

Fachbereich Wirtschaftswissenschaft

Regional Orientated Global Logistics Networks Redesign  
with Respect to the Belt and Road Initiative (BRI)

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Angabe der beiden Gutachter  
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## **Declaration**

I declare that this thesis has been composed solely by me and that it has not been submitted, in whole or in part, in any previous application for a degree. The work was made without unauthorized aid. No other than the specified sources and aids were used. Except where states otherwise by reference or acknowledgment, the work presented is entirely my own.

### **Date & Place**

October 8th, 2020, Bremen

### **Signature of author**

A handwritten signature in black ink, appearing to read "Ye Jing".



# Acknowledgments

In the vastness of the universe, human beings seem so ignorant and insignificant. The only thing we can do is to keep exploration and enjoy adventure. Truth may be hard to reach, but every move we try can make it closer. Luckily, we are born with curiosity, the endless source of energies leading to creation. And more fortunate is we have each other on our way of the journey.

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# **Abstract**

Along with the globalization trend, the spatial pattern of global logistics network (GLN) evolves as the emergence and expansion of global production networks. Since maritime shipping is the predominant mode supporting world trade, the global shipping network comprising several regional hub-and-spoke networks represent the vast majority of the GLN. Port hubs are playing a significant role in the GLN and get more and more integrated into the global supply chains (GSCs). The GLN represents the geographical dispersion of production and distribution sites all over the world, which are closely interacted with the pattern shift of global transportation infrastructure and service networks. In the dynamic world, MNEs need to relocate their manufacturing plants and distribution centers (DCs) from time to time to pursue comparative advantages from multiple countries which are unattainable in their home countries. Compared to domestic firms, MNEs are more sensitive to macroeconomic environment, and their relocation behaviors are more related to region/country characteristics such as transportation infrastructure, connectivity, political factors, natural and labor resources, subsidies and taxes, etc.

Against the background of a slowdown in the domestic growth, China proposed to jointly establish the “Silk Road Economic Belt (SREB)” and the “21st Century Maritime Silk Road (MSR)” in 2013, also called the Belt and Road Initiative (BRI). The SREB refers to land-based trade corridors linking Asia and Europe by establishing roads, railways, and pipelines. The MSR refers to maritime shipping passages spanning across the South China Sea, the South Pacific Ocean, and the Indian Ocean area. As the implementation of BRI, large amounts of investments flow in infrastructure construction projects, covering transportation and communication, utilities (water, electricity), energy, etc. Trade liberalization agreements are signed between China and BRI-countries to promote trade and investment environments. Though potential risks exist, it has been several years since its announcement, BRI's implementation is inevitably changing the regional connectivity, the climate of international trade & investment, as well as the competitiveness of some critical logistics nodes along the BRI. While all these three aspects are closely related to MNEs' location selection decisions, their combined effects as a complex are reshaping the pattern of GLNs at a regional level. There is an urgent need to investigate the impacts of BRI on GLNs, and the driving forces of these impacts to reinforce the relocation tendency and network redesign process.

Focusing on the fundamental role of transportation infrastructure, this research ana-

lyzes the impacts of BRI's implementation on the GLN. After the investigation about the critical aspects and key trends determining the GLN, this study applies a system thinking view to argue that transportation infrastructure is a strong driving forces for the dynamic evolution process of the GLN. Especially in context of the BRI, with its large scale and broad scope transportation infrastructure construction and upgrade, the spatial structure of GLN is rapidly altering due to the changing competitiveness of some logistics nodes and links. These changes can further induces a sequence of dynamic process, such as development of local logistics industries, MNEs' relocation behaviors, industrialization of local regions, etc, hence substantially shift the pattern of the GLN on a long-term view. Case studies of Piraeus port and Gwadar port were conducted to validate the impacts of ports infrastructure improvements on global shipping network and its potential for regional economic growth. Apart from sea port, a very important aspect is the improvements of land connectivity and the construction of dry ports. With the operation of CR Express, China and Europe are connected passing through the vast territory of landlocked countries in between. Through investigating the case of Khorgos dry port city, the study also presents the pattern shift induced the large potential of land logistics nodes.

**Keywords:** Belt and Initiative, global logistics network, transportation infrastructure, seaport, dry port

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# List of Abbreviation

<b>ASEAN</b>	Association of Southeast Asian Nations
<b>BRI</b>	Belt and Road Initiative
<b>CAREC</b>	Central Asia Regional Economic Cooperation
<b>CEEC</b>	Central and Eastern European Countries
<b>CIS</b>	Commonwealth of Independent States
<b>COPHC</b>	China Overseas Port Holding Company
<b>CPEC</b>	China-Pakistan Economic Corridor
<b>CR Express</b>	CHINA RAILWAY Express
<b>DC</b>	Distribution Center
<b>EAEU</b>	Eurasian Economic Union
<b>EIT</b>	(Global) Enabling Trade Index
<b>EU</b>	European Union
<b>FDI</b>	Foreign direct investment
<b>FTA</b>	Free trade agreement
<b>FTZ</b>	Free Trade Zone
<b>GDP</b>	Gross domestic product
<b>GLN</b>	Global logistics network
<b>GPN</b>	Global production network
<b>GSC</b>	Global supply chain
<b>GVC</b>	Global value chain
<b>ICBC</b>	(Khorgos) International Center for Boundary Cooperation
<b>JIT</b>	Just-In-Time
<b>LPI</b>	Logistics Performance Index
<b>LSCI</b>	Liner Shipping Connectivity Index
<b>LSBCI</b>	Liner Shipping Bilateral Connectivity Index
<b>MNE</b>	Multinational enterprises (also refers to multinational orientated/engaged enterprises in this research)
<b>MSR</b>	The 21st Century Maritime Silk Road
<b>NDRC</b>	National Development and Reform Commission (of China)
<b>NELBEC</b>	New Eurasian Land Bridge Economic Corridor
<b>OCED</b>	Organization for Economic Co-operation and Development
<b>OLI</b>	Ownership, Location, Internationalization (paradigm by Dunning)
<b>SREB</b>	Silk Road Economic Belt
<b>SCM</b>	Supply chain management
<b>SD</b>	System dynamics
<b>SEZ</b>	Special Economic Zone
<b>TEU</b>	Twenty-foot equivalent unit
<b>TFI</b>	Trade Facilitation Indicators
<b>TRACECA</b>	Transport Corridor Europe—Caucasus—Asia
<b>UNCTAD</b>	United Nations Conference on Trade and Development
<b>WE-WC Highway</b>	Western Europe—Western China Highway
<b>WTO</b>	World Trade Organization

# 1 Introduction

## 1.1 Research background

Over the last several decades, the world has witnessed the irreversible trend of globalization. Economies are more and more connected and interdependent because of the increasing cross-border trade in goods and services. The configuration of global logistics network (GLN) quickly turned to be a critical supply chain strategy determining a multinational enterprise's (MNE's) profitability. Many MNEs have relocated their facilities to foreign countries to pursue comparative advantages that are unattainable in their home countries. The most representative comparative advantages include the allocation of low-cost natural and labor resources, proximity to suppliers or customers, accessibility to reliable transportation systems, tax incentives, etc. It usually happens in the cases of labor-intensive industries/sectors that MNEs relocate from developed economies to the emerging economies, to take advantage of the cheaper labor forces. The rapid rising of China to be the "world factory" since the 1990s is a typical example resulting from MNEs' relocation to China, especially to the special economic zones (SEZs) in China's coastal areas. In the current changing world, MNEs facing more intensified competition are increasingly interested in relocating facilities; network redesign processes become more frequent (Hammami and Frein 2014). MNEs are motivated to move by varying reasons such as offshoring outsourcing, expansion opportunities to new markets, mergers and acquisitions, financial and tax advantages and so on (Hammami et al. 2008; Melo et al. 2014).

Along with this trend is the growing demands of transporting physical materials for production and marketing around the world. This drives the prosperity of the logistics industry especially the maritime shipping industry. Maritime shipping maintains its leading role in supporting about 90% of world trade due to its capability of conveying massive goods for long-distance with a cheap price. To pursue economies of scale and maintain competitiveness, carriers tend to use larger shipping vessels and form mega alliances. In this way, carriers only need to call at a smaller number of ports to reduce expensive port fees, which leads to a growing traffic concentration at certain ports and causes intensified port competition. Ports with higher attractiveness such as good geographic position; good quality infrastructure that capable to handle mega vessels; better access to hinterland transportation networks and so on acquired large traffic volumes. In such situation, competitive ports turned to be hubs and the other ports

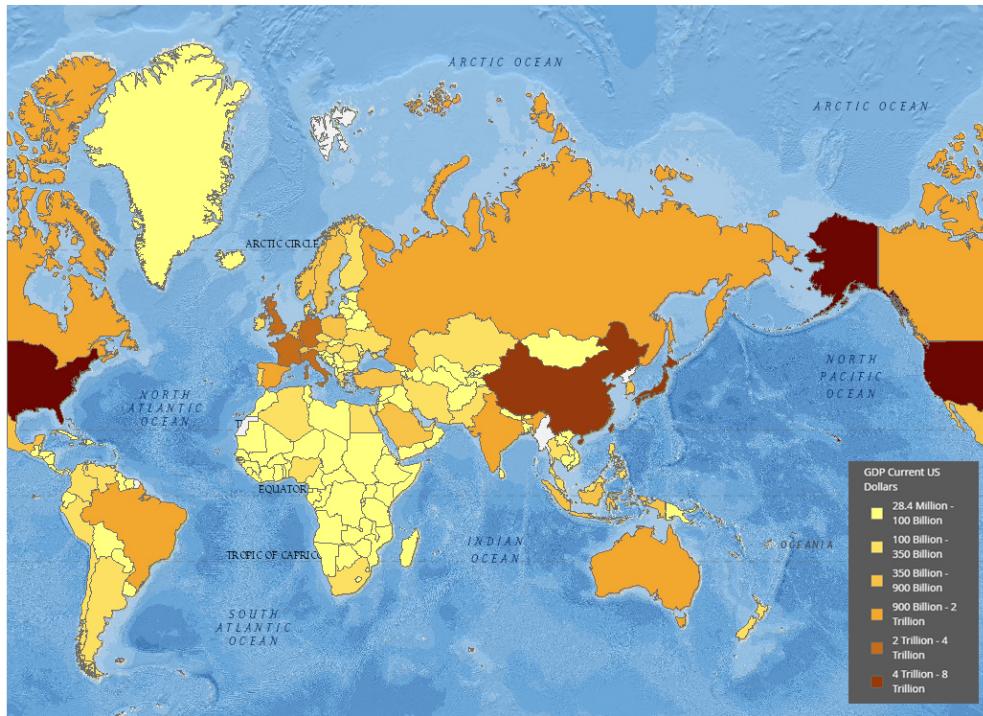


Figure 1.1: The geography of world GDP

Source: ArcGIS<sup>1</sup>

function as feeder ports or even died off. Logistics hub/cluster quickly specialized around the hub port area to support hinterland transportation, and the specialization further being a strong source to enhance the competitiveness of the hub itself. Ports act as a critical role shaping the structure of the global transportation network, and the easy access to sea therefore is a crucial determinant for MNEs' location selections. Hubs and its hinterland transportation systems become more and more integrated into global supply chains, and contribute significantly to the local economies.

Due to the strong economic engine role of ports, around the globe it has developed a specific ocean-core economy pattern. Countries occupying leading ports are more involved in the global value-added activities. The existence of hub ports usually refers to higher level of shipping connectivity, more job opportunities and tax revenues. On the contrary, being landlocked means lack of access to sea, indicating higher transportation and trade costs. As shown in Figure 1.1, it is easy to perceive that most of the landlocked countries/regions tend to have lower GDP, and almost all the high GDP countries are allocated with long coastlines.

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<sup>1</sup><https://www.arcgis.com>, accessed in May 2020. Data source: World Bank.

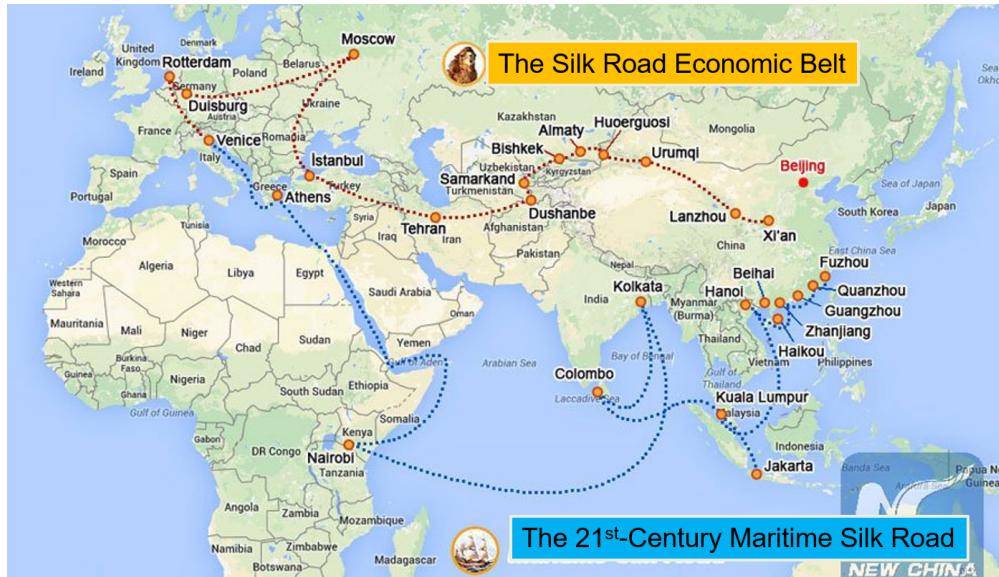


Figure 1.2: The Belt and Road Initiative

Source: Xinhua News Agency

## 1.2 Belt and Road Initiative

Against a slowdown in the domestic growth, China proposed to jointly establish the "Silk Road Economic Belt (SREB)" and the "21st Century Maritime Silk Road (MSR)" in 2013, referring to the Belt and Road Initiative (BRI). It is also called One Belt One Road or New Silk Road in some resources. The BRI represents a trans-continental long-term national and international development initiative, with the intention to promote facilities connectivity and regional cooperation among Asia, Africa, and Europe. The plan is as shown in Figure 1.2.

