is difficult  
2. The level of development of each city differs significantly, and need to strengthen the macro-control  
3. Low level of regional development, local government lack of experience in planning and management and the degree of market operation of city cluster planning and construction is low | 1. Each city economy is independence, high levels of economic development, city cluster has a tradition of government coordination  
2. The level of development of each city is close  
3. High level of regional development, local government has rich experience in planning and management  
4. High degree of market forces operations of city cluster planning and construction | 1. Single factor restricting the development of city cluster  
2. The factor lead to a complicated and serious conflict on interest coordination  
3. The single factors will have a significant impact on the future development of city cluster |
| **Examples**                              | Beijing-Tianjin-Hebei CC: Economic development in Hebei province is lower than Beijing and Tianjin. The complex relationship between Hebei, Beijing and Tianjin, coordination task is extremely difficult | Yangtze river delta CC: Has a tradition of coordination between cities within city cluster, and the level of development of each city is with a similar high degree of market-oriented operation | The coordination problems of the intercity transport infrastructure |
City cluster traffic construction Option 2 is essentially the city cluster planning Type 1, combined the city cluster traffic construction and the city cluster planning types, there are 3 main types for China city cluster transportation institutions:

- Type 1: it is part of the city cluster planning institution and managed by the city cluster regional planning agencies.
- Type 2: It is part of the joint planning agencies between governments.
- Type 3: City cluster set up an independent transportation planning and construction agency.

For the city clusters that are still in the beginning stage, due to the lack of connection among cities, the necessary coordinated affairs are not great so that the Type 3 is feasible, that is to establish the sole functional regional coordination institution, such as transport coordination committee. With the development of the city cluster, the connections will be closer among cities; there will be more coordinated affairs. Under this circumstance, sole functional regional coordinated institution is hard to meet the requirements. It is feasible to expand the function of the institution, changing it to Type 1 or 2.
10 Funding and Financing Policies for CCC Integrated Eco-transport

Based on the analysis of China city cluster transport funding and financing policies, suggestions of transport infrastructure funding and financing are proposed in terms of institution design, market tools, central government finance controls, strategic TOD, and regional differentiation.

Table 10.1 the general recommendations for transport infrastructure funding and Financing

<table>
<thead>
<tr>
<th>Category</th>
<th>Main policy recommendations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Institution Arrangement</td>
<td>Establish CCC specific coordination institution. CCC transport infrastructure construction is fundamental to achieve planning objectives. A specific institution is needed to manage infrastructure construction according to CCC planning. Improve the funding utilization efficiency. Positively improve budget performance management system. Strength the inner control, project management and cost control so that the efficient use of the funding can be increased. Improve the legal protection and attract private capital through investment protection. Optimise and upgrade the city investment company. City investment company is created to meet the financing needs of transport infrastructure construction, it achieves financing through a bank loan, issuing medium-term bonds etc., has become an important tool for transport infrastructure construction funds in China.</td>
</tr>
</tbody>
</table>
| Diversified marketization financing | With the improvement of the market system, varieties market financing will continue to become the important funding sources for the transport infrastructure.  
- Public-private partnerships (PPP) mode.  
- Form a long-term and stable funding source.  
- Issue China style bonds.  
- New added tax for transport infrastructure construction, traffic impact fee for instance. |
| Control of central finance      | Local government plays the leading role of financial investment, improving the investment. The government should have the leverage to introduce more private capital into a public transport sector by providing return guarantees and risk reduction. The government led investment can be improved by multiple ways:  
- Strengthen the financial guarantees for the expenditure of the transport infrastructure  
- Make use of the central transport special funding investment and financing policy  
- Properly resolve debts and financing for under-construction project |
| TOD joint development           | The joint development of transport and land is mainly introduced for urban areas. The construction of transport infrastructure can increase the land and real estate price of surrounding areas and promote the development of relevant industries. Among different transport modes, metro, regional rail and HSR has the most obvious influence of land price increase of surrounding areas, while the effects of road and expressway are relatively slight. Through transport infrastructure construction and surrounding land development, drive real estate development and property rent business to make more profits. |

<table>
<thead>
<tr>
<th>Characteristics of different transport infrastructures</th>
<th>Category</th>
<th>Infrastructure</th>
<th>Suggestion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-profit</td>
<td>Urban road, non-toll road, bridge and road greening</td>
<td>Governmental finance as the major source with the support of taxes and fees</td>
<td></td>
</tr>
<tr>
<td>Quasi-profit</td>
<td>HSR, metro</td>
<td>Abstract private investment with governmental subsidies</td>
<td></td>
</tr>
<tr>
<td>Profit</td>
<td>Toll road, including expressway</td>
<td>Rely on the private market with the management and supervision of the government</td>
<td></td>
</tr>
</tbody>
</table>

| Different regions | Based on the different development conditions of east, middle and west CCCs, different standards and patterns can be implemented accordingly, in the aspects of transport infrastructure toll, governmental finance support, market funding and funding alternatives. |

Since different transport infrastructure has its own features, the detailed recommendations for each transport mode are:

Table 10.2 the specific recommendations for transport infrastructure modes on funding and Financing

<table>
<thead>
<tr>
<th>Category</th>
<th>Main policy recommendations</th>
</tr>
</thead>
</table>
| Road     | Adjust central investment policy, balance investment and financing development for regional highway: the state should carry out preferential policies for relatively poor areas and towns in middle and western region and, and through cross subsidy payments or other means to make the eastern, middle and west area develop in coordination to reduce inter-regional differences in the level of economic development.  
Stabilize and expand existing financing channels to ensure rapid development of highway construction: The Government should stabilize the existing investment channels, to guide the market develop orderly, use foreign investment, encourage private capital to participate, expand investment and financing sources.  
Improve regulations and policies to accelerate the CC area road infrastructure privatization: At present, China's private |
The following two financing forms should be considered in CCC transport development:

- Transport infrastructure + land use development: this form is suitable for intercity rail/urban rail transit financing. Rail is a good choice for city cluster eco-transport development with higher efficiency and lower energy consumption and emission. This financing form is recommended which encourages land use development along the rail transit routes.
- Regional differentiation financing: this approach is suitable for China as regional development status is quite different. Due to the different modes of transportation infrastructure and different characteristics, combined with the funding and financing characteristics of various transportation infrastructure, the applicability of all types of transportation infrastructure funding and financing modes are summarized as follows:

<table>
<thead>
<tr>
<th>Category</th>
<th>Main forms</th>
<th>Road</th>
<th>Railway/Intercity railway</th>
<th>Hub Passenger hub</th>
<th>Hub Freight hub</th>
<th>Public traffic/Rail transit</th>
<th>Air</th>
<th>Pipeline</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Government-</td>
<td>Financial investment, bank loans, bonds, etc.</td>
<td>++</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>++</td>
<td></td>
<td>++</td>
</tr>
<tr>
<td>led finance</td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

| Table 10.3 The applicability of different transport infrastructure funding and financing modes |
| Government investment + Marketing operation | Public-Private Partnerships (PPP) | - | ++ | ++ | + | ++ | ++ | ++ | + |
| Transport infrastructure + Land Development | Land development income, increment tax on land value etc. | - | - | ++ | ++ | + | ++ | ++ | + |
| Diversification project financing modes | BOT, BT etc. | - | ++ | + | + | ++ | ++ | + | + |
| Transport fund | Transportation construction funds | ++ | + | + | + | + | + | ++ | ++ |

Note: "++" is very useful, "+" is applicable, "-" is not applicable.
11 CCC Integrated Eco Transport Development Policy Study

In order to achieve the city cluster integrated transport development with Ecological as the core, the national, regional and local policy guarantee and support is needed. The key point of this chapter is to analysis the existing policies related to city cluster eco transport development and summarize the issues. Then, propose the policy making ideas which guide to adjust the existing policies and propose new policies which are consistent with the requirements of city cluster integrated eco transport development.

Currently, the major CCC integrated eco transport development strategies include transport strategies and management policies, transport planning and technical capacity policies, transport oriented development related policies and other related policies.

City cluster integrated eco transport policy is to guide the systematic development of city cluster. By the integration and coordination action of policy, to promote the city cluster transport system development and management orderly. The recommendations for the city cluster integrated eco transport policy mainly includes Transport planning control, Transport planning technique, Transport institution, Transport Funding and Financing and Transport oriented development. The detailed information is:

<table>
<thead>
<tr>
<th>Policy direction</th>
<th>Issues</th>
<th>Adjustment Recommendations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transport planning control</td>
<td>1. Lacking legislation and regulation for:  - There are some issues in the integrated transport institution and lack of legislation.  - The State Council formulated the city cluster planning management regulations, but lack of the law force and difficult to implementation and evaluation  - Cross-provincial city cluster planning lack of law or regulation. The integrated transport planning, approval, implementation and evaluation process is missing.  - Corresponding departments for transport infrastructure planning approval.  2. Separate spatial planning.</td>
<td>1. Integrated the road/rail/air legislations as integrated transportation legislation to guide the planning, construction and management of city cluster integrated transport. All transport modes should be managed by a single department to avoid the overlap in management functions.  2. adjust existing City and Town Planning Act with city cluster town planning and guide city cluster integrated transport planning  3. establish an auditing institution for city cluster integrated transport planning  4. integrate various planning deliverables</td>
</tr>
<tr>
<td>Transport planning technique</td>
<td>1. Lack of city cluster regional integrated transport planning standards and regulations. Existing transport planning technical standards are not ideal. Outdated standards. Weak coordination among different standards.  2. Lack of approaches for transport planning quantitative technique. Transport planning lacks of the support of transport modelling  3. Lacking sustainable transport planning policies. There is a lack of ecologic integrated transport assessment indicator system</td>
<td>1. Develop new transport planning technical standards and timely update the existing technical code and standard.  2. Accelerate the development of integrated transport model for national, provincial and inter-province city cluster. To promote the transport model assessment techniques during the city cluster integrated transport planning.  3. To improve the transport basic survey task for the transport model; to add the work place and commuting mode information during the population census, to cooperate with the National Tourism Administration, adding the commuting trip survey in the ongoing tourist transport survey; to improve the transportation statistical system and add the private car travel indicators  4. Promote the application of the city cluster eco transport evaluation indicator system and can be improved in practice.</td>
</tr>
<tr>
<td>Transport institution</td>
<td>1. Lack of institutionalization coordination among cities in terms of city cluster transport planning, construction and management in city cluster.  2. Lack of specialization institution body to manage the city cluster transport plan and construction.  3. Lack of technical department and decision making in city cluster which can support the transport related policy making for city cluster.</td>
<td>1. East city cluster can set up a comprehensive coordination institution to coordinate the land use, environmental management, industry cooperation and transport planning and construction. The middle and west city cluster can set up the institution with single function. This institution is responsible for the transport plan and construction related things. The technical department in this institution is responsible for the management and maintenance for the city cluster integrated transport model. And the decision department in this institution can consist of the leaders from Ministry of Transport, Transportation department.  2. The daily fund for the institution should be provided by national and provincial transport department directly. The support capital from national to local should be audited by this institution.</td>
</tr>
<tr>
<td>Transport Funding and Financing</td>
<td>1. The investment capital scale for transport infrastructure is enormous and has a huge gap in the future funding.  2. At present, many local governments debt is very</td>
<td>1. Proposed the funding and financing mode through Institution Arrangement, Expand funding channels and options, Control of central finance, TCD joint development, Funding &amp; financing patterns for different regions. The “transport infrastructure + land development”</td>
</tr>
<tr>
<td>Policy direction</td>
<td>Issues</td>
<td>Adjustment Recommendations</td>
</tr>
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<tr>
<td><strong>Transport oriented development</strong></td>
<td>1. The policy and safeguard measures for transport oriented development (TOD) is insufficient. And only have some transit oriented development (TOD) policies. It lacks of TOD policy at city cluster level and other transport oriented development policy. 2. The coordination on Transport oriented development among cities in the city cluster has many issues in terms of institution, planning policy, investment cost-benefits share.</td>
<td>1. Combined with the current state of city cluster is promoting rail transport infrastructure demonstration projects and piloting the transport accessibility oriented development. 2. According to the pilot process problems, targeted the development of relevant planning policy, land policy, funding policy and advocacy policy, to ensure the transportation accessibility oriented land development can be smoothly carried out.</td>
</tr>
</tbody>
</table>
12 Conclusions

City Cluster integrated eco transport through systematic research, planning, management of transport and environment-related aspects, mitigates the transport system impacts to the environment within the ecological limits. The city cluster transportation not only transfer passenger, freight and information flow to support and guide the development of socio-economic, but also through the AOD and systematic traffic planning and design, improve, beautify and enhance the city cluster’s spatial distribution and regional ecological environmental quality.

The main features of this study include:

- The passenger and freight distance is a key indicator to measure polluting emissions, environmental impact and the transport activity intensity. This study recommended the application of the passenger/freight transport supply optimization model at the strategic level. This model is based on the pollution limits of regional transport, maximizing supply, to obtain the feasible solution for each transport mode with its capacity. This can guide the city cluster transport strategy and guarantee the achievement of the plan objectives.

- The city cluster transport plan also proposed the transport accessibility oriented land use plan suggestion to ensure the plan can significantly improve the transport accessibility in nodes and corridors and guide the regional land development. Meanwhile, the government can capture the land value incremental benefit by the transport investment in these nodes/corridors. Then, the government can manage these nodes/corridors effectively through land use plan.

- Environmental impact evaluation throughout the whole transport decision-making process and the construction of transport facilities. Including: the SEA in planning phase, the EIA in construction and operation phase.

After analyse on the benefits of energy saving and emission reduction for each transport mode, rail is the most effective strategic mode. Rail infrastructure carries 10 times more transport units per kilometre than roadways, while using nearly 40 times less land than roads. On average, every dollar spent on rail infrastructure results in between 3 and 10 times less CO\textsubscript{2} emissions compared to each dollar spent on road. For non OECD countries, dominated by India and China, compared to the 4DS scenario, the 2DS scenario can save 6.7 million lane kilometres newly road construction and 13.6 trillion USD can be saved on the road and parking construction. However, the total investment for high-speed railway, normal railway and BRT facilities is only 300 billion USD. This can newly construct 200 thousands railway kilometres supply to meet the shift transport demand from road. Therefore, in 2050, if the developing countries chose the right inter-city transport mode, and move to railway and BRT construction, more than 13 trillion USD can be saved on the road and parking construction.

Compared to 2015, the national passenger/freight transport demand increases by 100% in 2030 and 2.5-fold in 2050. If using the existing development strategy for road, rail and air, compare to 2015, the average annual passenger trip length will increase by 2.4 times. Among them, the road will increase 2.3 times, and 2.4 times for rail, 3.5 times for air. This forecast result means that if we continue to use the existing transport development strategy, there will face great challenges on transport infrastructure construction, transportation structure, transport management, environment, construction capital etc. And it is hard to achieve the city cluster integrated eco transport plan objectives.

Therefore, the general strategies include: establish transport supply structure meeting environment protection and emission reduction targets; develop intercity rail and peri-urban rail for eastern CCCs and properly control the space of road construction; develop intercity rail and comprehensive transport network for west CCCs; optimise the layout and integration of CCC transport hubs; conduct the environmental impact assessment of transport planning, construction and operation; promote transport informatisation to improve efficiency; and conduct CC spatial development and planning to improve transport accessibility.

Also, the transport strategies on transport network, transport hubs, eco transport environment, transport accessibility oriented development and transport informatization are also proposed. It is recommended that China city cluster should adopt the passenger transport development patterns like Tokyo metropolitan where rail is the dominant passenger mode and New York metropolitan where rail and water mode is the dominant freight mode. The rail density is more than 4 times the freeway network for this transport pattern with well-developed transport hubs, effective transport demand management and integrated transport service integration, maintain good inter-city transport operation financial situation, guide the spatial development in the city cluster and create good spatial form. And then the city cluster integrated eco transport development objectives can be achieved.

Other key conclusions on transport policy study include:

- to guide the integrated transport plan, construction and management in city cluster. A single national central ministry or sector to manage all kinds of transport modes to avoid the overlap on responsibility and authority in different sectors.

- Adjust existing City and Town Planning Act with city cluster town planning and guide city cluster integrated transport planning.

- Develop new transport planning technical standards, timely update existing technical norms and standards. Promote the application of the city cluster eco transport evaluation indicator system and can be improved in practice.
Accelerate the development of integrated transport model for national, provincial and inter-province city cluster. To promote the transport model assessment techniques during the city cluster integrated transport planning; to improve the transport basic survey task for the transport model; to add the work place and commuting mode information during the population census, to cooperate with the National Tourism Administration, adding the commuting trip survey in the ongoing tourist transport survey or travel diaries; to improve the transportation statistical system and add the private car travel indicators.