Chinese president Xi Jinping first unveiled the vision of revitalizing the ancient Silk Road to jointly build the "Belt" (SREB) at Nazarbayev University on Sept.7, 2013 as part of his state visit to Kazakhstan. The idea of establishing the "Road" (MSR) was released one month later during his state visit to Indonesia. Focusing on land connectivity, the SREB plans to establish roads, railways, oil and gas pipelines spanning the Eurasian continent from Xi'an province of China stretching to European destinations. The MSR targets at enhancing maritime shipping connectivity through port infrastructure construction projects. Start from Lianyungang port in Jiangsu province, the MSR is planned to span across the South China Sea, the South Pacific Ocean, the Indian Ocean area, and the Arctic Ocean. Later on, Chinese authorities released the "Vision and Actions on Jointly Building Silk Road Economic Belt and 21st-Century

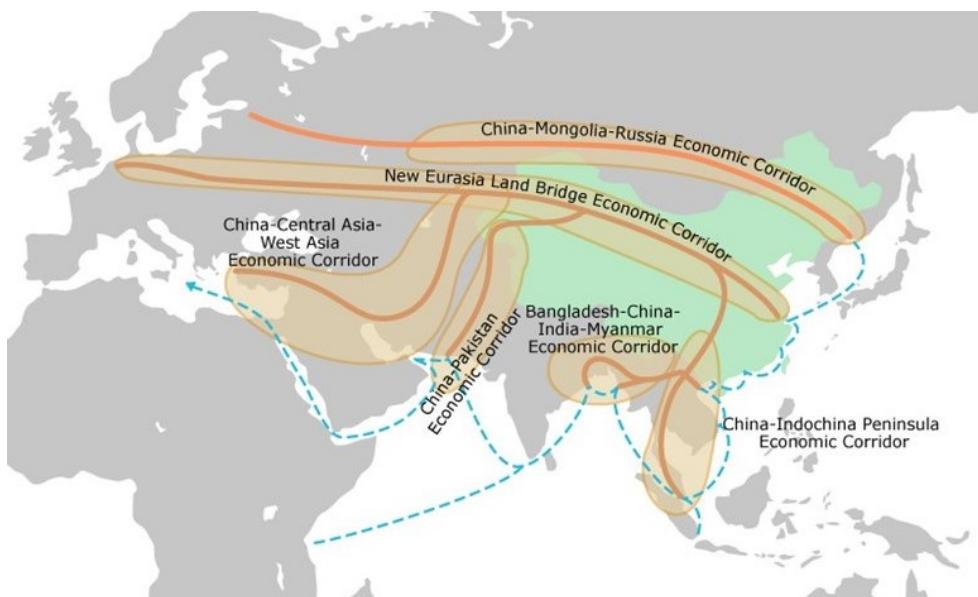


Figure 1.3: Six economic corridors

Source: HKTDC Research<sup>1</sup>

Maritime Silk Road” in March 2015. In this document, land connectivity improvement plan is further specified as the construction of the six economic corridors, as shown in Figure 1.3.

According to the ”Vision and Actions” document released by Chinese National Development and Reform Commission (NDRC), Ministry of Foreign Affairs and Ministry of Commerce, there are five goals of priority representing the strategic-level guidelines: policy coordination, facilities connectivity, unimpeded trade, financial integration, and people-to-people bonds. These goals reveal China aims to not only enhance regional connectivity through infrastructure projects, but also cooperation in various areas including policies, trade and financial facilitation, and cultural exchange. Besides, energy, industrial projects and special economic zones (SEZs) are also important co-operation areas.

In 2015, China found the Office of the Leading Group for the Belt and Road Initiative, which published the implementation plan—”Building the Belt and Road: Concept, Practice and China’s Contribution” (2017). Described in this document, the framework for construction consists of ”six corridors, six means of communication, multiple countries, and multiple ports”. The ”six corridors” present the six international economic cooperation routes including: The New Eurasian Land Bridge Economic

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<sup>1</sup><http://china-trade-research.hktdc.com>, accessed on April 20th, 2017

Corridor, the China-Mongolia-Russia Economic Corridor, the China-Indochina Peninsula Economic Corridor, the China-Pakistan Economic Corridor, and the Bangladesh-China-India-Myanmar Economic Corridor (see Figure 1.3). The "six means of communication", planned as one of the main objectives, targets to build an integrated information network connecting rail, highway, seagoing transport, aviation, pipelines, and aerospace. The "multiple countries" and "multiple ports" present the vision to combine with numerous countries and ports to jointly improve traffic connectivity. There are also a lot of other official documents that explain policies, regulations, bilateral agreements, and local planning, such as "Action Plan on Belt and Road Standard Connectivity (2015-2017)" and its updated version "(2018-2020)", "Development Plan of China-Europe Freight Train Construction (2016-20)", "Vision for Maritime Cooperation under the Belt and Road Initiative", "Guidance on Promoting Green Belt and Road", "Education Action Plan for Belt and Road Initiative", etc.

As a summary, the BRI is a massive infrastructure-led development initiative with numerous supportive measures in cooperation with involved economies. This national initiative creates a new mode of mutually beneficial cooperation reinforcing the globalization trend on a regional scale and presents opportunities to improve regional land and sea connectivity, facilitate cross-border trade and investments, and prompt local development.

### **1.2.1 "Belt": six economic corridors**

Through its core node Xinjiang Autonomous Region, the "Belt" is planned across Central Asia, Western Asia and extends to Europe. Some branches also stretch to Southeast Asia, South Asia and the Indian Ocean. The construction of the "Belt" mainly focuses on the establishment of the six economic corridors, as shown in Figure 1.3. These corridors in progress are jointly constructed relying on the six international transportation channels, supported by the nodal cities along it. The primary goal is to connect China's inland cities to neighboring countries and extend to diverse directions, actively seeking cooperation and growth opportunities. Cooperation projects include highways, ports, pipelines, electricity, optical cable, etc.. Key economic and trade industrial parks are also established as cooperation platforms.

- New Eurasia Land Bridge Economic Corridor (NELBEC)

The construction of this corridor indicates the idea of improving regional growth and economic cooperation along the New Eurasian Land Bridge (NELB), which is also known as the "Second Eurasia Land Bridge". This is a transcontinental railway transportation route, extending from China's eastern port city Lianyungang (Jiangsu province) to one of the European largest ports-Rotterdam (Netherlands). The NELB exits at the border Alashankou (Xinjiang Autonomous Region) and passes through Kazakhstan, Russia, Belarus, Poland and Germany,

covering over 30 countries and regions. Linking the Pacific and the Atlantic economic center, this corridor improves Eurasian's land connectivity. To facilitate physical movements and trade, China has gradually opened diverse international freight railway transportation services from inland cities to European destinations. In 2016, Chinese authorities established CHINA RAILWAY (CR) Express as the unified brand to integrate all the available routes and resources. Besides, under the framework of NELBEC there are some construction projects. For example, China-Kazakhstan (Lianyungang) Logistics Cooperation Base is marked as the first physical platform of the "Belt". China-Kazakhstan Khorgas Border Cooperation Center is the first international border cooperation center China established with foreign countries as a demonstration zone.

- China-Mongolia-Russia Economic Corridor (CMREC)

The idea of jointly building the CMREC is first proposed in September 2014 at the meeting of the heads of China, Russia and Mongolia. Chinese president Xi jinping suggested to integrate the "Belt" construction with the innovations of Russian Trans-Eurasian Railway and Mongolia's "Steppe Road" initiative. The aim is to strengthen the construction of interconnections including railways and highways, to promote customs clearance and transportation facilitation. The three sides agreed to enhance cooperation under the Shanghai Cooperation Organization (SCO) framework. Based on this agreement, a year later the three heads of states met again in Ufa (Russia) and approved the "Mid-term Roadmap for Development of Trilateral Co-operation between China, Russia and Mongolia". The CMREC comprises two connections: one starts from Bohai Economic Rim region (Beijing-Tianjin area) through Hohhot (Inner Mongolia Autonomous Region) to Mongolia and ends in Russia; one goes from China's northeastern area including Dalian, Shenyang, Changchun and Harbin, passing through the border Manzhouli then ends at Chita (Russia). Representative projects include China-Mongolia Cross-border Economic Cooperation Zone, Ceke port along China-Mongolia railway, Uligi highway port, Russia's Kyzyl-Kuragino railway construction.

- China-Central Asia-West Asia Economic Corridor (CCWAEC)

The CCWAEC starts from Xinjiang Autonomous Region, running west after the border Alashankou to access to the railway networks of Central Asia and West Asia. The final destinations are the Persian Gulf, the Mediterranean coast and the Arabian Peninsula, spanning the five countries in Central Asia (Kazakhstan, Kyrgyzstan, Tajikistan, Uzbekistan and Turkmenistan) as well as Iran and Turkey in West Asia. Considering the abundant energy resources of these countries, this corridor is also strategic positioned as energy channel for oil and gas. The China-Central Asia natural gas pipeline is currently the longest over the world, starts from the border of Turkmenistan and Uzbekistan on the right bank of the Amu Darya River and enters China from Khorgas through central

Uzbekistan and southern Kazakhstan. Chinese governments are also seeking mutual benefits that tally with each country's national development strategies, such as Kazakhstan's "Road to Brightness", Tajikistan's "Energy, Transport and Food", and Turkmenistan's "Strong and Happy Era". With the enhancement of cooperation, a batch of projects completed, including logistics cooperation bases, fast clearance channels for agricultural products, as well as border crossings. In the future, this corridor will be continuously extended to countries in West Asia and North Africa, such as Saudi Arabia, Iraq, etc.

- China-Indochina Peninsula Economic Corridor (CICPEC)

Within the framework of China-ASEN community of common destiny, the CICPEC is a land bridge linking China's southeastern area especially the Pearl River Delta economic circle and the states of the Greater Mekong subregion. This corridor starts from Nanning (Guangxi province) and Kunming (Yunan province), spanning through Vietnam, Laos, Cambodia, Thailand, Myanmar, Malaysia, etc. and at last ends in Singapore. The main content of it include motorways, railways and air connections. The strategy of jointly building this corridor is also actively seeking consistent with Vietnam's "Two Corridors and One Circle" conception, Cambodia's "Four Corners" strategy, Indonesia's "Global Ocean Fulcrum" envision, as well as Brunei's "Vision for 2035" blueprint. The "China-Indochina Peninsula Economic Corridor Proposal" was released on the 9th Pan-Beibu Gulf Economic Cooperation Forum in 2016, along with several pilot construction projects including China-Indochina Peninsula Cross-border E-commerce Settlement Platform, China-ASEAN (Qinzhou) Huawei Cloud Computing and Big Data Center, Longbang Chaling Cross-border Economic Cooperation Zone, Myanmar China (Jinshandu) Agricultural Demonstration Zone, etc..

- China-Pakistan Economic Corridor (CPEC)

In May 2013, Chinese Premier Li Keqiang visited Pakistan and proposed the idea of constructing CPEC to enhance cooperation in transportation, energy, maritime and other fields. This corridor runs from Kashgar (Xinjiang Autonomous Region) as the northern terminal to Pakistan's Gwadar port as the southern end. Soon, as the release of BRI, the conception of CPEC was integrated into the framework. In 2015, Chinese president Xi Jinping visited Pakistan and launched a \$46 billion investment plan indicating the construction entered the implementation stage. Heads of the two countries also agreed on the "1+4" cooperation plan with focus on Gwadar Port, energy, transportation infrastructure and industrial cooperation. Described as the most effective economic corridor, many infrastructure projects have completed and a significant progress has been achieved. Pakistan is China's neighboring country with the access to the Arabian Sea. Through it, China can transport energy resources and goods via Gwadar port and reduce its reliance on the Malacca Strait.

- Bangladesh-China-India-Myanmar Economic Corridor (BCIMEC)

The idea of intensifying regional cooperation between Bangladesh, China, India and Myanmar traces back to the first economic cooperation conference held in Kunming in 1999, and the jointly signed document "Kunming Initiative". Until 2013, Chinese premier Li Keqiang visited India and official proposed the envision of building the BCIMEC. Received active responses, the four countries established a united working group, agreed on the "Bangladesh-China-India-Myanmar Joint Research Program" after negotiations and discussions. This corridor links Yunnan to Kolkata (India) via Mandalay (Myanmar) and Dhaka (capital of Bangladesh), connecting various countries of the Gulf of Bengal. Due to geopolitical issues and other reasons, the construction of this corridor is not so active compared to others. While there is great potential for cooperation, especially linking the Pearl River Delta economic center to the ones in India. One of the most important projects is the oil and gas pipelines between China and Myanmar, has become the 4th largest energy import channel after the Central Asian oil and gas pipeline, China-Russia crude oil pipeline, and maritime shipping channel. The gas pipeline starts at the port of Kyaukpyu, where the industry park and deep water port projects are also in progress.

### **1.2.2 "Road": BRI's vision for maritime**

The "Road" is short for the "21st-Century Maritime Silk Road (MSR)". When Chinese President Xi Jinping first proposed to jointly build the MSR in 2013, it was merely a concept of reviving the ancient "Maritime Silk Road" to enhance cooperation between China and the ASEAN. Over the last several years, MSR's concept and scope keep expanding, evolved from the initial idea of two shipping routes to the vision of "three blue economic passages", and then lately a new route going to the Latin America emerged. Nowadays, the MSR has become the general concept representing China's vision to enhance maritime shipping connectivity in the context of the BRI.

The MSR at first is framed as two directions: one is from the South China Sea to the Indian Ocean then extending to Europe; one is heading to the South Pacific. This initial idea is released in the first BRI official document 'Vision and Actions on Jointly Building Silk Road Economic Belt and 21st-Century Maritime Silk Road' in 2015, jointly published by China's NDRC, Ministry of Foreign Affairs, and Ministry of Commerce. This document also emphasizes that ports are the important nodes for building smooth, secure and effective transport corridors. Chinese leading coastal areas including the Yangtze River Delta, Pearl River Delta, West coast of the Taiwan Strait, and the Bohai Bay Rim are framed to drive the construction of the Shanghai pilot free trade zone as well as the Guangdong-Hong Kong-Macao Greater Bay Area, and support Fujian province to develop as the core area of the "Road".

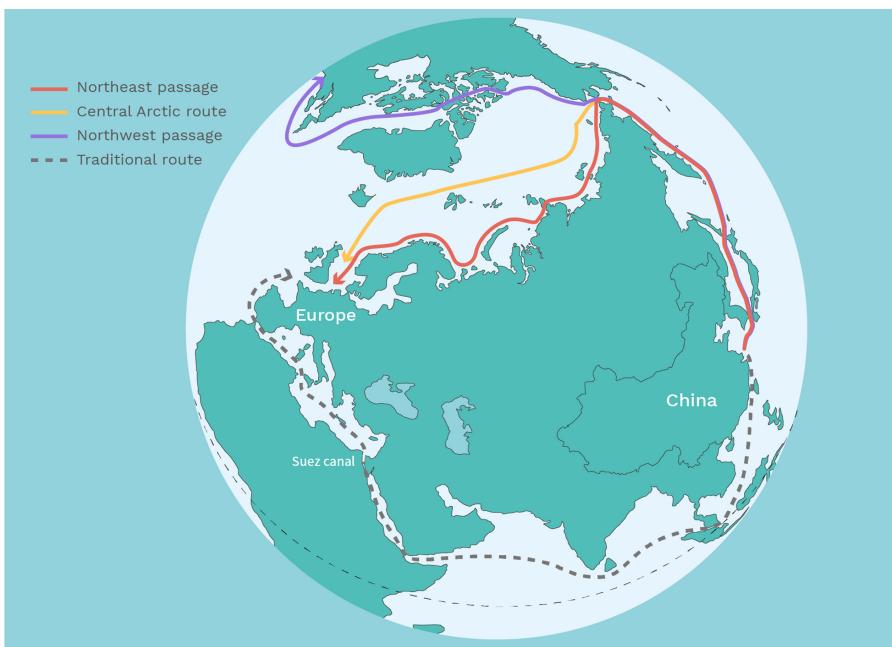


Figure 1.4: Arctic shipping routes  
Source: Chinadialogue Ocean<sup>1</sup>

An important turning point is at the first "Belt and Road" International Cooperation Summit Forum on May 14th, 2017, Russian President Putin clearly stated his idea of jointly exploit the Arctic shipping routes with China and expressed the wish of connecting it to the BRI. Soon, China and Russia reached a consensus on building the Northern Sea Route named "Polar Silk Road" or "Ice Silk Road". According to the white paper titled "China's Arctic Policy", the Arctic shipping routes comprise the Northeast Passage, Northwest Passage, and the Central Passage, as shown in Figure 1.4. The Northeast Passage in this context is consistent with Russia's definition of the Northern Sea Route, becomes the major cooperation content of the "Polar Silk Road". Chinese enterprises are encouraged to participate in the infrastructure construction and trial voyages to pave the way for commercial and regularized operation. The idea of the "Polar Silk Road" is quickly being integrated into the re-framed MSR's vision. In 2017, the NDRC and the State Oceanic Administration (SOA) jointly released "The Vision for Maritime Cooperation under the Belt and Road Initiative". As the first official document focusing on China's maritime construction cooperation plan, it proposed the concept of the three "blue economic passages", extending the initial MSR to three directions (see Figure 1.5, except China-Latin America passage). Revealed in this vision plan, Chinese authorities intend to build the mutually-beneficial

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<sup>1</sup><https://chinadialogueocean.net/12569-chinas-arctic-silk-road-projects/>, accessed on January 12th, 2020.