Set an integrated transport planning professional management institution in city cluster level, its operation capital should be provided by the higher transport authorities, responsible for auditing the national funds apply for transport construction projects in city cluster, management of city cluster integrated transport plan and developing the short-term transport construction plan, maintenance of the city cluster transport model.

Proposed system design, expand the sources of funds, regulation of central financial resources, TOD bundled development, regional differences in investment and financing mode for city cluster transportation construction investment and financing policy recommendations.

Combined with the current state of city cluster is promoting rail transport infrastructure demonstration projects and piloting the transport accessibility oriented development. According to the pilot process problems, targeted the development of relevant planning policy, land policy, funding policy and advocacy policy, to ensure the transportation accessibility oriented land development can be smoothly carried out.
A PLANNING GUIDELINE
Foreword

Urbanization is to continue as one of the main features of China's development in the near future, and is one of the major drivers and key components of China's economic development. A new urbanization strategy has been set out which proposes new development strategies at the national level. The National Strategic Function Zoning Plan was issued by the Government in 2010 which recommended to promote city cluster as the main form of urbanization development; and as stated at the urbanization seminar, “adopt city cluster as the main form of strategic urbanization development”.

Importantly, transportation development must adapt, serve and lead this city cluster strategy. The development of city cluster integrated eco-transport system is the main transport planning vision of the 13th Five Year Plan and beyond. This report is the China City Cluster Integrated Transport Planning Guidelines, and is an important component of China City Cluster Integrated Transport Development Project funded by the Global Environmental Facility (GEF). The report will be reference for Ministry of Transport to compile the government sponsored China City Cluster Integrated Transport Development Project.

1 General Guideline

1.1 OBJECTIVES AND FUNCTIONS

1.1.1 City cluster eco-transport planning will be consistent with the implementation of the national urbanization and regional development strategies and will support and guide of city cluster development, and mitigate harmful emissions from the transportation industry by energy saving and emission targets.

1.1.2 City cluster eco-transport planning is a vital component of city cluster development planning and will be statutory policy document to guide the city cluster eco-transport development. The plan is the basis from which to compile the short-term transport construction plans and project implementation for city clusters, as well as the external transport and hub planning of cities within the city cluster.

1.1.3 City cluster eco-transport planning is designed to meet the future development demands of city clusters in a balanced way, by allocating transport resources through quantitative analysis whilst promoting comprehensive, green, safe and smart transport, by integrating transport subsystems of the city cluster rationally and building a sustainable-development eco-transport system of the city cluster.

1.1.4 City cluster eco-transport planning is the foundation for transport infrastructure and facility planning, construction and operations of each city in the city cluster as well as the coordination of major schemes between the cities.

1.2 KEY PLANNING REFERENCES

1.2.1 Key planning references are listed below:
- National strategic function zoning plan
- National New-type Urbanization Plan
- Comprehensive transport network mid and long term plan
- New-type Urbanization comprehensive transport network plan
- national/regional regulation and legislation on city cluster planning and regional planning
- City Cluster urban system plan
- The Provincial and city master plan or urban system plan related to city clusters
- The Provincial and city comprehensive transport plan related to city clusters
- Other related planning documents of city clusters
- Previous eco-transport plan and short term construction plan of city clusters

1.3 PLANNING PRINCIPLES AND PLANNING REQUIREMENTS

2 Main Phases and General Scope of Work

There are three main phases of city cluster eco-transport planning which includes: existing conditions, detailed analysis on specific issues and planning draft.
3 Planning Contents

3.1 INTRODUCTION
3.1.1 Main contents for CCC planning include:

- **Existing condition analysis/existing planning review**

- **Transport modelling**
  - Demand forecast

- **CC integrated eco-transport development strategies**
- **CC integrated eco-transport development objectives**

**Evaluation of CC integrated eco-transport Plan**

- **External corridor plan**
- **Internal corridor plan**
- **Transport hub plan**
- **Transport Informatization plan**
- **TOD land use suggestions**

**Disapproved**

**Approved**

- **Short-term construction plan**
- **Planning implementation and safeguard measures**

3.2 EXISTING CONDITIONS AND PLANNING REVIEW
3.2.1 The analysis of existing conditions and planning review is the basis of the overall plan, including:

- **Social-economic existing condition analysis of city cluster**: historical change of population quantity and structure, economy developing trend, industry structure, the change of job quantity and structure.
- **Existing land use development of city cluster**: historical expansion of the city land use, density of population and jobs, and change of constructed area. This analysis is to illustrate the land use spatial characteristics changes of the city cluster. The existing condition of TOD and freight hub oriented land use should be emphasized.
- **Existing condition of transport of city cluster**: transport infrastructure and structure, traffic demand, transport supply service, the level of service of key transport facilities. The analysis of node of transport network with high accessibility should be included.
- **Analysis of future economy of city cluster**: the analysis would base on the social-economic planning and forecast result of related planning of cities within the city cluster.
- **Analysis of land use plan of city cluster**: review city cluster urban and rural system plan and other related urban and rural plan; and review the master plan, regional plan and even regulatory plan which covers key interchange of cities in the cluster. An evaluation should be provided for analysing the consistency of current land use plan compared with transport network accessibility oriented land use mode.
- **Review of existing transport plan of city cluster**: the plans should be reviewed including existing comprehensive plan of city cluster, intercity transport railway and highway network plan. The comprehensive transport plan, external transport plan and related specific transport system plan (especially interchange plan, peri-urban railway plan, etc.) should be included as well. By this review, the node and areas with high accessibility of the city cluster transport network should be identified.
- **Analysis of transport construction and coordination institutions**: including transport construction condition of the city cluster, and the coordination institutions in transport planning, construction and management of city cluster. Existing issues and successful practices should be analysed as well.
- **Diagnosis of city cluster transport issue**: on the basis of identification of the development stage of city cluster transportation, the issues of transport network, interchange, network accessibility and oriented landuse development, coordination of transport planning, construction,
3.2.2 City cluster transport existing condition and planning review should include the following contents:

- Based on quantitative analysis to clearly identify the transport existing conditions and future planning prospects of the city cluster by using data analysis and clear qualitative analysis, and then summarizing the existing transport issues and future challenges of the city cluster.
- Discuss the relationship between city cluster social-economic development, spatial structure, land use and its transformation, transport development. Identify existing issues based on the discussion
- Summarize city cluster social-economic level and city cluster industry structure, city cluster transport demand characteristics, funding and financing conditions and issues
- Analyse the features of city cluster population and workers and the impact on transport demand

3.3 TRANSPORT MODELLING AND DEMAND FORECAST

3.3.1 Demand forecast is a core requirement of city cluster transport master plan. The transport demand forecast of city cluster is a much larger area than a city, and needs to be analysed at the regional estratégic level. This requires a robust regional passenger and freight transport model to support the external and through passenger and freight transport demand forecast of the city cluster.

3.3.2 The transport demand forecast of city cluster needs the support of a rigorous and scientific multi-modal transport model. The model can effectively support the testing and analysing of different scheme options (scenarios) to optimize the planning and design schemes and test the scope of the facility and construction phasing plan. This approach avoids substantial cost caused by excessive construction of large transport facility with limited demand. The model also enables the testing of phasing and coordination of projects to maintain social benefit.

3.3.3 The base year multi-modal transport model should be developed including airway, highway, railway and other passenger transport modes, and waterway, highway, railway and other freight transport modes. The time profile for different type of days should be identified especially daily and peak hour traffic demand of a typical normal day. The type of demand includes external and through traffic demand, intercity traffic demand, core city peri-urban railway demand, for both passenger and freight transport and different transport modes in the city cluster. The fully developed transport model should be validated by standard modelling calibration/validation values, whilst accepting the strategic nature of the model.

3.3.4 The forecast year transport model is developed on the basis of the base year model with planned population, jobs, land use development, transport networks and other background plans to forecast demand of different transport modes and test city cluster transport policies or strategic plans. Intercity/larger distance travel is coupled with GDP growth, so it is necessary to integrate this into forecast model as well as the ability to model induced or generated demand and local/rural redistribution of residents and attractions.

3.4 CITY CLUSTER INTEGRATED ECO-TRANSPORT DEVELOPMENT STRATEGY

3.4.1 The overarching strategy is the core content of the city cluster integrated eco-transport plan, and is the basis and guidance of the followed planning and evaluation indicators adapted.

3.4.2 The strategic analysis of the transport supply structure is based on the target indicators and constraints of meeting the targets of transport emission of pollution and energy consumption. An optimized passenger and freight transport model will have the target to optimise the entire transport supply of city cluster to save time, cost and energy. Standard models can be used find the optimal solution of passenger km and freight ton km for each transport mode within the city cluster, and subsequently an optimized supply structure for passenger and freight transport is provided. A suitable passenger and freight transport supply scale and structure which meets the requirements of emissions, pollution and energy consumption can then be selected.

3.4.3 City cluster transport network development strategy includes general strategies, transport network hierarchy strategy, low-carbon transport modes priority strategy and transport network integration strategy.

- **General strategies**: promote the construction of integrated transport network based on city cluster demands of external transport, through traffic, intercity transport and peri-urban transport; optimise comprehensive transport corridors and regional transport arteries to improve connectivity and integration; develop intercity rail and peri-urban rail for city cluster within development conditions and travel demands; For freight transport, improve vehicle technology of freight and optimise sustainable logistics. Focus on the development of water and rail freight; improve the external transport of small cities/towns; use the transport network to guide urban layout and propose rail, road, air, water transport development strategies based on the local conditions.
- **Transport network hierarchy strategy**: city cluster transport network including airway network; a railway network with speed of 250km/h; 120~200km/h; 80~160km/h; expressways with 120km/h speed limit; and national/provincial highway with a 80km/h speed limit; and waterway transport with lower speed.
- **Low-carbon transport modes priority strategy**: intercity railway and waterway freight transport are both low-carbon transport modes and also the key transport network that is valued by sustainable cities. Based on different characteristics, city clusters in East, Middle and West of China will have different development strategies. The specific strategies for east, middle and west CCCs are different.
- **Transport network integration strategy**: based on different features and technical requirements of transport modes (with the prerequisite of meeting the requirement of environment and energy consumption) coordinate the transport modes to meet the city cluster transport demand, to realize optimal transportation efficiency,
minimize transportation cost, provide reliable transport network service and other operation and management objectives.

- The specific development strategies of air, rail, road, water and pipe networks need to be specified and should be based on the national master transport network planning.

3.4.4 City cluster transport hub development strategy includes general strategy, passenger hub integration, freight transport hub integration, strategy of improve passenger/freight transport service through technology innovation, integrate hub construction and operation strategy, and other transport strategies:

- **General strategy:** implement the transport hub plan of cities in the city cluster in medium/Long Term Planning of Comprehensive Transport Network. Construct integrated passenger transport hub involving High Speed Rail (HSR) station, intercity rail station, coach station and air transport, integrated freight transport hub involving rail, road, water and air freight. Conduct layout optimisation and function improvement.

- **Passenger hub integration strategy:** based on spatial structure and travel features, construct passenger hubs with different levels and functions to connect CC external transport, internal transport and urban transport. Achieve seamless interchange of urban rail transit, road public transport, peri-urban rail, artery rail, intercity rail, road and airport. Simplify transfer process and reduce transfer distance. The integrated layout of regional transport airports and intercity rail stations can mitigate the traffic pressure on regional highways in city cluster central cities.

- **Freight transport hub integration strategy:** optimise the spatial layout of freight hubs, industry parks and logistics parks; enhance the integration of freight hubs to achieve convenient, safe and seamless freight transport and lower cost; Rail freight hubs can connect to road freight collecting and distributing networks and construct interchange facilities; Freight ports can connect to rail freight collecting and distributing networks and expressways; Freight airports can connect to high class roads and other freight facilities and corridors; Road freight hubs should connect to supporting road freight collecting and distributing networks to improve function and efficiency.

- **Strategy of improve passenger/freight transport service through technology innovation:** In the construction and operation of CCC transport hubs, integrate existing information resources and establish information sharing platform to provide real-time travel information; For passenger transport, establish integrated travel system for rail, road, water and air transport, and promote unified and convenient online ticketing network; For freight transport, promote multimodal transport such as sea-rail freight and container freight transport.

- **Integrate hub construction and operation strategy:** Encourage private sector to conduct the design, construction, operation and management of transport hubs according to comprehensive transport hub planning; The design of transport hubs should follow the principal of integration, with coordinated arranges the construction schedule of facilities, to guarantee coordination operation of all facilities; Innovate management model and optimise coordination institutional arrangements, and establish specific transport hub management and operation business to improve efficiency, ability and profitability.

3.4.5 **City cluster integrated eco transport environmental strategy:** the planning, construction, operation and management of CCC transport facilities should meet environmental requirements. However, the current environmental impact study of transport projects only focuses on the construction process. The environmental strategy contains:

- Transport planning stage: Strategic Environmental Assessment (SEA) or Planning Environmental Assessment (PEA)
- Construction and operation stage: Environmental Impact Assessment (EIA)
- Integrated eco-transport evaluation (transport department): using city cluster integrated eco-transport evaluation indicators and methodologies

3.4.6 **Transport accessibility oriented spatial development strategy:** the construction of high-capacity CCC corridors and hubs are of high-cost. The surrounding land development can help obtain land value capture to fund transport construction. The use of those revenues to finance city cluster transport project can improve the accessibility and promote low-carbon transport development.

3.4.7 **City cluster transport informatization strategy:** transport informatization involves broad contents transport survey, planning, Intelligence Technology System (ITS) facility, information platform, transport facility monitoring, data collection, infrastructure maintenance, transport demand management and emergency addressing. The objective of city cluster integrated eco-transport development strategy is to propose quantitative targets and indicators of eco-transport development in city cluster based on strategies of integrated eco-transport network, hubs, ecology environment, spatial development and informatization development.

3.5 **CITY CLUSTER INTEGRATED ECO-TRANSPORT DEVELOPMENT AIMS AND OBJECTIVES**

3.5.1 Based on above strategies, detailed city cluster eco-city development objectives should be set to reflect the characteristics of city cluster transport system and requirement of national and regional development strategies. The Objectives should include:

- City cluster integrated transport network development
- City cluster integrated hub development
- City cluster integrated transportation development
- City cluster transport oriented land use development
3.5.2 City cluster integrated transport network development objective: develop integrated transport network and improve the coverage and connections; promote the mode share of railway, water transport and other low-carbon transport modes in city cluster passenger and freight transport supply; ensure the reliability of integrated transport network operation and reduce the congestion. Quantitative indicators to target are listed below:

- Intercity railway covers 98% transport node cities and 60% towns, passenger aviation service covers 90% of the population of city cluster.
- Realize 1-hour access between adjacent core cities and core cities with surrounding area in 2020, 1~2-hour access between core cities and main cities within the most area of city cluster.
- 1-hour access between core cities and core cities with main cities in 2030.
- The mode share of railway, water transport and other low-carbon transport modes in city cluster passenger and freight transport supply should be no less than 50% in 2030.
- 3 periods including weekday, weekend and holiday should be analysed in transport network level of service evaluation, and evaluated types of facility should include expressways, national and provincial highway, railway, passenger and freight hub, airway network, airport, waterway, ports, pipe transport system, etc., and the holiday's transport demand should be met for these facilities. The number of congestion issues should decrease at least 5% for each year compared to last year.

3.5.3 City cluster integrated hub development objective: implement national major hub plan within city cluster area, improve seamless transfer service for passenger and freight hub. Details below are important for achieving the objective:

- Main airport hub of core city in city cluster should connect with intercity railway and urban railway system in advance, and the intercity railway and urban railway stations should be planned for new airport plans.
- Main ports of core city in city cluster should connect with intercity freight railway, which should be planned for new port plan.
- Service objective of city cluster integrated hub: at least 1 passenger or freight transport mode can operate normally in general disaster to avoid paralysis of city cluster transport service.

3.5.4 City cluster integrated transportation development objective: promote passenger and freight flow of integrated transport, realize single payment system for highway and urban public transport within city cluster, increase Park and Ride (P&R) mode share of city cluster railway system.

- Gradually increase the mode share of passenger integrated multi-modal transport. Indicators are founded on base year data and to increase gradually to a stable level.
- The mode share of tonnage and mileage of freight multi-modelled transport trips which include water-railway, highway-railway and highway-waterway should be in increasing trend, and the indicators can base on base year data to increase gradually to a stable level.
- Share of single payment system in expressways system: 100% as soon as possible
- Share of single payment system in public transport system: 100% in 2030
- P&R mode share of city cluster railway system: 5% annually increasing to a stable level.

3.5.5 City cluster transport oriented land use development objective: Accessibility Oriented Development (AOD) development realized in city cluster transport network nodes and corridors with high accessibility. The construction of nodes and corridors with high accessibility is recommended to use financing modes based on AOD future revenue and promote the utilization of Public and Private Partnership (PPP) mode. The share of population and jobs in AOD area should be increased annually. Quantitative indicators include:

- AOD implementation percentage of nodes and corridors with high accessibility increases annually and reaches 100% in 2030.
- Transport facility construction of nodes and corridors with high accessibility that utilize PPP method based on AOD income raises to 100% in 2030.
- The share of population and jobs in AOD area should be increased annually to a stable level.