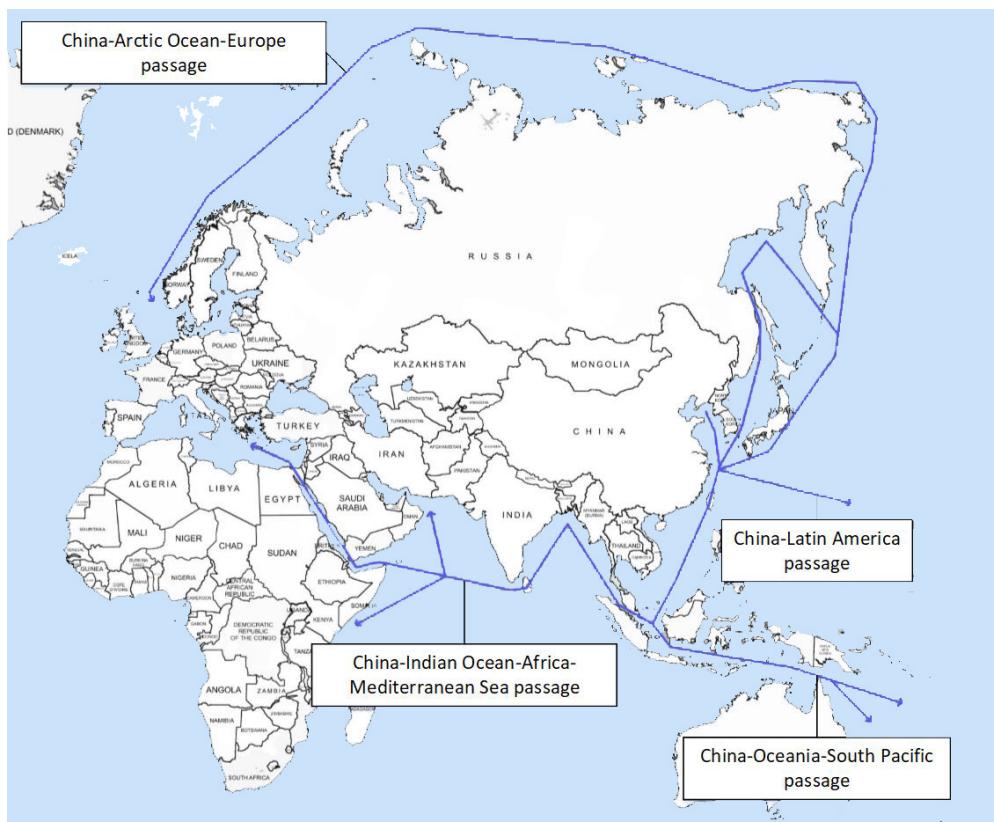


Figure 1.5: Planned shipping passages of the MSR

”blue partnership” with involved countries and emphasized the green development, ocean-based prosperity, maritime security, innovative growth, and collaborative governance. Meanwhile, the three planned passages are focusing on not only the traffic infrastructure improvement, but also the cooperation in trade barriers remove, marine resources utilization, maritime industry development, information exchange, maritime law enforcement, marine scientific research and technological development, etc. From the view of maritime shipping, it aims to promote connectivity between ports in various countries, and utilize marine resources in a sustainable way. Currently, the ”Polar Silk Road” is just at the initial stage of exploitation and restricted a lot to the weather. While considering the trend of global warming, it has a great potential to be the busiest trade route. Connecting China and Europe, it has the shortest distance of around 7,000 nautical miles, and the traditional route via the Malacca Strait and the Suez Channel is around 10,000 nautical miles. Shipping through it can reduce the delivery time for at least 12-15 days.

The further expansion of the MSR heading to the Latin America indicates that the BRI is not merely restricted to Africa, Asia, and Europe. At the second "Belt and Road" International Cooperation Summit Forum on May 26th, 2019, Chinese President Xi Jinping emphasized the new opportunities for updating China-Latin America economic and trade cooperation. Soon, Latin American and Caribbean countries are officially affirmed to be the participation countries of the BRI. Consequently, the shipping route heading from China's coasts to the Latin America becomes an integrated part of the MSR. Panama becomes the first country that signed a memorandum with China for joining the BRI.

In a summary, the scope of the MSR keeps expanding and currently there are four shipping routes heading from China and almost covers all the possible directions, as presented in Figure 1.5.

- China-Indian Ocean-Africa-Mediterranean Sea passage: this passage intends to link the China-Indochina Peninsula Economic Corridor, running westward from the South China Sea to the Indian Ocean, and connecting the China-Pakistan Economic Corridor (CPEC) and the Bangladesh-China-India-Myanmar Economic Corridor (BCIMEC).
- China-Oceania-South Pacific passage: this route runs from the South China Sea to the Pacific Ocean.
- China-Arctic Ocean-Europe passage ("Polar Silk Road"): this economic passage is envisioned extending to Europe via the Arctic Ocean.
- China-Latin America passage: this route goes from China to the Latin America.

### 1.3 Research motivation

Though potential risks and many issues exist, it has been six years since the announcement of the BRI. As its implementation, large amounts of investments flow into transportation and communication infrastructure projects. This significantly improves the status of transportation infrastructure in many countries. Land connectivity on a regional scale is supposed to be improved due to the construction of the six economic corridors spanning numerous landlocked countries along the SREB. Sea connectivity may be improved as well because of the new available shipping routes via the constructed and upgraded ports along the MSR. Besides, the climate of international trade & investment is also changing due to the agreements achieved between the related countries. Considering the broad geographic scope and the large-scale of transportation infrastructure investments, it is of several parties interests to understand BRI's impacts on the GLN constituting the research motivation.

## **Logistics industry**

The direct impacts of infrastructure and connectivity improvements are on the logistics industry. In the maritime shipping industry, the relative importance of certain ports may shift, as well as the relative significance of certain shipping routes. BRI's efforts improve port infrastructure and sea connectivity, may possibly change the port choices of shipping companies, and consequently alter the shipping routes. This will eventually shift the pattern of the shipping network in the BRI region. It is necessary to acquire information about which ports are/will be improved in the context of the BRI and how the port hierarchy and the shipping network could evolve. In terms of land logistics, the construction of the six economic corridors could improve the land connectivity in the Eurasian continent, may possibly distract some of the market share from the shipping industry. Logistics hub/cluster could be developed through specialization in the inland countries/regions, maintaining certain amount of traffic volumes. Besides, BRI's implementation also offers the sea-rail inter-modal transportation possibilities in the logistics market. For instance, the operation of CHINA RAILWAY (CR) Express, a regular container block train service, offers a railway transportation alternative between China and Europe, two of the largest economies in the world. The rail services could substitute part of the shipping services, and also play a supplementary role in offering various inter-modal transportation solutions (for instance, partly transported by rail and partly transported by sea). Local logistics service providers therefore are facing both challenges and opportunities at the same time. It is crucial to understand the impacts of the BRI on the inland transportation to identify the potential developing opportunities as well. In a word, BRI's investments in transportation infrastructure adds uncertainties to the logistics industry, which could change the pattern of the GLN on a regional scale requiring careful investigation.

## **Multinational enterprises**

Good transportation infrastructure and access to global transportation systems enable MNEs to exploit comparative advantages in various countries. Domestic transportation capabilities are also important component constituting comparative advantages determining companies' location selections. In the context of the BRI, first of all, better infrastructure and connectivity could drive MNEs to apply more optimal delivery solutions, change the pattern of shipping network and land transportation network. Secondly, the BRI reinforces the globalization trend through motivating MNEs to relocate their facilities including manufacturing plants and distribution centers (DCs). The agreements on trade and foreign direct investment (FDI), the construction of special economic zones (SEZs), the cooperation projects of industrial and logistics parks, all work together could create a more preferable macro-economic circumstances for MNEs to invest and relocate. Hence the BRI could alter the geographical dispersion of production sites and DCs, which causes substantially changes to the GLN. It is of

strategic importance for MNEs to understand how BRI could offer the opportunities for them to exploit comparative advantages of foreign countries, and seek new opportunities for both procurement and marketing. MNEs are also motivated to reconsider and reassess the current configuration of their facilities at a global level, to better respond to the dynamics induced by BRI.

### **BRI-related countries/regions**

Transportation infrastructure is considered as an important economic engine to drive growth. The BRI spans Asia, Africa and Europe, covering numerous countries including coastal countries and landlocked ones. These countries are unevenly developed with different allocation of natural endowment and different level of transportation infrastructure. Whether the infrastructure investments in these countries could benefit the local regional development is the major question. In general, coastal countries benefit from ocean access are more involved in the global economy, while most of the landlocked countries are less accessible and less developed. For both kinds of countries, BRI offers capitals to facilitate the construction of infrastructure, which is a good opportunity for countries/regions to specialize in logistics and manufacturing industries, to acquire sustainable development chances. It is critical for the involved countries to understand whether BRI's investments can help to realize the growth potential, to promote trade performance and economic development. In addition, transportation infrastructure presents spillover effects due to its network features. Improved infrastructure can facilitate mobility of physical materials, people and technology, therefore it will also affect the adjacent countries/regions. Hence it is strategically important for local countries/regions to gain knowledge to guide the policy-makers to set up supportive policies and regulations to attract investments, skilled labor, and technology.

## **1.4 Research Questions**

BRI's implementation covers Asia, Africa, and Europe, and may cause many changes to the logistics industry, MNEs, and the related countries/regions. Therefore, the main research question of this thesis is:

- What are the impacts of BRI on the structure of the GLN on a regional scale?

To figure out this main question, there are several sub-questions requiring research. The first category of the sub-questions relates to GLN. Answering these questions can gain a comprehensive understanding about the concept of GLN, the relations between GLN and MNEs, as well as the current status of GLN.

- What is the definition of GLN?
- What is the connection between GLN and MNEs?
- What determines the structure of GLN?
- What drives MNEs' network redesign decisions (or relocation decisions)?
- What is the current status of GLN in the BRI-related region?

The second category of the sub-questions relates to the BRI. Answering these questions can help to learn more details about this initiative, and to analyze the state-of-art in terms of BRI research.

- What is the concrete content of the BRI?
- How researchers have investigated the impacts of BRI, especially the impacts on GLN?

The third category of the sub-questions focus on the role of transportation infrastructure in reshaping the GLN. BRI is an infrastructure-led development initiative. Through transportation infrastructure projects BRI affects logistics industry, MNEs' location selection, as well as countries/regions. Therefore, it is critical to understand what are the consequences of transportation infrastructure improvements, and how these consequences contribute to the pattern shifts of GLN in the BRI context. These questions are as follows.

- What is the role of transportation infrastructure in the GLN?
- How transportation infrastructure affects logistics industry?
- How transportation infrastructure affects MNEs' relocation decisions?
- How transportation infrastructure affects countries/regions?

The three categories of sub-questions show that transportation infrastructure is the standpoint connecting the BRI and the structure of GLN. Based on the investigation results of these questions, the implications can be generated to answer the last category of sub-questions as follows.

- What are the implications for logistics industry?
- What are the implications for MNEs?
- What are the implications for the involved countries/regions?

- What are the insights derived from BRI's implementation in terms of the redesign of GLN?

## 1.5 Methodology

To address the aforementioned research questions, several approaches are applied.

- Literature review

One of the main methodologies used in this research is integrative literature review. The main objective is to clarify key concepts and identify main connections between the GLN and BRI. This research reviews literature in several topics: the concept of GLN, network re-/design determinants, MNEs' re-/location decisions, BRI related articles, and the role of transportation infrastructure. Besides, information related to BRI's implementation are in most cases published online from the sources of official documents, reports, websites, TV, etc.. Therefore, BRI information are searched, reviewed, screened and organized from online resources.

- Conceptual framework

Conceptual framework building is necessary for the research. BRI is a comprehensive development initiative dominated by infrastructure investments with supportive measures. The structure of GLN is a multidisciplinary research topic relates to many concepts in various fields. To identify BRI's impacts on GLN, it is necessary to produce a conceptual framework representing both the content of BRI and the structural components of GLN, to further identify the linkages between GLN and BRI. These conceptual frameworks can help to understand from which aspects the BRI affects the evolution of GLN.

- System dynamics modeling

Transportation infrastructure improvements are important content of BRI, and can produce significance effects on the structure of GLN through many aspects, including logistics & transportation, trade relations, regional development, and so on. These aspects however interact with each other, constituting complex interrelations as a whole system. Understanding these interrelations can generate more comprehensive insights and implications about the role of transportation infrastructure in shaping the GLN, therefore should not be ignored. In such situations, system dynamic approach is applied as a useful tool to analyze and present the dynamics existing between transportation infrastructure and the GLN.

- Case studies

Considering the large scale of the BRI, it is impossible and unnecessary to collect all the related information in regards to transportation infrastructure projects and related MNEs as well as countries/regions. By applying case studies on the typical examples, BRI's impacts on GLN can be investigated and proved with details and evidences. In this work, cases of Piraeus port and Gwadar port are chosen to analyze the impacts of BRI on GLN through port infrastructure improvements. The cases of Chongqing (city in China's western inland area) and Khorgas (border between China's Xinjiang Autonomous Region and Kazakhstan) are chosen to analyze BRI's impacts on GLN through land transportation infrastructure improvements.

## 1.6 Thesis Outline

The dissertation is structured in five chapters, as shown in Figure 1.6.

Chapter 1 introduces research background, Belt and Road Initiative (BRI), research motivation, research questions and the applied methodologies.

Chapter 2 conducts literature review in regards to GLN re-/design, location selection, BRI research status and logistics-related articles. Transportation infrastructure as the backbone supporting logistics activities and the top priority of BRI, is considered as the standpoint of this research, hence the related literature is also reviewed.

Chapter 3 builds the main theory. The location decision process for MNEs shows that there are some common external factors that affecting firms' re-/location decisions. A three-layer framework of GLN is formed extending the initial concept of GLN that merely focusing on MNEs' management perspective. Afterwards, the critical aspects and key trends of GLN are summarized. Then applying system dynamic modeling approach, the role of transportation infrastructure in reshaping GLN is modeled through analyzing its effects on transportation & logistics, international trade, and regional development.

In chapter 4, a general analysis of BRI's impacts on GLN is conducted. To validate the arguments, cases of Piraeus port and Gwadar port are analyzed to investigate the impacts of port infrastructure investments and sea connectivity improvements. Case of Khorgas in the context of CR Express operation is discussed to research the impacts of land connectivity improvement.

Chapter 5 presents the research conclusion and limitation.

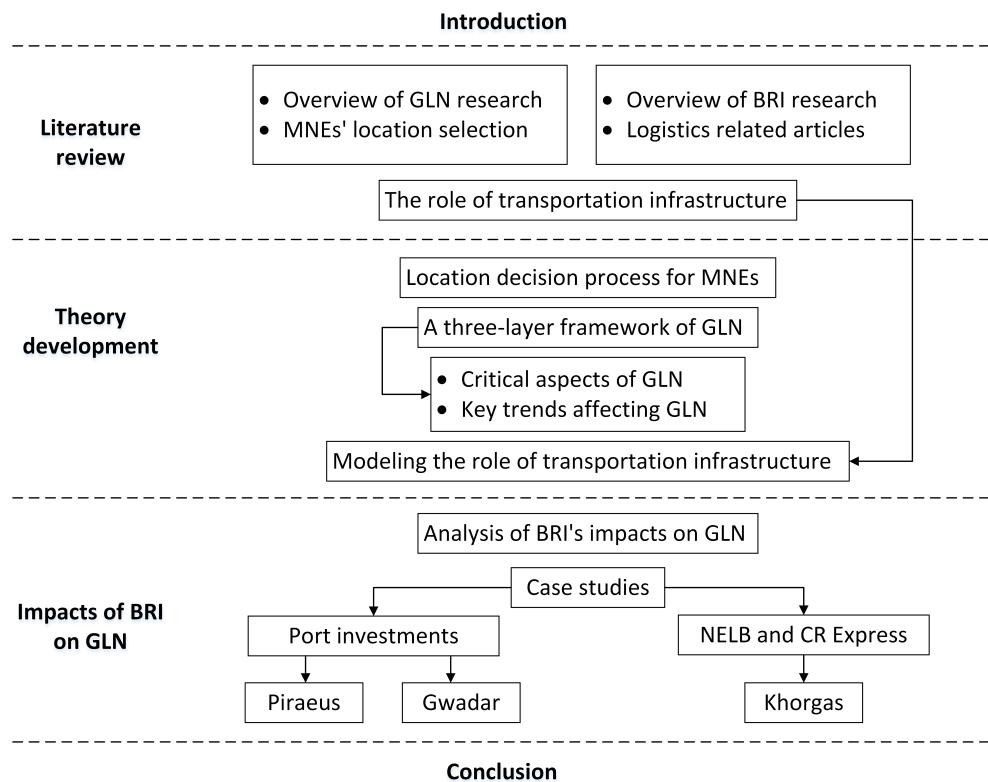


Figure 1.6: Thesis outline

## **2 Literature Review**

To investigate BRI's impacts on the GLN, it is necessary to clarify the definition of GLN and GLN re-/design. Section 2.1 reviews literature to clarify these concepts. Section 2.2 focuses on location selection for MNEs since it is the most critical decision in GLN re-/design. Three streams of research fields are identified, and the concept of location advantages is introduced. Research interests in BRI keeps rising since its announcement in 2013. Section 2.3 conducts a systematic literature review first to get an overall impression on the current study topics and fields, second to analyze the BRI research specifically related to logistics. All the logistics-related literature in terms of the concern has been clarified into three groups: logistics & transportation issues; international trade and business; as well as regional development. The following summary sub-section analyzes the BRI literature relevant to network re-/design issues and presents a framework of potential research topics about BRI. Section 2.4 reviews literature focusing on the role of transportation infrastructure. BRI's top priority is to improve regional physical connectivity. Enormous transportation infrastructure projects are planned, in progress and completed; covering highway, road, railway, seaports, dry ports, air ports, gas and oil pipelines. Therefore, it is necessary to understand the role of transportation infrastructure. Three general research directions are summarized in terms of perspectives: logistics perspective, economics perspective, and geographers' perspective.

### **2.1 Overview of GLN research**

The topic of GLN gained research interests since 1990s coming along with the globalization of the world economy. Yet, searching "global logistics network" in the database such as Web of Science, Scopus, or ScienceDirect, the author could barely find articles using the term not to mention its definition. The lack of search results, fortunately, does not indicate the deficiency of studies. The related literature however shows several terms that have been used to express the similar meaning but with different focus. Such terms include "global/international/multi-national supply chain", "global production—distribution network", "global logistics system", "global value chain", "global commodities chain", etc. are mainly distributed in the fields of management science, transportation research, economic geography. Apparently, GLN research is a multidisciplinary topic relates to various aspects, covering trade, transportation, ge-

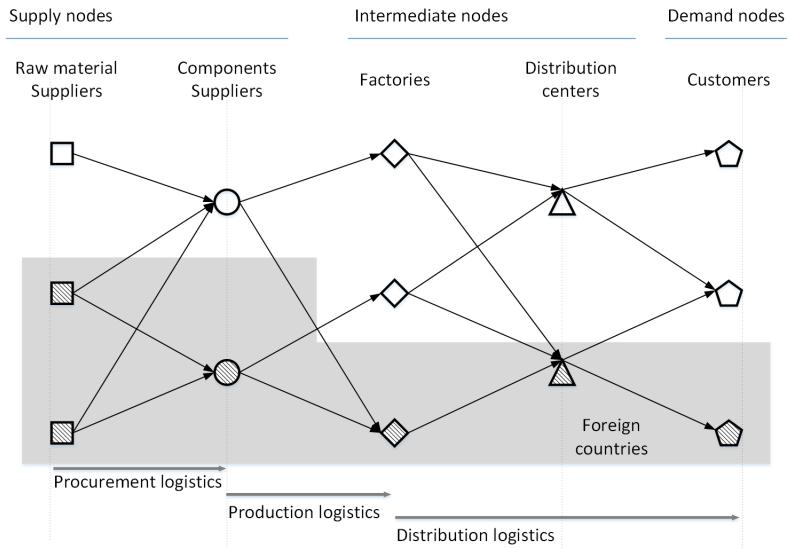


Figure 2.1: A framework for global logistics network

ography, investment and so on. To generate a comprehensive understanding of GLN, instead of making efforts on exhausting all the related documents, this section reviews literature with the objective to clarify the concept of GLN and GLN re-/design and addresses the related fields.

### 2.1.1 Three understandings of GLN

Articles directly used the term "global logistics network (GLN)" are scarce, instead, the term "global supply chain (GSC)" was widely applied. Though most of the cases GLN and GSC are replaceable, researchers emphasized different perspectives and research issues. GSC studies focus on supply chain management (SCM) in a global context, pay more attention to organizational issues from enterprises' point of view. Among these GSC research papers, GLN is considered as the spatial layout of suppliers, factories, distribution centers (DCs), and customers for a specific manufacturing enterprise. A typical structure of GLN is shown as Figure 2.1. Suppliers, factories, distribution centers (DCs), customers are the logistics nodes, together with the freight flows supporting procurement, production and distribution logistics constitute the logistics network. Some scholars also include the flow of information, technology, capital and personnel as part of the network. This understanding is a simple extension based on the definition of (domestic) logistics network emerged as global business expansion of manufacturers.

In many literature GLN also refers to the network of the global transportation/shipping system. This understanding is applied by researchers in transportation science, maritime shipping management, and geography. GLN in such context usually corresponds to a specific international logistics service provider (such as shipping company or freight forwarder) or the entire industry. Researchers mainly focus on the transportation aspects. Related articles analyze the GLN to investigate the topological feature such as hub-and-spoke network (see Figure 2.2) (Kelly 1996); structure of maritime shipping network (Ducruet and Notteboom 2012); the function of transportation infrastructure like dry ports (Wang et al. 2018); inter-modal transportation network design (Woxenius 2007) and so on.

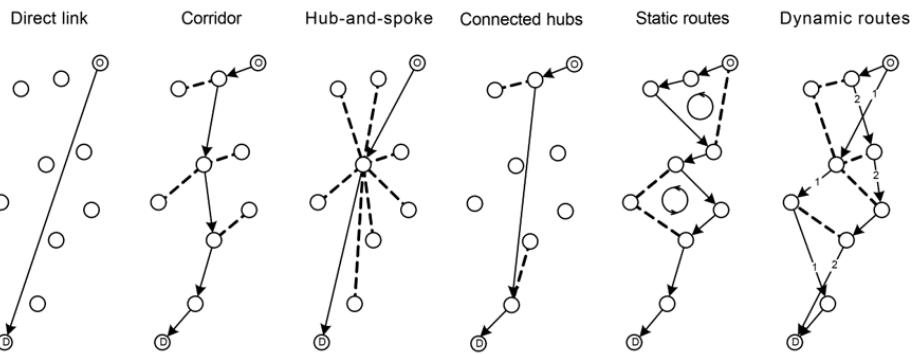


Figure 2.2: Possible transportation routes with ten nodes in the network

Source: Woxenius (2007)

Another group of researchers regard GLN as the spatial structure of logistics activities allocation at the global level. It consists of the nodes where economic activities (i.e. value-added activities) undertake and the links through which physical materials flow. This understanding is usually applied by economic/transportation geographers or regional scientists, does not necessarily refer to a specific company. Instead of addressing corporate management issues, researchers investigate the GLN to understand the spatial pattern shifts of freight flows within a regional or global scope. This research stream argues that conventional economic studies merely include time-related factors, and ignored the space-related factors. Therefore, (New) Economic Geography emerged to figure out solutions to include the consideration of spatiality, see Cidell (2010), Fujita and Krugman (2003). Topics addressed include the phenomenon of globalization and its implications for transportation (Tavasszy et al. 2003), changing trends of the GLN and its implications for better land use (Cidell 2011), the formulation of production and distribution networks in east Asia (Ando and Kimura 2013), the relations between transportation and global production network (Rodrigue 2006), etc.

## 2.1.2 GLN design and redesign

### GLN design

Due to the different understandings of GLN, re-/design of GLN also refers to diverse meanings in different fields. The largest group of researchers understand GLN design as operational research modeling issues. In this context, GLN design normally targets at companies, from the perspective of manufacturers or international carriers (Creazza et al. 2010). This idea is also reflected in the prior reviews (Goetschalckx et al. 2002; Meixell and Gargeya 2005; Schmidt and Wilhelm 2000; Vidal and Goetschalckx 1997) that analyzed literature addressing network design problems in the global scenario. Almost all of them paid attention to mathematical modeling papers in which profit maximization (or cost minimization) is the common objective. Recent review article by Olhager et al. (2015) applied content analysis as method and analyzes both mathematical modeling issues and theory development studies. This article confirms that most literature focus on manufacturing firm applying mathematical models. Improvements compared to the previous ones is they also include papers in the field of transportation geography such as the work by Hesse (2006, 2007); Hesse and Rodrigue (2004); Rodrigue (2006), which analyze the effects of geographical factors on supply chain decision making through conceptual modeling method. Hence, generally there are two perspectives of GLN design.

**Manufacturers' perspective** Adapting the manufacturers' point-of-view, the emergence of the research of GLN design is consistent with the development of logistics management, a concept appeared before SCM and later being integrated to SCM (Ballou 2007). Researchers deem it as the strategic-level decision-making part embedded in SCM issues, since the configuration of the network determines the overall performance of the enterprise. GLN design has become a useful supply chain strategy to main competitiveness and pursue profitability. The logistics network design problem usually involves decision-making in terms of:

- the number, location, capacity and technology of manufacturing plants and warehouses;
- the selection of suppliers;
- the assignment of product ranges to manufacturing plants and warehouses;
- the selection of distribution channels and transportation modes;
- the flows of raw materials, semi-finished and finished products through the network.

When in the global context, it is almost the same decisions to make but in a broader geographical scope. Transcending national boundaries add extra considerations, therefore decision-makers should also take fully account of international/global factors. Table 2.1 shows the main considerations in GLN design research articles. This understanding of GLN design is in line with the idea of many researchers in the field of management science like Chopra and Meindl (2007); Goetschalckx et al. (2002); Meixell and Gargeya (2005); Schmidt and Wilhelm (2000); Vidal and Goetschalckx (1997, 2001). The commonly design objectives are profit maximization or cost minimization while satisfying constraints such as customer demand, service level, delivery time, environmental considerations, etc. According to the time horizon of planning, GLN design decisions can be distinguished into three levels: strategic, tactical, and operational (Ballou 1999; Vidal and Goetschalckx 1997).

**Carriers' perspective** Some researchers design GLN adapting an international carrier's point-of-view, pay attention to optimize the service network to satisfy customers' freight delivery demands. In many articles, it also refers to the configuration of physical distribution or transportation network, with the given locations of origins and destinations. Hence, to some extent it is similar to the tactical level GLN design for manufacturers, which mainly concerns about the configuration of warehouses and routing optimization issues. Hesse and Rodrigue (2004) summarized the typical network structures for freight distribution (see Figure 2.3). The decision of GLN design

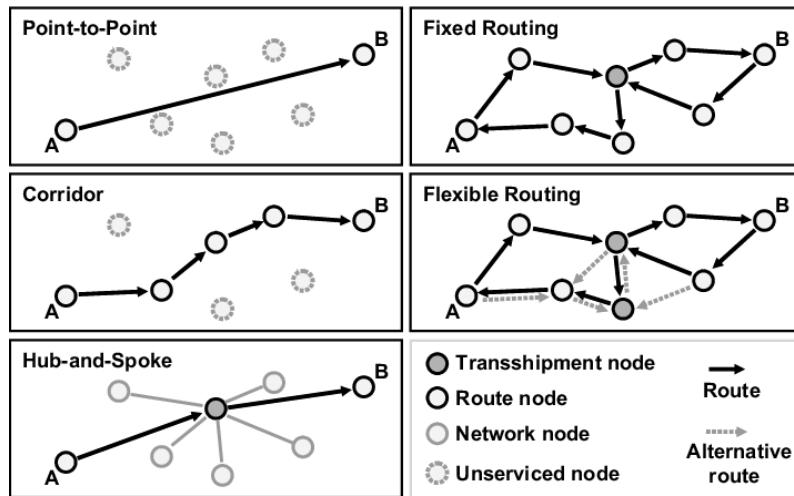


Figure 2.3: Freight distribution and network strategies

Source: Hesse and Rodrigue (2004)

for carriers mainly include the location, number, capacity of warehouse, the selection of transportation mode and route. The main idea is to apply operational research

Table 2.1: Main global considerations in GLN design models

Source: adapted from Goetschalckx et al. (2002); Vidal and Goetschalckx (1997)

Category	Content
Stochastic features	Exchange rate fluctuation Suppliers' reliability Reliability of transportation channels Lead times Stochastic facility fixed costs Stochastic demand Uncertainty of market prices Political environment Stochastic customer service level
Taxation and cash flow features	Taxes and duties Modeling of Profit repatriation Duty drawback and duty relief Modeling of transfer prices
General features	Selection of manufacturing technology Product differentiation by country Bill of materials (BOM) constraints Impact of economies of scale Excess capacity determination Financial decisions Infrastructure modeling Cash flow modeling Information flow modeling Global supply chain coordination Modeling of competitors' actions Modeling of alliances
Trade barriers	Quotas Local content Offset requirements Subsidies

modeling to minimize the total logistics cost considering the trade-offs between inventory costs and transportation costs, as shown in Figure 2.4. Some articles also present

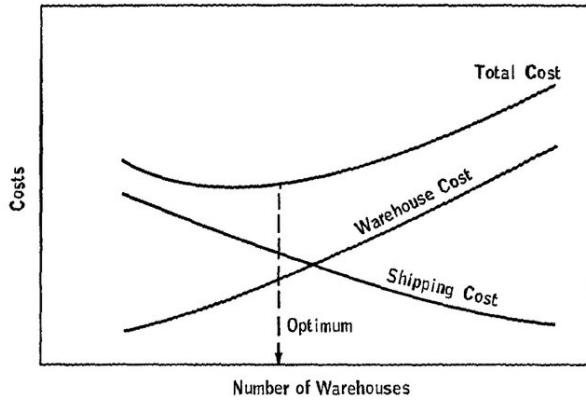


Figure 2.4: Trade-off between shipping costs and warehouse costs  
Source: Feldman et al. (1966) cited by Davydenko (2015)

non-optimization methods to support the network design. For instance, Creazza et al. (2010) designed five logistics networks for container shipping and develops a taxonomy for carriers to select the most suitable configuration. Sheu and Lin (2012) designed a hierarchical facility network planning model for global carriers based on cluster analysis.