3.5.6 City cluster transport ecology environment quality and transport safety objective: Pollution emission and energy consumption should be controlled to meet the regional environment quality control objective in city cluster, as well as the objectives in transport industry. Transport safety should be enhanced.

- Pollution emissions meet the regional environment quality control objective, provide higher quality of environment for city cluster and improve the quality of life by developing intercity green transport.
- Significant improve of transport safety, 5% annual decrease of accident/fatality rate.

3.5.7 City cluster transport informatization development objective: gradually develop transport data platform of city cluster which collects all data of transport survey, monitoring, operation, infrastructure, etc., to support development and operation of city cluster integrated transport model. Based on big data and transport model, support the decision making and improving transport operation efficiency of city cluster. Detailed requirement is:

- Gradually develop and improve city cluster integrated transport model
- Gradually develop decision making supporting based city cluster transport information system
- Gradually develop transport operation improvement based city cluster transport information system
- Gradually develop transport service improvement based city cluster transport information system
3.6 CITY CLUSTER EXTERNAL CORRIDOR PLAN

3.6.1 The principle and general requirements are:
- The city cluster external corridors are comprised of expressways, HSR, intercity railway, arterial railway, major airport’s airline, high level inland river channel and external waterway of coastal ports.
- The number and scale of corridors in each direction should be analysed based on the position of the city cluster at national lead and its connectivity with other adjacent city clusters. Except external corridors constructed or confirmed in level national plan, new planned city cluster external corridors must have detailed demand forecast analysis, function identification and transport modal comparison.
- Propose the indicator of travel time from the city cluster to adjacent province capital and core city of adjacent city clusters.
- For city clusters located at the border of China, the corridors connect to adjacent country’s major port should also be considered.
- In a single direction, the number of external corridors should be no less than 2 (or at least two external transport modes) to ensure safeguarding of the transport network.
- It is encouraged for use integrated corridors for highway, HSR and intercity railway in the same Right of Way (ROW).
- The planning evaluation for external transport corridor should include the accessibility, travel time, congestion, energy cost, emission and other related indicators for corridors connect to adjacent area of city cluster.

3.6.2 City cluster external highway corridor planning
- Review the planning of national expressways and highway, as well as the arterial highway connect to adjacent area.
- Plan the total highway lanes of each direction, to meet the fast growing demand of external transport.
- Optimize constructed and national planned external highway corridors, reconstruction or widen external highway corridors.
- Plan new external highway corridors, including number of lanes, route layout, main node and construction phasing.
- Plan city cluster highway ring corridor, including number of lanes, route layout, main node and construction phasing.

3.6.3 City cluster external railway corridor planning
- Review the planning of HSR, intercity railway, national railway and core city peri-urban railway system within city cluster.
- Review the railway planning of adjacent city cluster.
- Plan the number of external railway corridors and technical standards especially the speed requirement.
- Plan the through railway of city cluster.

3.6.4 City cluster external airway planning
- Review the level, function, scope and number of major airports in city cluster.
- Plan number, scope and layout of major airports.
- Plan and coordinate external service function of each major airport in city cluster.
- Review city cluster airport class/ system structure/ functions/ scale/ number.
- City cluster airport planning / airport layout plan/ define airport number and scale.
- City cluster external airline planning coordinating with city cluster central cities, transport hubs and other airlines.

3.6.5 City cluster external waterway planning
- City cluster harbour and port layout plan: review external harbour and port layout plan of city cluster, and plan number, scale, function and layout for both inner water ports and coastal ports.
- City cluster arterial waterway plan: review the level and capacity of existing external channel, and plan the number and technical of external waterway of city cluster.

3.6.6 Integrated plan and coordination of city cluster external transport system
- Coordinate city cluster external transport network with plan of national and adjacent city cluster and area’s transport network.
- Coordinate service and competition between external transport modes in city cluster and integrate them for diversified transport service based on interchange and hub, to improve the liability of city cluster external transport services and accessibility.

3.7 CITY CLUSTER INTERNAL CORRIDOR PLAN

3.7.1 The principle and general requirements are:
- The city cluster internal transport is comprised of expressways, national arterial highway, HSR, intercity railway, peri-urban railway, regional airport’s airline and inland river channel.
- Propose the travel time targets to internal transport corridor from any place in city cluster.
- Confirm the coverage and connectivity of internal transport corridor.
- City cluster internal transport corridor should be seamlessly connected to external transport corridor and hubs.
- Except internal corridors constructed or confirmed in national plan, new planned city cluster internal corridors must have detailed demand forecast analysis, function identification and transport modes comparison.
- It is encouraged for using same corridor or ROW for highway, HSR and intercity railway.
- The planning evaluation for internal transport corridor should include travel time, congestion due to emergency
events, energy cost, emission and other related indictors.

3.7.2 Highway corridor plan
- Reasonably plan the network structure of internal highway corridors, grid network is preferred for polycentric city with close connection and high integration, and radial network for single centre city. The two types of network can be used in combination according to different characteristics of city clusters.
- Planning key is to reconstruct and widen of existing highway, and new planned highway involves route layout and key nodes.
- Propose the coverage, connectivity and travel time targets from any place in city cluster of highway network.
- Plan core city ring road of city cluster based on city cluster through traffic volume
- Plan highway accesses to city cluster central cities
- Connections between arterial roads in central cities and the city cluster highways. The highway connections are regarded as the external access of urban corridors in central cities. The connections are key references for other feeders/line routes/infrastructure layout plan

3.7.3 Passenger railway corridor plan
- Function and positioning, system structure and scale
- Plan intercity passenger rail lines
- Plan peri-urban railway of core city
- Plan other sort of railway system
- Plan integrated railway transport with various railway types.

3.7.4 Freight railway corridor plan
- Function and positioning, levels, system structure and scale
- Plan intercity freight rail lines, mainly connect to ports, railway interchange, and large warehousing of sources.
- Study of using core city peri-urban railway for freight.

3.7.5 Inland waterway transport (marine shipping) plan
- City cluster inner water ports or marine shipping docklands layout plan: evaluate existing ports/docklands planning. City cluster inner water port and marine shipping dockland planning with detailed number/scale/functions/system structure and layout
- City cluster inner waterway plan: evaluate the class/capacity/level of service for existing inner waterways in the city cluster and identify the number and technical standards for city cluster inner waterways
- Coordination the planning for the internal water transport service such as dock and harbour inner city cluster. Especially for the transfer connection and the landside collecting and distributing function.

3.7.6 Integrated plan and coordination of city cluster internal transport system
- Coordinate city cluster internal transport network with plan of national and adjacent city cluster and area’s transport network.
- Coordinate service and competition between internal transport modes in city cluster and integrate them for diversified transport service based on interchange and hub, to improve the reliability and efficiency of city cluster transport services.

3.8 CITY CLUSTER TRANSPORT HUB PLAN

3.8.1 The principle and general requirements are:
- Promote integration and connection of individual cities spatial in city cluster.
- Promote integration of city cluster transport network
- Vertical development of transport hub and reduce land take
- Separation of Passenger and freight traffic flow
- Optimize location of hubs, coordinate the overall layout of airport, railway station and highway hubs.

3.8.2 City cluster airport hub plan includes location options, hub transfer system, entrance and main access, to ensure the operation service.

3.8.3 HSR and intercity hub plan needs the location to be close to airport and other passenger hubs as much as possible, and the transfer system and service transport network should be considered.

3.8.4 Normal passenger railway station plan includes location, transfer system, service transport network, etc.

3.8.5 Freight railway hub plan should include location, transport service network and combined transport of multiple freight transport modes.

3.8.6 Highway Coach station plan should include the hub location, transfer system and service transport network.

3.8.7 Highway freight hub plan should include location, transport service network.

3.8.8 Port plan should include access passages, combined transport facilities, logistic park, passenger transfer system and transport service network.

3.9 CITY CLUSTER TRANSPORT INFORMATIZATION PLAN

3.9.1 City cluster transport informatization is one of the effective measures for improving transport facility efficiency, effectively managing transport facilities and improving passenger information service.

3.9.2 The plan includes:
- City cluster corridor and hub monitoring and emergency information system
- City cluster corridor and hub travel information service system
Information connection and sharing system between transport modes
Integrated information system of internal transport system
Integrated information system of external transport system
Eco-transport information system of city cluster
Application of latest internet, internet of things (IoT) internet of vehicles

3.10 TRANSIT ORIENTED DEVELOPMENT AND LAND USE SUGGESTIONS

3.10.1 Transit orientated development (TOD) is one of the key contents in city cluster integrated eco-transport development.

3.10.2 In the city cluster, strategic TOD can lead the city cluster transport development at key nodes and corridors with high accessibility. Suggestions are focusing the following aspects:

- City cluster passenger transport network: suggestions for key nodes/ corridors/ regions and land use adjustment
- City cluster freight transport network: suggestions for key nodes/ corridors/ regions and land use adjustment
- City cluster land planning adjustment suggestions for comprehensive transport network, corridors and other land use planning.

3.11 ECOLOGY ENVIRONMENT ASSESSMENT OF CITY CLUSTER ECO-TRANSPORT PLAN

3.11.1 Ecology environment assessment of city cluster eco-transport plan includes the EIA at strategic planning stage, and scheme EIA and EIA in operation phase.

3.11.2 The strategic EIA is necessary for the plan that includes:

- Multi-criteria eco-transport comprehensive assessment system, including 1 general target, 7 major indicators and 40 minor indicators,
- Optimal transport supply structure analysis and evaluation based on constrains of environment quality and energy consumption,
- Assessment of the quality of SEA process and evaluation contents.

3.11.3 The private scheme EIA should be implemented for each specific construction phase of city cluster transport facilities, and the process should base on legal regulation.

3.11.4 The EIA at operational phase mainly focus on environment impact of current transport network operation based on transport operation monitoring outputs.

3.12 SHORT-TERM TRANSPORT CONSTRUCTION PLAN

3.12.1 City cluster short-term transport construction plan should be based on city cluster development short-term goals and objectives, city cluster transport model and short-term development strategies. The construction plan includes external corridor, internal corridor, transport hubs, transport informatisation infrastructure and relevant management or institution arrangement.

3.12.2 The time horizon for short-term construction plan is suggested to be in 5 years (3-5 years)

3.12.3 The short-term construction plan should coordinate with existing construction plans and land use development plan within the city cluster.

3.12.4 Key contents in short-term transport construction plan include

- transport development policy and measures
- city cluster transport plan options
- transport projects and phasing plan
- Investment estimation

3.13 PLANNING IMPLEMENTATION SAFEGUARD MEASURES

3.13.1 City cluster transport policy safeguards: It is necessary to propose city cluster transport policies ensuring and guiding transport facilities work coordinative and effectively. Transport demand management can be used in some cases to ensure a good level of service for the operation of city cluster transport system.

3.13.2 City cluster transport planning unit operation safeguard policy: the legal position, responsibility and funds of city cluster transport planning unit is the key for the good operation of the unit.

3.13.3 City cluster transport plan coordination and negotiation arrangement: the planning process needs communication and negotiation between related institutions regularly, and the final option also needs communication and negotiation between cities of city cluster to achieve agreement.

3.13.4 Other necessary safeguard policy includes the policy to promote integration of transport network and hub, policy for promoting transport informatization development, policy to protect transport environment and promoting city developing guided by transport accessibility.
4 Planning Technical Requirements

This chapter sets out the key planning technical requirements to guarantee the acceptable technical level of city cluster integrated eco-transport planning and planning practice.

4.1 EXISTING CONDITIONS AND TRAFFIC SURVEY

The main objective of the investigation of existing condition and traffic survey is to provide the basic information for analyzing current situation as well as to provide data for the base year model of the integrated transport of city cluster, and help to understand the underlying inter urban travel behavior and the trends for forecasting.

4.1.1 Basic requirements for data collection:
- The data should cover a larger region than the city cluster, but model area focus on the study area and include the main affected area.
- The data includes statistical data, government documents, surveys, and extant relevant plans (texts and drawings).
- The data of existing conditions should be collected within one year, or two years in particular cases before the study base year.
- The historical data to reflect the development trends should cover five years or more, and the last year should not be more than two years prior to the base year.
- The relevant plans should include the latest that has been approved or is under preparation.
- The Orientation and Destination (O-D) survey data of the last 5 years can be used to the access current situation and trend analysis, while data more than 5 years old cannot be used and need to be update through additional investigations. To save costs and improve data quality, model development can also refer to alternative data sources such as mobile data, weekly travel diaries, existing Household data. GPS freight monitoring, railway OD data, travel card data and possibly census data

4.1.2 Data Collection: data can be provided by government departments, or obtained from discussions, site survey, urban and transport planning report and reports discussing population and economy. The data covers various aspects, including urban socio-economic, land use, transport modes, transport infrastructure, traffic operation and management, public transit, external transport, transportation policy and regulations, transportation investment and environment, transport research and planning. These data can be divided into the following categories:
- City cluster socio-economy: city profile, administrative divisions, population and land use, urban production, industrial structure, layout and logistic; urban layout, built-up scale, land use layout, population and employment distribution and car ownership; urban socio-economic development planning, urban master planning, regulatory planning and related special planning, urban statistics, etc.
- Urban transport infrastructure: the network of air transport, water transport, roadway, railway; the scale, function, management, multi-mode integration, etc. of passenger/freight hub; external traffic facilities.
- Intercity transport service: bus routes, frequency, speed, schedule, operation mode, vehicle type, and fare system; tourist & recreational infrastructure layout, the status quo and development of tourist transport; passenger & freight transport volume and properties, roadway traffic, multi-mode transport and management, and transport informatization, etc.
- The development and application of existing transport model.
- The current situation of transport oriented land use development.
- Transport environment: requirements on traffic emission and environment protection, statistical data of vehicle age and emission, number of new energy vehicles, and vehicle emission management.
- The level of integrated transport informatization.
- Transport related plans: including the national, city cluster, and provincial master planning, township planning, integrated transport planning, all kinds of special transportation planning, transport informatization planning, short-term construction plan, and major project construction plan.
- Transportation policy and regulations: transportation construction investment scale, the proportion of investment in facilities, existing local traffic laws, standards, social passenger and freight transportation management mechanism, and related transportation development policy research, coordination mechanism of city cluster transport planning, construction, management and construction.

4.1.3 Comprehensive traffic survey methods include:
- Traffic counting at screening lines: The survey duration at different site determined by model calibration and validation requirement should cover the peak periods. Normally a 12-hour or 24-hour continuous survey is suggested. Survey sites should cover main strategic interurban roads within city clusters and choice of interurban road should be based on road hierarchy, traffic volume, meeting the forecasting model requirements. Survey condition for different city clusters should be taken into consideration, such as weather which impact traveller’s trip pattern in different seasons. A Pilot survey is required to help arrange the surveyors at each site. The survey can be conducted by manual counting or digital recording. The digital recording can be conducted at toll gate, by loop detector or plate recognition.
- Roadside interview: Survey site should locate where it’s convenient for parking and impact on traffic should be minimised. The sample interview needs the assistance from the traffic police. Pilot surveys are implemented to test whether the survey design can meet the data needs and make the necessary amendments. At the same time,
Identify the optimal transport composition that meets view with sta and planning: one of the vital tasks. While the traffic demand is satisfied, the emission (e.g., CO, PM2.5) may be limited, it means the planning satisfies the suggested to be 12 hours. Number of surveyor at each hub is decided according to number of lines passing through and hub scale/function.

Journey time survey: Floating car method is suggested to be adopted and survey time is during peak hours. Pilot surveys are required to help determine the number of vehicles needed for each route.

Stated preference survey: Stated preference survey by questionnaire should be conducted for different interurban travellers at main bus/rail stations and inter urban cars, such as service stations in order to study passenger’s willingness to pay to save time/improve facility. The sample size is related to the level of disaggregation of person type.

Occupancy survey: A 12-hour or 24-hour continuous survey of passenger car occupancy is proposed. Survey sites locate at the same place with counting and survey is conducted manually. In the meantime, interview with intercity bus operators within the city cluster is needed to collect information, like bus frequency, route layout, ticket price, vehicle type and so on. This provides a basis for checking bus passenger survey result. Pilot surveys are required to help determine the number of surveyor at each site according to vehicle volume.

Inter-city PT Satisfaction Survey: The inter-city PT Satisfaction Survey can be conducted at selected transport hubs during certain periods of every year. The duration is suggested to be 12 hours.

Other source of data: Other data source can be collected from corresponding authority to save survey costs and improve data quality. These include but not limited to mobile phone data, travel diary, existing Household data, GPS freight, rail/coach OD data, travel card data, toll data and census etc.