### **GLN redesign**

Network redesign problem is based on the assumption that an initial logistics network exists. Many factors may trigger GLN redesign process. Mergers & acquisitions, removal of trade barriers between countries are some common motivating factors in the globalized world. Still, operational research modeling is the most used method to identify the optimized solutions, with the objective to diminish the total costs. From the perspective of manufacturers, the research mainly focuses on the reconfiguration decisions including the relocation of logistics activities from existing to new locations (including transferring capacities), and closure or opening of facilities. Representative works include Ivanov et al. (2013); Melo et al. (2012, 2014); Nagurney (2010); Vos (1997). For example, Hammami and Frein (2014) developed an optimization model for SC redesign including the international consideration of transfer pricing. From the perspective of logistics service providers, the relocation decision mainly refers to reconfiguration of DCs and transportation routes. For instance, Shang et al. (2009) redesigned the distribution network for a pharmaceutical company through relocating its regional DCs. In fact, after decades of globalization, many MNEs already expanded their facilities world-wide, design a new logistics network is not common and practi-

cal. In the modernized world, network redesign should be more frequently used as a strategy to maintain competitiveness for a relatively mature supply chain. As argued by Hammami and Frein (2014); Melo et al. (2009), network redesign processes have become more frequent and attractive. In reality, enterprises should review and reconsider the configuration of their networks from time to time to better respond to the fluctuations and dynamics in the changing world.

## 2.2 Location selection for MNEs

As described above, GLN re-/design is normally conducted as optimization issues along with the development of SCM. During this process, researchers started to learn the benefits of integrating different parts of the supply chain. Stratford (1957) first proposed the concept of total cost approach, emphasized the importance to consider transportation cost, inventory cost and service level in a integrated way. It is this origin of research perspective that nowadays GLN re-/design research continues the tradition and still regards network design as an integrated optimization issue. However, in the practical world, restricted by many factors such as land use limitation, macroeconomic factors, most MNEs do not select locations in this way. Indeed, MNEs conduct location selection at strategic level with respect to their overall SCM strategy. While, most of the time location selection are considered as independent decisions instead of a dependent one embedded in the re-/design of the entire network. Hence, it is also critical to pay special attention to location selection decisions of MNEs which can cause substantial changes to the structure of GLN.

### 2.2.1 Research perspectives and methodologies

Location selection as the strategic-level decisions for GLN re-/design has been studied mainly in three disciplines: management science, economic & transportation geography, and international business, as summarized in Table 2.2.

#### Management science

In this group, network re-/design issues are embedded in SCM research, and this group accounts for the largest proportion. Researchers classified three levels of supply chain planning: strategic, tactical and operational depending on the time horizon. Most of the articles applying mathematical models are based on operation research theories. The principle is to minimize the total cost objective function (or maximize profits) while satisfying constraints including markets' demands and customer service levels.

Table 2.2: Location selection research in three disciplines

Disciplines	Consideration	Perspective
Management science	Spatial economic costs such as labor costs, transportation costs, land costs, etc.	Operational research
Geography	Economies of scale; Network features; Agglomeration economies	Concentration and de-concentration; friction of distance
International business	Dunning's eclectic OLI paradigm (ownership, location, and internalization)	FDI location selection: location advantages of countries

Optimization models are established to identify the best locations and capacities by selecting sites from candidate locations (usually cities/ports). Mathematical formulations or computer simulation are conducted to solve the models. While, how the set of these candidate locations were selected is not included. In addition, different from domestic network design research, global considerations have attracted special interests, including taxes and duties, exchange rates, transfer pricing, environmental issues, etc. Most of these global considerations are economic factors which can be quantified in the modeling process. Some key location-specific factors which cannot be directly calculated or quantified, are not fully considered, for example, the impacts of different trading policies between countries on the logistics activities. Some researchers studied hub-and-spoke network design, and both conceptual and mathematical modeling were applied. Besides, some researchers addressed single facility location selection issues instead of multiple facilities. In these cases, multi-criteria decision tools such as analytic hierarchy process (AHP), data envelopment analysis (DEA) were applied to rank the available locations.

### **Economic and transportation geography**

Different from the first category, geographers concern about the spatial characteristics of economic/transportation activities on a global/regional scale. Articles in this group addressed GLN configuration issues can be summarized to three levels. On the global level, some researchers analyzed the role of transportation in the formulation of global production networks, for example see Hesse and Rodrigue (2004); HESSE and RODRIGUE (2006); ? and the resulting agglomeration effect in critical cities/regions, see Barrios et al. (2006). Hub-and-spoke network configuration also attracted some interests, for instance, Kelly (1996) analyzed hub-and-spoke network from the geographer's perspective. Research on selecting "global city" and important locations for national/regional logistics hubs are also included, see O'Kelly and Miller (1994). On the regional or city level, the relevant focus is on the location selection of city logis-

tics centers or DCs. Some transportation geographers also studied the transportation infrastructure and networks, container terminals, gateways, ports cooperation and regionalization, transportation network, etc., for example, see Hesse and Rodrigue (2004); Rodrigue (2008); Rodrigue and Notteboom (2012). Cidell (2010) analyzed the geographical concentration and decentralization features of the distribution network in US metropolitan areas. On the industry or firm's level, researchers concern about the location selection for logistics service providers, and the cluster phenomenon. Other aspects also include the implication of logistics activities on land use and regional development such as Cidell (2011). The prominent emphasized issues are the agglomeration effect and spatial concentration feature induced from economies of scale, which can provide complementary insights for the classical location theories. Articles in this group normally applied theoretical analysis including case studies, interviews, conceptual modeling.

### **International business**

In the field of international business, foreign direct investment (FDI) is studied as an indicator to illustrate the interaction between MNEs and countries (Dunning and Lundan 2008). MNEs' facilities (subsidiaries) configuration processes accompany with the FDI location selections. FDI location is used to present not only the firms' locational preference for countries/regions but also the locational attractiveness of these countries/regions. The most widely accepted theory is Dunning's Ownership, Location, Internationalization (OLI) eclectic paradigm. The location-specific advantage is a concept embedded in this theory that demonstrates country/region characteristics which are decisive for firms' location decisions. These factors are derived from the heterogeneity and uneven development of countries, including infrastructure, regulation & policy, the presence of competitors and suppliers, differences in culture and religion, political stability, etc. (Dunning 1998; Dunning and Lundan 2008; Mudambi et al. 2018; Narula and Santangelo 2012). Research perspectives in this group are normally from enterprises, industries, and governments. The macroeconomic level research papers focused on the resulting effects of location selection of FDI on countries/regions, and how local governments can improve their location-specific advantages to attract foreign trade and investment. The micro-economic level research concentrated on helping enterprises to make wiser investment choices.

#### **2.2.2 The concept of location advantages**

The concept of location advantages derives from Dunning's OLI paradigm. It addresses the question in which countries MNEs prefer to invest and configure their subsidiaries. This section first introduces the OLI paradigm to explain the connection between

MNEs and countries, then investigates what are the locational advantages and their effects on MNEs' location selection.

### **MNEs and countries interaction: Dunning's OLI paradigm**

Why, where and how MNEs expand their business cross national boundaries, as well as the resulting effects on countries are always the main research concerns in academia. Among all the theories trying to explain MNE foreign production, Dunning's OLI eclectic paradigm is deemed as the leading framework. After been revised by several researchers and Dunning himself (Dunning and Lundan 2008, 116), it evolved to be the most widely accepted explanation conceptual framework. It demonstrates the interactions between the macro-level determinants (country-level locational advantages) and micro-level determinants (firm-level ownership advantages), as well as summarizes the benefits of ways of transferring location advantages to ownership advantages as internalization advantages.

Ownership advantages answer why some firms can expand to foreign countries, some can not. It refers to firms' assets that can generate enough value to overcome the extra costs of not operating in their home economies. Compared to location advantages, ownership advantages are mobile. For example, intangible assets, such as product innovations, accumulated experience in target markets, a brand's reputation. Location advantages concentrate on why MNEs prefer some specific countries instead of others. These advantages are immobile and restricted to home or host countries, such as energy resource, investment incentives and disincentives, cultural differences. Internalization advantages explain how MNEs involve and operate in foreign countries. A company can acquire internalization advantages through keeping its foreign production within one enterprise, instead of export, licensing, or joint venture. Such advantages can be reduce transaction or information costs, gain from economies of common governance, or avoid risks of broken contracts. If a company plans to take all the three advantages, it need to construct at least one value-added subsidiary (i.e. factory) in foreign countries through investment. Because of this, the OLI paradigm is also widely applied by researchers to study FDI.

In addition, by extending the earlier taxonomy of Behrman (1972), Dunning and Lundan (2008) summarized four types of objectives to explain MNEs' overseas expansion behaviors: nature resource seeking, market seeking, efficiency seeking, strategic asset seeking. These four objectives that consistent with corporates' strategies, corresponds to various requirements for the three kinds of advantages. For a specific MNE, it may pursue only one of these objectives or a combination of these objectives to select a country to set up subsidiaries.

As an explanation framework, the OLI paradigm build a solid theoretical background linking the micro-economic theory of firm and the macro-economic theory of interna-

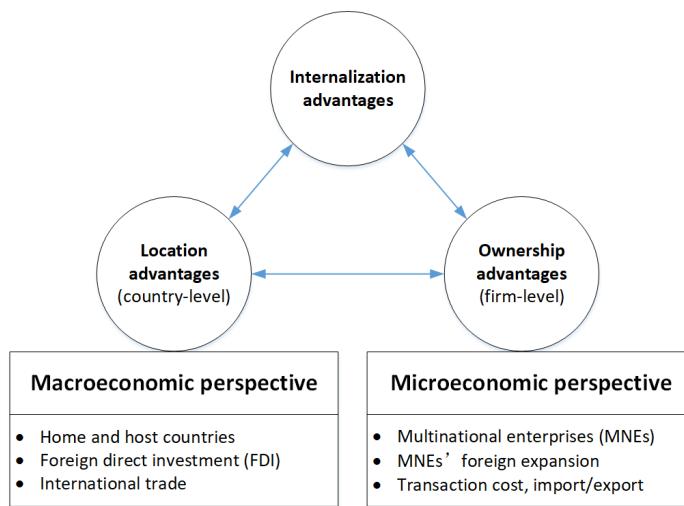


Figure 2.5: Interaction between MNEs and countries

Source : based on OLI paradigm from Dunning and Lundan (2008)

tional trade, as shown in Figure 2.5. From the perspective of MNEs' location selection, it presents the relationship between MNEs and countries through the concept of location advantages. Implications are as follows. (1) The varying location-specific advantages of countries are external factors for firms, but are indeed decisive for their decision-making. (2) The heterogeneity and uneven development of countries have become sources of MNEs' profitability. Governments should improve their location specific advantages to attract foreign trade and investment.

### Location advantages

Dunning's OLI paradigm introduced the concept of location advantages, and in this paradigm location advantages specifically refers to country level locational attractiveness. As mentioned by Mudambi et al. (2018), location advantages are sometimes synonymous with country-specific assets due to its root. Thus, the competitiveness of the countries in which MNEs located to some extent can be transferred to the competitiveness of the firms. This implies some countries are more suitable for certain kinds of MNEs to conduct certain activities, and the comparison between countries can help MNEs to make decisions.

Narula and Santangelo (2012) extended the concept, and defined location advantages as 'a set of characteristics associated with a location'. Such advantages that embedded in locations are equally available to all the firms, even some are more publicly acquirable (Mudambi et al. 2018). In fact, it is more accurate to use location charac-

teristics instead of location advantages. Not all the location-bound characteristics are beneficial for firms, some of them are limitations, such as trade barrier policies. MNEs need to acquire relevant knowledge to make better decisions. Even some location characteristics are beneficial, they may be not equally available to varying sectors. This is because a company's location section is a complex, and many factors such as the firm's corporate strategy, in which sector, are all influential. That's why some researchers classified location advantages into categories from various aspects.

The classic Dunning's theory classifies location advantages according to the four types of objectives as mentioned in the last section: natural resource seeking, market seeking, efficiency seeking, and strategic asset seeking. Narula and Santangelo (2012) organized location advantages into three broad categories depending on the perspectives: macro-region/country-level, industry-level, and firm-level (see Figure 2.6). Furthermore, they identified and categorized the macro-region/country-level location advantages into three types: (1) exogenous L advantages, which derive from natural assets, such as culture, political stability, climate, proximity to other markets; (2) fundamental L advantages, including basic infrastructure, legal infrastructure, regulation infrastructure, and financial infrastructure; (3) knowledge asset L advantages, i.e. knowledge infrastructure, such as tertiary education, universities. The industry-level L advantages consist of: (1) structural L advantages, souring from market and demand structure; (2) collocation L advantages, covering the advantages from the aggregation effect, industrial policy, as well as ownership advantages which are location-bound. The last category firm-associated L advantages overlap with the industry-level category, comprising merely collocation L advantages. The authors generated this classification because they focuses on the collocation behaviors of the MNEs' R&D activities. They emphasized the role of other players in the location selection. The cluster phenomenon and its resulting locational attraction and competition indeed influence the network configuration decisions of MNEs. In their recent research, Mudambi, Narula and Santangelo (2018) explained traditional location advantages considers exogenous factors, endogenous factors, as well as sociological or anthropological factors. The collocation L advantages, they defined as 'a function of membership to a system or network of actors', actually are cluster advantages that closely related to the agglomeration effect.

From a geographical perspective, location advantages are not merely restricted to countries. Though country is a commonly used analysis unit in terms of location advantages, it is worthy noting that supra-national, national sub-regional characteristics are also influential (Narula and Santangelo 2012). Supra-national organizations, such as the European Union (EU), Association of Southeast Asian Nations (ASEAN), BRICS, offer particular policies and trade convenience to the member countries. On the other hand, large countries such as China, in which regions are unevenly resource allocated and developed. For example, eastern part coastal provinces such as Zhenjiang accounts for 6.26% of China's GDP in 2017; while western landlocked provinces such as Qinghai accounts for only 0.32%. The different levels of economic development lead to different location advantages. According to the varying natural resource

The diagram illustrates three levels of location advantages (L advantages) on the left, each connected by a bracket to a specific column in the table on the right:

- Macro-region/country-level L advantages** connects to the **Exogenous L advantages** column.
- Industry-level L advantages** connects to the **Fundamental L advantages** column.
- Firm-associated L advantages** connects to the **Collocation L advantages** column.

	TYPE OF L ADVANTAGES	SOURCES OF L ADVANTAGES	EXAMPLE OF L ADVANTAGES
	<b>Exogenous L advantages</b>	These derive from natural assets (independent of development stage)	Sociological/anthropological <ul style="list-style-type: none"> <li>- Culture, norms, religion, political stability.</li> <li>- Land availability, rainfall, climate, extractive resources, basic population</li> <li>- Proximity and accessibility to other markets</li> </ul>
<b>Fundamental L advantages</b>		Basic infrastructure	<ul style="list-style-type: none"> <li>- Primary schools</li> <li>- Health care</li> <li>- Transport (roads, railways)</li> <li>- Utilities (electricity, water)</li> <li>- Telecoms</li> <li>- Ports</li> <li>- Efficient bureaucracy</li> <li>- Public transport</li> </ul>
		Legal infrastructure	<ul style="list-style-type: none"> <li>- Legal system</li> <li>- Security and police</li> <li>- Tariff system</li> <li>- Property rights</li> <li>- Tax and excise</li> </ul>
		Regulation and policy	<ul style="list-style-type: none"> <li>- Incentives</li> <li>- Subsidies</li> <li>- Tax holidays</li> <li>- Regulatory agencies</li> <li>- Industrial policy</li> <li>- Competition policy</li> <li>- Capacity to enforce regulation</li> </ul>
		Financial infrastructure	<ul style="list-style-type: none"> <li>- Banking, insurance, stock exchange</li> </ul>
	<b>Knowledge asset L advantages</b>	Knowledge infrastructure	<ul style="list-style-type: none"> <li>- Tertiary education, universities</li> <li>- Public research institutes</li> </ul>
	<b>Structural L advantages</b>	Market and demand structure	<ul style="list-style-type: none"> <li>- Income distribution</li> <li>- Size of potential market</li> <li>- Wage rates</li> <li>- Skilled employee mobility/scarcity</li> </ul>
	<b>Collocation L advantages</b>	L advantages that derive from the presence of other actors in the same location	<ul style="list-style-type: none"> <li>- Agglomeration economies</li> <li>- Networks of suppliers</li> <li>- Networks of customers</li> <li>- Level of intra-industry competition</li> <li>- Concentration ratio</li> <li>- Market size and potential</li> <li>- Presence of support industries (inter-industry)</li> </ul>
		Industrial policy	<ul style="list-style-type: none"> <li>- Specific policies associated with given industry</li> <li>- Presence of significant customer</li> <li>- Presence of significant supplier</li> </ul>
		L advantages that derive from location-bound O advantages of other actors	

Figure 2.6: Location advantages in three dimensions

Source: Narula and Santangelo (2012)

and geographical conditions, provinces applies diverse incentives and policies to attract trade and investment. The smallest geographical unit of analysis are Special Economic Zones (SEZs), such as Free Trade Zones, Industry Parks, Logistics Parks, are constructed by the local governments to improve their locational attractiveness.

Overall, in terms of a specific location, MNEs should consider the different dimensions of location advantages. It is important to note that the location advantages have different tendencies to be affected. Exogenous L advantages are stable characteristics, such as natural resource allocation or geographical proximity, nearly impossible to be changed by human will. In contrast, endogenous L advantages are capable of improvement, and actually are the government priorities for competitiveness promotion. Cluster L advantages can be understood as the resulting effects of high level of exogenous and endogenous L advantages on industry/firms.

## 2.3 BRI Literature review

The initiative was proposed in 2013, however, until the year 2015 researchers started to show their curiosities and interests in analyzing the implications of BRI in various aspects: politics, international relations, world economy, regional development, logistics and transport etc. The reason of this phenomenon maybe is because even the concept of the BRI was unveiled in 2013, the first official document 'Vision and Action' that explains the strategy was published in 2015. Since then, articles studying the initiative are continuously being published. In terms of the research areas, though the BRI is a relatively new concept, it relates to various aspects and has strong economic, geographic, and political characteristics. This implies research on the BRI may involve in multiple disciplines. As shown in Figure 2.7, in this section the first step is conduct an overall literature keywords analysis, to acquire the first impression on the BRI research overview. By searching the keywords in the database 'Scopus', until Nov.09, 2018 there are 675 documents published related to the BRI. A literature selection procedure is also applied to select the BRI research in the field of logistics. There are 91 results filtered at last, and used to further investigate the state of the art by conducting a bibliometric analysis.

### 2.3.1 Overview of BRI research

There are 675 documents in English and Chinese language studying the BRI, published respectively in 2015 (13), 2016 (69), 2017 (241), and 2018 (352), as present in Figure 2.8. The sharply increasing numbers imply the BRI research has attracted tremendous attention in academia. The top five countries/territory are: China (379), United Kingdom (50), United States (48), Australia (41), Hong Kong (31). As the

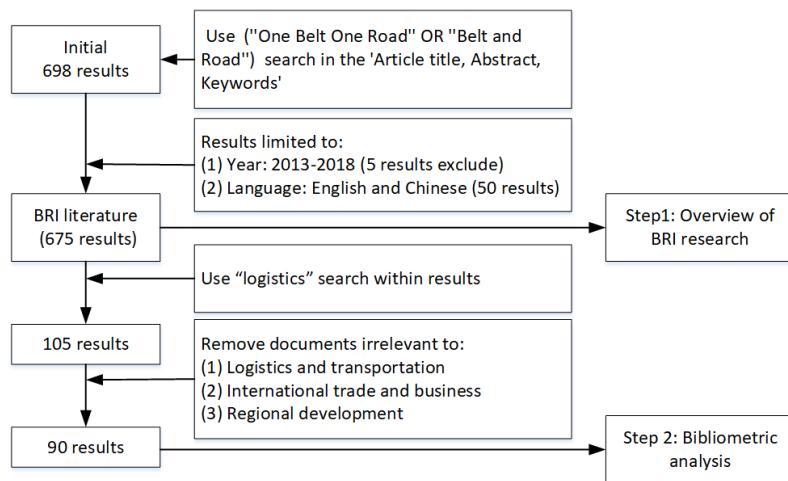


Figure 2.7: Literature selection process

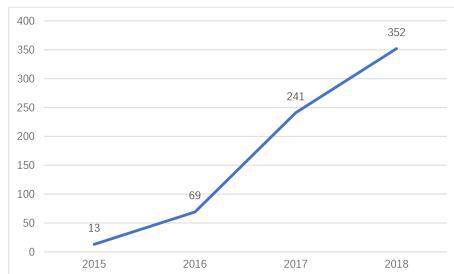


Figure 2.8: Distribution by year

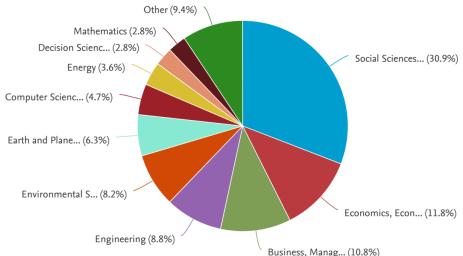


Figure 2.9: Distribution by research area

proposed country, China contributes to around 56% documents. Though United Kingdom, United States, and Australia are not involved in the BRI cooperation framework, they showed interests in research. This is maybe because majority of the researchers population belong to these countries. The distribution of research areas is illustrated as Figure 2.9. Research areas covering Social Science; Economics, Econometrics and Finance; Business, Management and Accounting contribute more than half of the BRI research. This is reasonable since the BRI is proposed to promote regional economic cooperation and involve various stakeholders.

To generate initial ideas of the most attractive research topics of the BRI literature, the software 'VOSviewer version 1.6.5' was applied due to the large amounts of documents. The most commonly used keywords (including author's keywords and index keywords) were clustered and visualized as shown in Figure 2.10.

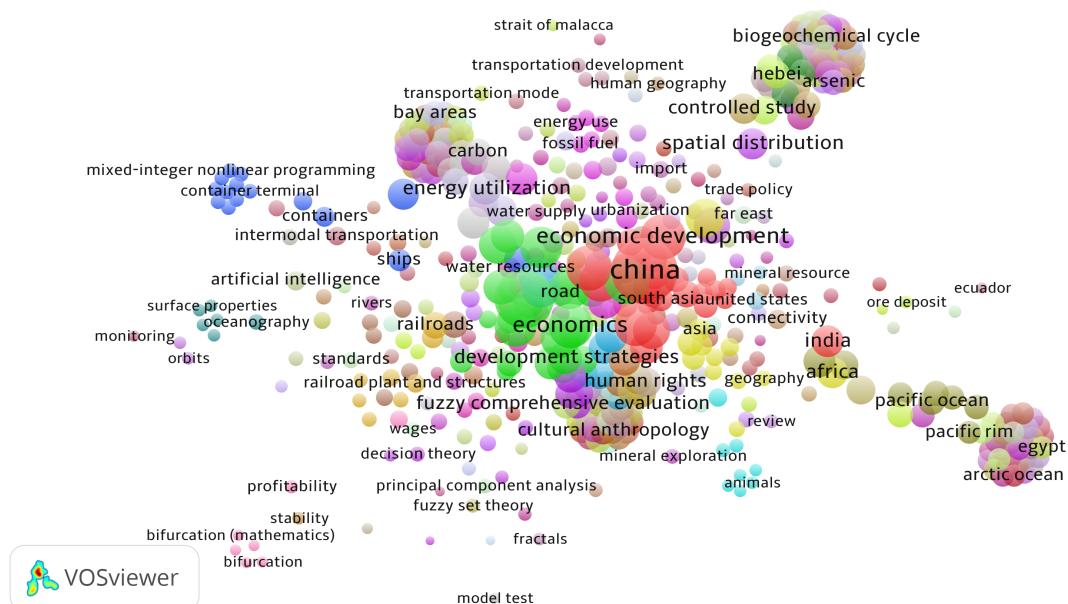


Figure 2.10: Keywords cluster visualization of the BRI literature

It is notable that the most commonly used keywords can be divided into several categories.

- Geographic perspective: China, India, Africa, Asia, South Asia, Pacific rim, Arctic Ocean, Strait of Malacca, bay areas, etc.

- Economic perspective, including economics, economic development, development strategies, etc.
- Transportation perspective: transportation development, transportation mode, container terminal, intermodal transportation, ships, railroad plan and structures, etc.
- Energy perspective: include energy utilization, fossil fuel, carbon, energy use, etc.
- Methodology perspective: mixed-integer nonlinear programming, artificial intelligence, fuzzy comprehensive evaluation, decision theory, fuzzy set theory, bifurcation, etc.
- Policy and socio-cultural perspective: cultural anthropology, trade policy, human rights, etc.
- Other perspectives include keywords such as biogeochemical cycle, carbon, water resource, mineral exploration, human geography, etc.

Indeed, the BRI documents cover various disciplines, representing it has become a research hotspot and its broad influence. Meanwhile, the BRI research work related to logistics and transportation accounts for a small portion. Since the BRI is a infrastructure-led policy-supportive development strategy involving various countries, economic cooperation between countries, and the international relations between China and countries are also critical research issues. Paying more attention on the logistics research trend, the following work is to identify the core BRI literature in the field of logistics, especially the study focusing on global logistics network.

### **2.3.2 BRI literature focusing on logistics**

The selected documents are first analyzed according to the year of publish, the country/territory, the document type, and the source. Then these documents are classified and analyzed according to the research topics.

#### **Descriptive analysis**

There are 90 documents are screened as the BRI literature related to logistics, respectively published in the year 2016 (5), 2017 (21), 2018 (65). The publish of these papers follows the same tendency as the BRI literature, shows a surge of increment in recent years. The distribution of the country/territory in which published above

3 documents is present as Figure 2.11. Still, China contributes to most documents, accounting for 66% of all. According to the document type, literature is counted as present in Figure 2.12.

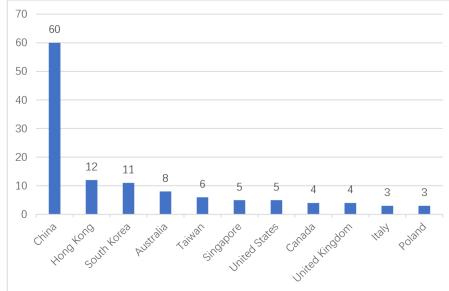


Figure 2.11: Country/territory distribution

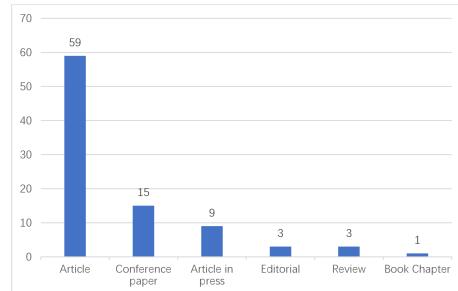


Figure 2.12: Document type distribution

It is worthy noting that there are three special issues focusing on the BRI, respectively are: (1) Volume 117 of Transportation Research Part E: Logistics and Transportation Review, include 1 editorial, 7 articles, and 11 articles in press (not able to access yet). (2) Volume 45(1) of Maritime Policy and Management: Special issue on 'Challenges and chances of the Belt and Road Initiative at the maritime policy and management level', including 1 editorial, 2 articles. (3) Volume 45(3) of Maritime Policy and Management: Special issue on 'Maritime Challenges and Opportunities Embracing Belt and Road', including 1 editorial, 1 review, 7 articles. Articles studying the BRI are continuously being published, the intensive BRI special issues are the evidences. The top 7 journals/conference distribution are present as Table 2.3.

### Literature classification and analysis

Though there are two identified literature review articles. One review article by Liu et al. (2018) focused on the the BRI topics which are related to geography, and explored the literature from China Knowledge Resource Integrated Database. The research by Lee et al. (2018) contributes the overview of Chinese BRI papers with a focus on maritime transport, and identified key research trends. Both Liu et al. (2018) and Lee et al. (2018) contribute to the lack of English literature on the BRI research.