In the future, China can conduct regular national and provincial travel survey to expand census information, travel investigation and optimise statistics to enrich transport management data and planning data, which will provide solid base for transport model development.

4.2 Eco-oriented Passenger/Freight Traffic Supply Model

4.2.1 The planning methodology and contents differentiate City-cluster Ecological Integrated Transport Planning from normal transport planning. Special attention is given to the environmental impact, energy consumption and emission. During the process of SEA (Strategic Environmental Assessment), controlling the supply of passenger/freight transport inside/outside a city cluster is one of the vital tasks. While the traffic demand is satisfied, the emission (e.g., CO, CO2, NOx, CH compound, PM2.5) should be controlled in line with the policies and regulations of eco-friendly transport. Different transport modes contribute to different emissions and energy consumption per vehicle mileage. Hence, a model can be built to identify the optimal transport composition that meets the ecological requirements. When city-cluster passenger/freight transport planning satisfies the strategic goals and targets, it means the planning satisfies the key requirements of a strategic environmental assessment.

4.2.2 The eco-transport option model is a linear model which seeks to maximized passenger/freight transport supply to meet the demand whilst constrained by environmental quality and energy consumption. It produces the turnover scale of each transport mode along with its mode share ratio. The guidelines will illustrate more about this methodology.

4.2.3 The transport structure optimization model which meets the energy consumption constraints:

\[
\begin{align*}
\text{Maximize} & \quad \sum_{i} x_i \\
\text{subject to} & \quad \sum_{i} x_ia_{ij} \leq P_k \\
& \quad \sum_{i} x_ib_i \leq E \\
& \quad \sum_{i} x_i \geq D_i \\
& \quad x_i \leq S_{i\max} \\
& \quad x_i \geq S_{i\max}
\end{align*}
\]

Eq. 1

Where,
4.3 CITY-CLUSTER TRANSPORT MODEL AND DEMAND FORECAST

4.3.1 City Cluster traffic demand forecast model is a key to support strategic transportation planning. Multi-modal strategic modelling is an important part of City Cluster Integrated Transportation Planning. A demand model provides a solid basis for evaluating the impact of macro policies, spatial development at strategic level, large scheme transport project evaluation, transportation demand management and intercity transport operation options. To follow are the fundamental requirements for city cluster integrated modelling and demand forecast:

- City cluster transport model needs to be disaggregated to an appropriate level and demand segments. A macro-strategic model is at the top level, which usually covers the whole region. The model can be used to test regional integrated transport network solutions. It is usually based on traditional four-stage demand forecast model and is capable to handle macro-level transport analysis. The lower levels are the models for more detailed analysis with focus on small areas such as a city or an inter-city corridor. The level of detail depends on the required function. The Guidelines mainly focuses on the top-level model – Strategic Transport Planning Model which will interface with city models.

- Developing a regional cluster integrated transport model is usually with long term cycle with continuous updating and model structure optimization over time. It is usual to start the model development with a relatively simplistic model which can become progressively complex as more data is available and the China city cluster starts to be mature and stable. With a flexible structure, the model can be gradually improved.

- Integration or interface with the existing city models is recommended where possible. These models include transport models, socio-economic models and spatial models at city, regional, provincial and country level.

- Confirming the model structure and specification is necessary before starting model development and involves interpreting the key purpose of the model and available data, in order to avoid abortive work and save costs/resources. Normally, it should be able to assess but not limited to: changes in population, socio-economic, development planning, land development, policies, supply, pricing, environmental capacity and other basic input factors, revised and improved demand forecasting.

- The transport model should be able to reflect the trend of city-cluster traffic demand and further support the analysis of city-cluster transport planning within the next 20 to 30 years.

- A model should include but not limited to the following travel modes: passenger transport, highway, railway, air; freight: shipping (if applicable), highway, railway. Air should be included for cities with air cargo hubs, namely as an external mode unless there is intra-CCC (China city cluster) competition between air and other modes.

- A model should cover the whole city-cluster region but the key modelling area is outside the constructed urban area. Disaggregation should be applied in city centres to ensure the analysis of suburban railways and railway access nodes.

- Demand analysis should include but not limited to: external traffic, inter-city traffic, through traffic and traffic between city suburban areas and city centres.

- The output of transport model and demand forecast is applicable to estimate the general infrastructure scale along with mode-based infrastructure scales, assess transport systems on major corridors, and locate transport hub with function analysis.

- Transport model should be capable to test AOD measures, policies, traffic charges and the impacts of demand management. It supports the prioritization of construction.
4.3.2 Study area: the study area should cover the main city-cluster area, as well as the developed surrounding areas, transport hubs and external traffic connections. These have or will have significant impacts on the city clusters travel patterns. Include surrounded city clusters, urban areas with close proximity, industry areas, neighbour railway/coach stations, airports, freight distributors and pipelines. Main study area is the China city clusters whilst wider study area is the province or suitable buffer areas.

4.3.3 Zoning system: a fundamental part of the modelling process is the creation of an appropriately detailed zoning system to meet the objectives. The zoning system must cover the whole study area, ideally based on administration boundaries for easing planning inputs, and compatible socio-economic datasets. Attention should be given to major or special trip generators and attractors, such as railway/coach stations, airports and ports, which will be identified as special zones. For freight, traffic analysis zones can be used production zones and consumption zones. Additional freight traffic analysis zones may be needed depending on model requirements.

4.3.4 Transport network: the transport network should include all the major transport facilities and services for inter-city movements and inbound/outbound connections. It usually includes:
- Roads (car, bus, and trucks and inter-city coach service)
- Railway networks, intermodal terminals and rail service
- Waterways
- Air
- Pipe network for special freight

4.3.5 Time profile: time profile for intercity traffic is different compared to urban traffic. Regional models are often been designed to forecast the amount of travel on a typical day, including both weekdays and weekends. It should be noted that the peak hour especially for road network may occur on both weekdays and weekends. Sometimes, those special days may also need to be concern, such as national holidays.

4.3.6 Demand analysis: good understanding of different traffic demand patterns is the base for demand modelling development. Especially for city cluster, it is much more complicated as it is composed of a variety of traffic movements. Generally a city-cluster strategic model focuses on inter-city movements of passenger and freight while considering through traffic as background. Hence substantial amounts of data (including traffic survey data, statistics, planning, traffic analysis and etc.) need to be collected to provide the foundation for a quantitative traffic demand analysis. Basic data for demand analysis and modelling:
- Demographic and socio-economic, including population, GDP, household income, car ownership, industry and etc.
- Land-use distribution, including employment and education jobs, industry/warehouse/logistic, tourism place and etc.
- Transport infrastructure related data. Including roads, public transportation station/hubs, freight distributor/hubs and so on.
- Operating data. Including main traffic volume counting, travel speed/time, traffic delays, transportation ticket/toll fee and so on.
- Passenger and freight traffic character data. Including person/freight basic information, trip rates, Journey purpose, Occupancy, mode split, peaks and off-peaks, turnover, demand of transportation hubs and etc.
- Origin-destination data for passenger and freight from OD survey from various sources, such as railway/coach/air/waterway operating system, traveller interview, and freight stakeholders interview etc.
- Value of Time (VOT) is needed for inter urban travel (business/work, commuting and non-work) from SP surveys, wage rates etc.

4.3.7 Comprehensive traffic demand forecast: demand forecast provides the base for city-cluster transport master planning. Strategic traffic demand model is developed to reflect the complex relationship between transport supply and demand. This includes population migration, land-use changes, policy impact, infrastructure scheme and new transport mode induced traffic. Usually a base year model will be developed to represent the current transport situation. Forecast-year models with future planning data and network are developed for future year demand forecasting/scenario testing and etc. The basic demand forecasting contents include:
- Population growth and distribution
- Socio-economic growth, including GDP/income growth and Auto ownership
- Passenger/freight travel demand, including trip volume/distribution/trip length/mode share and etc.
- Network performance, including VC ratio/loading speed/VOC/fuel efficient/noise and emission and etc.

4.3.8 Major methodologies for demand forecasting include:
- Four-step trip-based model
- Activity-based methodology
- Direct Demand Model (DDM)

4.3.9 The four-step trip-based approach is the most commonly used methodology due to its relatively simple structure and availability in well-developed commercial software packages. The model can be structured with four stages as below:
- Trip generation, methods include Regression model, trip rates model and cluster analysis models etc. various
sub-models such as income model/car ownership model are used to support. Need to disaggregate by journey purpose (work, commute, leisure), car availability and distance.