The selected documents cover various aspects and research problems, which necessitates the classification of the research scope and perspective. Focusing on all the potential influencing factors to the global logistics networks re-/design, there are three aspects need to consider, which are also the principal of literature selection: (1) logistics & transportation, (2) international trade and business, (3) regional development.

Table 2.3: Documents distribution by source

Source of documents	Documents
Maritime Policy and Management, volume 45(1)(3)	2 editorial, 1 review, 9 articles
Transportation Research Part E: Logistics and Transportation Review, volume 117	1 editorial, 7 articles
Sustainability (Switzerland)	4 articles
ACM International Conference Proceeding Series	3 conference papers
International Journal of Logistics Research and Applications	3 articles in press
International Journal of Shipping and Transport Logistics	3 articles
Transport Reviews	3 articles

Some articles are categorized into two categories, since they are closely interdependent.

Table 2.4 shows the classification of 52 logistics & transportation research articles according to the varying research concerns. Most of them considered the new alternative transport routes and port research issues. Their applied methods include both qualitative and quantitative, covering questionnaire survey, scenario analysis, factor analysis, complex network theory, mixed integer programming model, Markov chains, multi-criteria decision analysis, Analytic Hierarchy Process (AHP), gravity prediction, etc. The quantitative research articles mainly concentrates on the potential shifts on freight volume or transshipment volume triggered by the BRI, and restricted to specific geographical scopes. Their research objectives are improve the performance and competitiveness of the nodes, improve cooperation and collaboration between nodes, reduce the total cost, reduce the environmental impacts, etc. Some research paid attention to legal regimes, government policies, and cooperation between stakeholders.

Table 2.5 shows the 25 BRI research articles related to international trade and business. International transportation and logistics are the drivers of international trade, at the same time are affected by the trade regulations and policies. As the BRI promote economic growth, aspects such as trade liberalization, international relations, political factors should also include. Both qualitative and quantitative methods were applied, covering computable general equilibrium (CGE) model, game theory, complex network, big data, etc.

Table 2.6 shows the 14 research articles related to the BRI and regional development. Both infrastructure construction and regional cooperation have significant effects on regional development. Some researchers analyzed the the impacts of the BRI on re-

Table 2.4: BRI literature addressing logistics &amp; transportation issues

<b>Topics</b>	<b>Description</b>
Network and corridors (9)	Gateways and DCs selection (Lau et al. 2018; Li et al. 2018) Transit corridors (Lim et al. 2017; Yang et al. 2018) Network improvement design (Fang et al. 2018; Yang et al. 2018) Transportation mode selection (Chen et al. 2017; Liu et al. 2018) Global logistics city (Gibson and Li 2018)
Railway transportation (5)	Railway construction priority (Shao et al. 2018) Legal regimes (Zhu and Vadim 2018) CR Express hinterland patterns (Jiang et al. 2018) CR Express government subsidies (Du and Shi 2017) CR Express container yard layout (Du et al. 2018)
Shipping and transportation (7)	Transshipment flows shift (Kim et al. 2018) Freight volume prediction (Zeng et al. 2018; Zheng et al. 2018) The Carat Canal (Zeng et al. 2018) Liner vessel sharing (Qiu et al. 2018) Container tracking system (Choi et al. 2018) Maritime research trends (Lee et al. 2018)
Port (11)	Port competitiveness (Gao et al. 2018; Ren et al. 2018) Ports cooperation (Huo et al. 2018; Saha 2018) Ports capacity sharing (Ruan et al. 2018) China's port governance (Notteboom and Yang 2017) Dry port (Wei and Sheng 2018) Port cluster (Chen and Yang 2018) Cabotage relaxation (Wong et al. 2019) Inland port and airport collaboration (Jia 2017) Yard storage planning (Li 2018)
Multimodal transport (6)	Empty container repositioning (Kuzmicz and Pesch 2019; Zhang et al. 2018) China's container transport (Hou 2018) Intermodal routing problem (Wang and Yeo 2018) 3D printer application (Chen 2017) Service system (Zhang 2016)
Environmental issues (5)	China's sea freight (To and Lee 2018) Container terminal emission control (Hou 2017b) Berth allocation (Hou 2017a) Eco-efficiency of closed-loop supply (Zhao et al. 2018) Sustainable cold chain design (Fang et al. 2018);
Others (8)	Risk management (Pradeep et al. 2018) China's energy strategy (To and Lee 2018) Transport system resilience (Chen et al. 2018; Wan et al. 2018) E-commerce logistics (He and Ying 2018; Huang et al. 2017; Ji and Sun 2017; Zhang et al. 2018)

gions, countries, and cities from the geo-economic and geopolitical perspectives. The majority of the articles applied qualitative analysis.

Table 2.5: BRI literature related to international trade and business

<b>Topics</b>	<b>Description</b>
Trade (2) liberalization	China's importing tariff (Zhang et al. 2018) Trade barriers (Cui et al. 2018)
Finance and monetary (4)	Investment to increase network resilience (Chen et al. 2018) Exchange rate (Li et al. 2018) Internationalization of Chinese currency (Fung et al. 2018) Toll structure of tanker traffic (Heng and Yip 2018)
International trade (6)	Korean international trade (Lee et al. 2018) China's export (Wang et al. 2019) Intra-industry trade (Luo et al. 2017) Trade comparative advantage of manufacturing industry in Guangzhou (Luo et al. 2018) Impacts on Italian bilateral trade (Fardella and Prodi 2017) Effects of free trade zones (Zhang et al. 2017)
International relations (4)	Perception of countries (Junchi 2017) Latvia's perspective (Spruds 2017) Economic and international relations (Rimmer 2018; Rolland 2017)
Political economy (5)	International political economy (Cau 2018)? ASEAN economic integration and connectivity (Chia 2016) Political and economic leverage (Cau 2018) Russia and China cooperation behaviour (Malle 2017) Comparative analysis of the Eastern European countries (NAZARKO et al. 2017)
Others (4)	Cross-border E-commerce (Huang et al. 2017; Li and Wu 2018; Zhang et al. 2018) Multinational enterprises sustainability innovations (Solmecke 2016)

## Summary

The literature review outcome shows the BRI has become a research focus. Articles studying the initiative has sharply increased recently, and this tendency is likely to continue in the future.

In terms of the logistics network re-/design articles, three directions are involved: location selection, route selection combined with transportation mode selection, as well as network optimization. Two papers addressed distribution centers (DCs) location

Table 2.6: BRI literature related to regional development

<b>Topics</b>	<b>Description</b>
Economic growth (4)	Economic growth in developing countries (Li et al. 2018) External economy benefits of traffic (Peng and Zhang 2017) Metropolitan logistic and economy (Yang et al. 2019) Regional economic growth and port logistics (Ding et al. 2019)
Geopolitics (5)	China and Pakistan (Akhter 2018) Geopolitics of MSR (Blanchard and Flint 2017) Geopolitical and geo-economic implication (Cau 2018) BRI research progress (Liu et al. 2018) Implication for Europe (Casarini 2016)
Others (5)	China's comparative regional productivity (Gibson and Li 2018) Urban expansion (Xu et al. 2018) Geopolitical and economic implications for Middle East (Kamel 2018) Łódź's benefits from the BRI (Bartosiewicz and Szterlik 2019) Regional economic cooperation and industry synergy (Zhu and Shao 2020)

selection problems: Li et al. (2018) applied complex network and improved entropy TOPSIS as methods to select DCs for China's imported grain. Lau et al. (2018) selected the gateways and DCs for China's wine import through minimizing the logistics costs, and concluded that maritime shipping remains to be the most economical mode for trans-continental transportation of wine. Both of them focused on China's import logistics but different commodities. While Li et al. (2018) also considered the effects of government policies on the available routes, which is a good example to combine qualitative and quantitative methods. Another interesting research by (Gibson and Li 2018) developed an evaluation system to identify global logistics cities according to the logistics infrastructure capacity and service responsiveness. This is a good example to identify the key logistics node in the global logistics network, though in the article only Asian cities were covered.

Articles addressing route selection problems are mostly related to the transportation mode selection, since a specific transport corridor is restricted to one mode. All the articles focused on either selecting a railway transportation link, or a maritime shipping channel. Many researchers choose the best transportation mode and route through cost minimizing model. Liu et al. (2018) and Chen et al. (2017) both worked on the transportation mode selection issues, the former applied pricing decisions to address channel coordination issues particularly for fresh products, the latter applied game-theoretic model to compare the costs of shipping and railway for container freight. Two researchers paid attention to network optimization issues. Yang et al. (2018) applied a bi-level programming model to maximize the total profit of the liner shipping company and minimize the cost of the shippers, to optimize the shipping network to compete

with the new railway links. Fang et al. (2018) designed the cold chain network for China's imported fresh agri-products considering the carbon emissions. Both of these two articles applied quantitative methods, which means the influencing factors which are unquantifiable such as non-tariff barriers are not considered.

Though global logistics issues are closed related to economy, political factors, geography, and regional development, few researchers covered all these aspects. To generate a overall research trends, Figure 2.13 presents the potential research perspectives and issues.

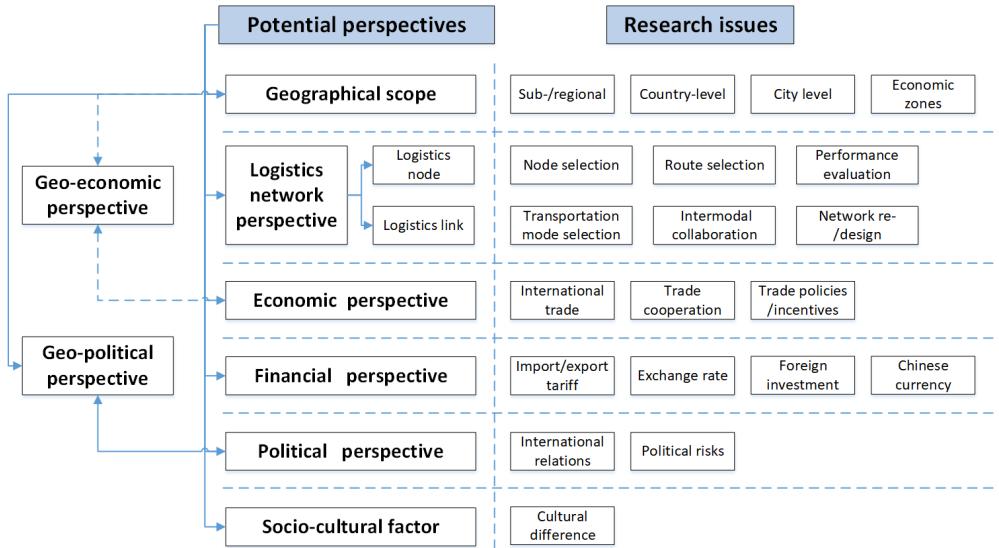


Figure 2.13: Framework of potential research topics

MNEs as the important roles of the world economy, are insufficiently considered. The only one related paper by Solmecke (2016) focused on the sustainability of innovations. How MNEs can take advantages of this initiative is a practical and urgent demand, require further investigation. Additional, the BRI is an 'on progress' initiative, as its implementation continues, the influences will expand further. Meanwhile, many risks exist and affected by diverse factors. Researchers addressing international relations considered the attitude of involved countries, which affects the risks of the implementation. Nevertheless, the risks of enterprises' investment and operation require more attention and research.

Future research should pay more attention to the local government policies, and cross-border trade and transportation barriers. These influencing factors are mostly unquantifiable, however, significantly affecting the implementation of the BRI, as well as the operation of new established transport corridors and ports. Intermodal cooperation is also an emerging research trend, even the identified articles did not consider the

intermodal transportation into the network optimization, it is a interesting topic to take multi-modal transport into account. MNEs play important roles in implementing the BRI, Chinese government offer subsidies to promote domestic enterprises to invest in target countries, and interact with local regional development. Western MNEs should take advantages of the supportive policies to take advantages. Thereby, MNEs' adaptation in the BRI context also requires attention in the academia.

## 2.4 The role of transportation infrastructure

Interest in the role of transportation infrastructure arises from many aspects. Most of them analyze the relationships between transportation infrastructure and economic growth, international trade, foreign direct investment (FDI) and so on. Such studies are normally conducted on a macro-economic level, in which a national perspective is usually applied to testify the significance of transportation infrastructure on promoting trade performance and regional growth. Recent studies start to emphasize its wider economic impacts, considering the spatial agglomeration phenomenon and the spillover effects. These researches include the factor of spatial characteristics, which is not a conventional consideration in economic studies. Some researchers adapt a micro-economic point-of-view, validating the effects of transportation infrastructure on transportation costs. Most of the time, it is assumed as natural mechanism that transportation infrastructure improvement will lead to reductions in transportation costs. From this point of view, economists either use empirical evidences to prove this hypothesis, or based on the assumption to deduce other conclusions. Except for economic perspectives, some researchers analyze the role of transportation infrastructure from the perspective of logistics, planning and geography. Relevant topics include logistics performance, connectivity/accessibility, agglomeration effects, positive and negative externalities, etc.. With focus on identifying the links between transportation infrastructure and the GLN, the review process only select some relevant topics that illustrate the effects of transportation infrastructure on altering the geography of logistics activities, trade, and firms' locations, etc.. Section 2.4.1 reviews literature analyzing the role of transportation infrastructure from the perspective of logistics. Section 2.4.2 reviews studies conducted from the economic perspective. Section 2.4.3 pays attention to articles from geographers' perspective. The main aim is to gain understanding of the function of transportation infrastructure in economic activities, and lay a solid foundation to further seek potential connections that normally ignored between transportation infrastructure and GLN in the following chapter.

### **2.4.1 Logistics perspective**

The status of transportation infrastructure is directly related to the logistics capabilities/performance. This research stream is relatively small, normally concentrated in the articles that establishing a national logistics performance evaluation system. Some articles discuss the importance of transportation in supply chains and mentioned the necessity of good infrastructure. More commonly the role of transportation infrastructure in determining logistics performance is present as an indicator in reports of international organizations. Table 2.7 lists some relevant work.

Table 2.7: The role of transportation infrastructure-logistics perspectives studies

Main topics	Reference
Logistics performance	Arvis et al. (2018); Lee et al. (2017)
Analysis of logistics infrastructure	Kampan (2017)
Logistics capabilities	Memedovic et al. (2008)

The role of transportation infrastructure in determining a country's logistics performance is a common sense in both academia and practice. International organizations regard transportation infrastructure provision as a critical indicator in assessment of national performance such as logistics performance, country competitiveness, trade facilitation, etc. World Bank Group constructed the Logistics Performance Index (LPI) evaluation system consisting international LPI and domestic LPI to survey international freight forwarders' and carriers' opinions of how ease to operate logistics activities in various countries. The international LPI system consists of six groups of indicators: (1) the efficiency of customs and border clearance; (2) the quality of trade and transport infrastructure; (3) the ease of arranging competitively priced shipments; (4) the competence and quality of logistics services; (5) the ability to track and trace consignments; (6) the frequency with shipments reach consignees within scheduled or excepted delivery times. The quality of infrastructure in the domestic LPI system is measured by the respondents ratings regarding each type of infrastructure: ports, airports, roads, rail, warehousing and transloading, and ICT (information and communication technology). According to their latest report 'Connecting to Compete 2018: Trade Logistics in the Global Economy' (Arvis et al. 2018), infrastructure provision is still a major concern in all economies except the top performers. Dissatisfaction with road and rail infrastructure exists especially in Latin American, the Caribbean and South Asia; while satisfaction with rail infrastructure is low in all regions. In addition, there is a ratings gap between services and infrastructure across World Bank regions. The relatively high ratings in service provision and the relatively low ratings in infrastructure illustrate that infrastructure provision should catch up with the development of the logistics industry. A country's infrastructure provision to a large extent restricts the improvement of the country's logistics performance. Some organi-

zations also consider transportation infrastructure as one critical dimension for trade facilitation measurement and country's competitiveness. Such evaluation systems are Global Enabling Trade Index (ETI) developed by World Economic Forum and the Global Alliance for Trade Facilitation, Global Competitiveness Index released by the World Economic Forum. For instance, in the ETI system, the availability and quality of transportation infrastructure including air, railroad, port, road are part of the subindex that considered to have large effects on the ease of trade.