- Trip distribution, including growth model, gravity model, logit model etc.
- Mode share, generally estimated by transfer curve model, Logit model, and gravity transformation models.
- Assignment, including all-or-nothing method, Capacity-restrained assignments and Stochastic assignment techniques.

4.3.10 Activity-based methodology: activity-based models are becomes more widely used on regional, national and multi-national levels. They are often aggregated into state/provincial-level models to help policy makers identify the necessary actions, including necessary improvements in vehicle technologies and other factors.

4.3.11 Direct Demand Models (DDM) structure: another useful analogy to understand the strategic travel behaviour is enshrined in a group of econometric models called Direct Demand Models (DDM). These models are simple in nature but can provide a robust forecasting tool, especially for inter-city flows. They can also distinguish freight and passenger traffic which is the core requirement of strategic traffic flow forecasting. It predicts the number of trips between origins and destinations. It is based on a function of travel time/distance/cost, as well as zonal characteristics such as population, employment, income, GDP and other available socio-economic variables.

4.3.12 Freight demand: freight is a big component of inter-city traffic. It is common to model the freight demand by categories. The method follows a process that is similar to four-step model with different details due to the unique aspects of freight movements. The basic steps are listed as below:

- Obtain Freight Modal Networks.
- Analyse commodity movements and develop Commodity Groups.
- Relate Commodity Groups to Industrial Sectors or Economic Indicators.
- Identify Base Year Commodity Flows.
- Forecast growth in industrial sectors and factor commodity flows.
- Develop modal cost for commodities.
- Split commodities into modes.
- Estimate daily trips according to loading weights and days of operation.
- Assign freight volumes to transport networks.

4.3.13 Model calibration/validation: The objective of model calibration/validation is to ensure that the model can reflect the existing travel situation. It is an iterative process. The following elements should be calibrated:

- Demand model structure
- Zoning system
- Transport supply facilities
- Economic and planning data
- Policy and growth assumptions
- Sub-model updates for trip ends, trip distribution, mode split and multimodal assignment
- Time profiles

4.3.14 Survey data is used for model validation. Similar case studies also provide good reference. The model for either passenger or freight should be properly calibrated/validated throughout the modelling process. The validation can be undertaken from the following aspects:

- Mode share
- Comparison between observed flows and modelled flows on highway screen lines
- Public transport passenger flows across the screen line
- Modeled and observed travel times for key routes
- Routing checking

4.3.15 Reliability and sensitivity test: model reliability tests need be carried out when the city cluster model has been calibrated and constructed. This ensures the model behaves realistically and checks the overall response of demand changes with general experience.

4.3.16 Scenario testing and appraisal: it is suggested to include a range of key variables such as population, employment, land use and so on. Various scenarios need to be developed using City Cluster model in order to help the Authority better understand the influence of different policies and interventions, as well as providing solid basis for decision-making. The principles that should be followed during scenario development are listed as below:

- Scenario design based on official planning, including socioeconomic, land use and infrastructure
- Consistency of comparison between different scenarios
- Reliable and convincing
- Satisfy the requirement of the study

4.3.17 Details of developing city-cluster model scenarios include:

- Necessity of scenario development
- Planning scenario specification and assumption
- Network change in forecast model without the introduction of scheme compared to base year
Network change in forecast model with the scheme compared to base year
Generalised cost adjustment (value of time; vehicle operating cost and public transport fare etc.)
Comparison among future scenarios (do nothing, do minimum and do something)

4.3.18 Usual outputs of scenario testing include:
- Travel demand and network performance, including figures of forecast flow, LOS and etc.
- Speed and other key network indicators
- Interpretation of model outputs and recommended measures with corresponding scenarios

4.4 EVALUATION OF CITY CLUSTER INTEGRATED TRANSPORT PLANNING

4.4.1 The principles to identify the indicators for the evaluation of city cluster integrated transport planning include: scientific and feasible, systematic and independent, pertinence and comparability. Following the principles, 40 indicators – divided by 7 categories - are selected. The data availability is estimated based on understanding of public data. With the constant improvement of the statistical system and the statistical institutional capacity, the data collection will be more in-depth and easy to retrieve. Thus, the data analysis for the indicators can be more detailed. For example, the fuel consumption indicator can analysed by mode and fuel type, combined with passenger volume for more detailed analysis.

4.4.2 The scoring system currently used for domestic cases is based on a rating of various indicators in the transport system to get the overall score for further comparison between regions. This is similar to Multi Criterial Analysis Framework (MCAF). International cases are mostly target oriented. Comparisons are made over time with cross sectional comparisons to access trends and effectiveness of certain target policies. The procedures are relatively simple.

4.4.3 Multi-Criteria Appraisal Framework (MCAF): MCAF allocates weights to each indicator according to its dimension and category. This reflects different importance among the indicators. In addition, the scoring of each indicator is further divided into bands.

4.4.4 Target Setting Method: Target setting must be applied strategically and carefully, with an understanding of the context in which targets will be applied. There is no one predefined, prescribed approach for setting and using targets because their intended use can vary greatly; in fact, no agency currently relies on a single, prescribed, systematic approach for setting targets.
5 Deliverables

5.1 DELIVERABLE FORMAT

5.2 PLANNING

5.2.1 Planning should use expressions with clear and concise contents. The contents should be instructive and implementable in order to meet basic requirements for approval.

- The mandatory clauses should be distinguished by using different font and colour.
- Alignment is required for external and internal corridors.
- Location and connection should be specified for hub planning.

5.2.2 The Planning should include the following contents:

1. **General provisions:** references, concept, principle, scope and horizon.
2. **Existing conditions and planning review:** city cluster overview, city cluster development progress and connections with transport development, existing condition, current planning, construction and operation of transport network and hub facilities, review of city cluster urban and rural comprehensive plan and other related plans, summary of current issues and future challenges of the city cluster.
3. **City cluster integrated eco-transport demand forecast:** prerequisite of demand forecast, demand forecast methodology illustration, analysis process of transport modelling, demand forecast outputs from transport modelling.
4. **City cluster integrated eco-transport development strategy includes:** city-cluster transport network integration strategy, transport network development strategy for each mode in the city cluster, city-cluster passenger/freight transport hub development strategy, city-cluster transport ecological and environmental quality development strategy, city-cluster transport oriented spatial development strategy, city-cluster integrated eco-transport informatization development strategy.
5. **City cluster integrated eco-transport development objectives:** the general development objectives should be based on the proposed strategies. The objectives should be in line with the National Transport Network and Corridor Plan, National Transport Hub Development and other strategic planning and policies within the city cluster.
6. **City cluster integrated eco-transport traffic organization:** city-cluster integrated transport composition, traffic connections between city cluster transport and urban transport/external transport, passenger/freight traffic organization and general transport framework, city-cluster transport backbone network, emergency handling, principles for disaster prevention and mitigation of transport network planning, passenger hubs/logistic centre system structure, coordination and management for city-cluster competing transport services, P+R at transport hubs and city cluster rail transit stops, transport informatization and traffic demand management.
7. **City-cluster external corridor plan:** road/rail external corridor and network layout, sizing (length/width), technical standards, grade and land use indicators, air and shipping corridor plan, service and operation of the corridors to strategic hubs and city-cluster central cities nearby, coordination of different modes.
8. **City-cluster internal corridor plan:** city-cluster road corridors plan, passenger/freight rail corridor plan, air line plan, inner waterway and marine shipping plan, integrated transport coordination plan.
9. **City-cluster transport hub plan:** airport plan, HSR/intercity-rail hub plan, passenger/freight rail hub plan, coach station plan and freight road hub plan, ports and harbours plan etc.
10. **City-cluster transport informatization plan:** demand analysis for city cluster transport informatization infrastructure, transport informatization infrastructure planning, informatization plan in support of city-cluster transport decision making and efficiency improvement, development and maintenance of city cluster integrated transport modelling based on big data and data mining.
11. **Suggestions on city cluster strategic TOD:** identification of node/corridor/region with high accessibility in passenger/freight transport network, proposed land use adjustment.
12. **City-cluster integrated eco-transport planning evaluation:** overall evaluation, strategic environmental assessment, the degree to which the transport composition satisfies the constraints in terms of environmental quality and energy consumption.
13. **City-cluster short-term construction plan:** construction plan (5-year-plan) for all modes, corridors, internal corridors, transport hubs, transport informatization infrastructures, relevant management and organization contents and capacity building.
14. **Institutional support measures:** public policy, operational support for city-cluster transport institution, coordinating mechanism for planning and implementation, and others.

5.3 SPECIFICATION, DRAWINGS, BIBLIOGRAPHY

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