It is the same opinion in the academia. (Lee et al. 2017) argued that few researchers focused on logistics performance measurement from a national perspective. The authors identified critical factors affecting logistics performance and compared three Asian countries: China, Japan, and Korea. Four key determinants for logistics performance are identified: industrial policy priorities, strategic infrastructure development, public-private logistics market growth, and communication network configurations. Strategic infrastructure development is defined as "long-term plans to improve capable inter-modal transportation network", confirmed as a critical factor determining a country's logistics performance in a long-term view. Önsel Ekici et al. (2016) argued that global competitiveness (in terms of trade) is closely related to a country's logistics efficiency. Applying LPI as the measure for logistics performance, the authors validate the interrelationship using an artificial neural network (ANN) and cumulative belief degrees (CBD) approach. The results validate that the extent and quality of the transport and communications infrastructure, as well as the associated services are critical elements to improve a country's logistics competitiveness level. They confirmed the same outcome with World Bank's LPI survey. Higher level infrastructure corresponds to higher level of information and communication infrastructure. Besides, the low level of rail infrastructure is the general reason of dissatisfaction. Kampan (2017) paid attention to analyze the strategic opportunities, weaknesses, and threats to trade in the ASEAN region, with a particular focus on logistics infrastructure. The author reviewed the quality of land, air, and sea transportation network in the region, and offered policy implications for improvement. The results shows the quality of logistics infrastructure (including roads, rail, ports, air) in six ASEAN member is poor and the further movements should concern the solution regarding lack of power in the Secretariat, inefficient customs procedures, and adversarial foreign investment laws. Memedovic et al. (2008) discussed how to promote a country's participation and competitiveness in the global value chain through increasing its logistics capabilities. In this study, hard infrastructure, transport corridors, stable and predictable business environment, quality of logistics services, and trade facilitation are summarized as the drivers of logistics performance. They mentioned that transportation infrastructure investments has become a challenge for both developed and developing countries, and capital investments have to catch up the growing speed of traffic volume. In their study, TIMM is 'defined as accessibility of ports and airports by road and rails, adapted to multi-modal transportation'. This work emphasized the importance to provide multi-modal transportation infrastructure, and the capabilities to transfer between different transportation modes.

As a summary, infrastructure provision in particular the inter-modal transportation infrastructure and the communication infrastructure are essential factors determining a country's logistics performance. Literature also shows the service level of logistics firms, soft infrastructure such as regulatory, and trade agreements are also critical determinants. The infrastructure promotion plans should cooperate with favorable policies and priorities to make the full use, therefore governments play an important role. A country's logistics performance is closely related to trade performance as well, to facilitate trade diminishing trade barriers or customs procedures is required. Furthermore, on a general scale, rail infrastructure is a crucial limiting factor for countries to get higher level of logistics performance.

## 2.4.2 Economics perspective

When it comes to the effects of transportation infrastructure, the first perception is its fundamental role in the mobility of physical materials as well as people between different locations. Therefore, the conventional idea is the improvements of transportation infrastructure have positive effects on decreasing transportation costs, and further create a sequence of positive economic returns such as higher trade volume or boosting growth rate. Economists conducted different kinds of investigation on these topics as shown in Table 2.8.

Table 2.8: The role of transportation infrastructure-economics perspective studies

Main topics	Reference
Transportation costs, trade performance	Bensassi et al. (2015); Bougheas et al. (1999); Francois and Manchin (2007); Limao (2001); Nordås and Piermartini (2004); Wilmsmeier and Hoffmann (2008)
FDI	Halaszovich and Kinra (2018)
Economic growth	Banerjee et al. (2012); Carlsson et al. (2013); Deng (2013); Jiang et al. (2017); Yu et al. (2012); Zheng and Kuroda (2013)
Broader economic consequences	Cohen (2010); Lakshmanan (2011)

### Transportation costs and trade performance

One of the common research topic is the relationship between transportation infrastructure, transportation costs and trade. Since transportation costs are important part of trade costs, one conclusion is the level of transportation infrastructure to a

large extent determine its transportation costs, and thus influence its trade performance. Examples include studies conducted by Bensassi et al. (2015); Bougheas et al. (1999); Francois and Manchin (2007); Limao (2001); Nordås and Piermartini (2004); Wilmsmeier and Hoffmann (2008).

Bougheas et al. (1999) investigated the role of transportation infrastructure on bilateral trade through its effects on transportation costs. Based on the classic theory of comparative advantage, they introduced the factor of transportation costs (as a fraction) and infrastructure to extend the previously adapted Ricardian model by Dornbusch et al. (1977). The new model offered theoretical foundation explaining that reduction in transportation costs make countries' comparative advantages more acquirable, therefore, increases the degree of specialization in production. To validate the assumed relation and the model, they developed an augmented gravity model and used the data of some European countries. The first result shows transportation costs depend on both the current flow of transportation infrastructure and the existing stock of infrastructure. With respect to this first stage conclusion, they used the stock of infrastructure capital and the length of the motorway network as proxies of the level of transportation infrastructure. Their empirical studies validate the positive effects of transportation infrastructure on bilateral trade volume.

Limao (2001) put efforts on testifying the common assumed relation between transportation infrastructure and transportation costs. Their solid empirical outcomes showed infrastructure is quantitatively determinant for transportation costs, especially for countries with geographical disadvantages. For the predicted transportation costs, poor infrastructure accounts for 40% for coastal countries. Comparatively, this ratio is 60% for landlocked countries. In terms of international trade, their results is 10% point increment in transportation costs will lead to approximately 20% trade volumes reduction. This study also indicates that transportation infrastructure promotion is more critical for landlocked countries to counterbalance geographical disadvantages if they want to participate more in global trading.

Nordås and Piermartini (2004) paid special attention to the relationship between behind the border infrastructure and bilateral trade. Through an augmented gravity model using bilateral trade data in automotive, clothing and textile sectors, they testified that both the quality of infrastructure and bilateral tariffs are determinants of trade performance. In addition, among all the indicators to represent the quality of infrastructure, port efficiency proved to be the most significant one affecting trade performance. By comparing three production sectors, they concluded that for just-in-time production sectors, export competitiveness is highly relied on timeliness and access to telecommunication. While, time and uncertainty are as well as affected by the quality of infrastructure, which are critical input factors for these sectors.

To figure out the reasons why some developing countries (like China and India) are more successful in international trade while some are not, Francois and Manchin (2007) investigated the relative importance of infrastructure and institutional quality for ex-

port performance. Through gravity modeling of North-South bilateral trade volumes, their conclusion indicates that improving transportation and communication infrastructure is substantially more effective to promote exports compared to removing artificial trade barriers for developing countries. And this is especially true for landlocked countries. Their study reveals the strategic importance of infrastructure improvements for increasing the probability to participate in global trading for those countries that currently are not involved.

Wilmsmeier and Hoffmann (2008) investigated the relative importance of liner shipping connectivity as well as port infrastructure in determining intra-Caribbean freight rates. Liner shipping connectivity in their research represents the supply of regular shipping services including six indicators such as number of carriers, number of vessels; while port infrastructure endowment comprises port area, storage area, length of quays, maximum draft in the country's main port. The statistic results indicate distance-the conventional determinant- only contributes one-fifth to the freight rate; while the number of carriers can explain around two fifths of the variance of the freight rate. Authors found several critical variables that significantly affect freight rate in the Caribbean, including transshipment or direct services; the number of competing carriers, shipping connectivity, transit time and port infrastructure endowment in the importing and exporting countries. They also emphasized transit time is more critical in indicating transportation costs compared to distance, especially for trade routes that direct services are not available. A worth noting suggestion is they pointed out that there is a potential circular causality, indicating that higher trade volumes and development level help to decrease transportation costs, and this further stimulates trade and growth.

Bensassi et al. (2015) developed an augmented gravity model to validate the function of logistics infrastructure on trade performance at a regional level, with a special focus on Spanish exports. Authors build a regional Logistics Performance Index considering number of logistics facilities (such as dry port, logistics zones, inter-modal centers, freight terminals, etc.), logistics area available, number of modes of transportation and number of logistics operations performed at existing logistics facilities in the divided 19 regions. Their main findings confirm the importance of geographical features, trade facilitation and logistics infrastructure. Shorter distance, the existence of a common border, the same free trade agreement (FTA) and a higher level of logistics infrastructure and services all indicate more exports.

## **FDI**

Except for the positive effects on trade, many other researchers concerned about the role of infrastructure on attracting FDI. The recent research by Halaszovich and Kinra (2018) conducted an exploration to find the answers why some Asian countries are more successful in participating in global value chains and some are not. this research vali-

date the positive influence of a country's transportation system on both trade and FDI, though there is a natural difference of how transportation costs being an obstacle for trade and FDI. Their conclusion is trade flows is more related to international transportation and port infrastructure, while FDI is more closely related to within-country transportation infrastructure, and good quality of land transportation infrastructure is also more important in this case. Blyde and Molina (2015) conducted a empirical examination proving that adequate logistics infrastructure indeed promote MNEs' location selection decisions.

### **Economic development**

Another conventional topic is the relationship between transportation infrastructure and regional development or more specifically- GDP growth rate. This is a general topic concerned in both economics and regional science. Literature shows there is a widely accepted hypothesis, which is, investments in transportation infrastructure have positive economic effects on specific regions/countries, though no consensus has been achieved (Jiang et al. 2017). More detailed topics concern a specific type of transportation infrastructure such as seaports, air ports, express lines. Most of these research provided empirical evidences to testify the positive externalities stimulated by infrastructure provision, but paid little attention to the mechanisms that how these positive effects take place.

Carlsson et al. (2013) argued that the notion of infrastructure system should be incorporated in macroeconomic growth theories, since investments in infrastructure has been widely considered as a simulator for economic growth. They pointed out the effect of infrastructure on growth is primarily considered through empirical studies in the relationship between transportation, trade and productivity. The traditional growth theories do not deal with the aspect of space, which means issues like location of firms or local endowments of a site are not considered. The only branch is new economic geography (NEG) by forming a network of linked regions, but without considering long-term growth mechanisms. The good thing is the new economic geography with growth (NEGG) extended this model and conquer the challenge. Still, they emphasized macroeconomic theories should incorporate national infrastructure system. Transportation and digital communication infrastructure are important factors in decreasing trade costs, thus leads to economies of scale and knowledge accumulation. Inadequate infrastructure have limiting effect on economic growth.

An interesting work by Deng (2013) analyzed why research results in regard of transportation infrastructure investments' effects on economic growth and productivity are quite different from each other. By surveying recent relevant theoretical and empirical studies, they focused on the diverse calculated output elasticity of transportation infrastructure and summarized ten possible reasons categorizing into three groups. The first group is due to different contexts, including research period, geographical scales

and country's capability in enabling economic development. The second is related to different measurements, comprising economic sectors, types of transportation infrastructure, quality levels of transportation infrastructure. The last group of reasons attribute to be technical- the different ways of measuring, such as measures to describe dependent variable and explanatory variable, functional specification, and estimation method of the economic model. At last, they pointed out due to network features of transportation infrastructure, externalities of transportation infrastructure is not in a liner relationship with economic growth. Besides, spatial features are also ignored.

Among studies focusing on transportation infrastructure and economic growth, China's rapid growth along with its considerable inputs in infrastructure has attracted a lot of interests. Besides its fast growth, China has developed the similar pattern of transportation infrastructure distribution with its economic activities and spatial clusters. Eastern region is far more developed compared to central and western region. Consider this fact, Yu et al. (2012) investigated the causal linkages between transportation infrastructure investments and economic growth in China at national and regional levels. Time series data between 1978-2008 is used under a Granger causality framework and the causality in a panel co-integration is examined. Their empirical evidences show at the national level, economic growth leads to increasing demands for transport services and the associated public investments. While at the regional level, the causality is quite different from region to region. For the China's case, the eastern region's economic growth has bidirectionally causality with transportation infrastructure investments. While in the western and central regions, this causality is unidirectional from economic growth to transportation infrastructure. Their conclusion is in the lower-income central and western regions, transportation infrastructure investments can not stimulate economic growth. The explanation is economic growth relies on many other factors including geographical position, technology, human capital, education level, etc.. Transportation infrastructure investment is not the priority for economic growth when other resources are scarce.

A similar research on China's regional disparities and infrastructure was concerned by Zheng and Kuroda (2013). They also included knowledge infrastructure to consider the effects of public infrastructure on industrial location, regional income inequality and growth. They found that road infrastructure improvement can both stimulates growth and decreases income disparities, resulting further industrial agglomeration. Different from transportation infrastructure, knowledge infrastructure can decreases both disparities and industrial agglomeration.

The study conducted by Banerjee et al. (2012) investigated the relationship between the access to transportation network and China's regional growth rate. By comparing areas closer to the railway lines that connecting to several historical cities, they figured out two research questions: whether access to better transportation can lead these areas more developed or less developed since labor and capital gets easier to lose; and whether better access function as an engine of growth. For the first question, they found areas closer or far away share the same growth rate, which indicates

transportation infrastructure either stimulates growth regardless of distance, or does not have a significant impact. They explained that in the specific context of China, infrastructure investments on a national scale is positive for economic growth, while at the regional level lack of factor mobility (in terms of labor and capital) limited regional development.

### **Broader economic consequences**

In recent years, the broader economic consequences of transportation infrastructure as a main question in Economic Geography attracted some interests. This concept is closely related to spillover effects and include spatial characteristics as consideration. Due to network features of transportation infrastructure, spillover effects such as labor, innovations, capital diffusion have been widely acknowledged. It illustrates transportation infrastructure influences not only the places where it established or invested, but also beyond its geographical boundary. As defined by Cohen (2010), "broader" economic consequences are the impacts beyond the geographic region, state or country in which infrastructure investments are undertaken; or the "indirect" benefits through spatial interactions. From the economics perspective, researchers seek ways to calculate spillover benefits and costs across geographical scopes to investigate the magnitude and significant of the transportation infrastructure investments. Thus, these studies also pay attention to the regions or countries that indirectly influenced by transportation infrastructure in their related locations, such as their adjacent regions or competing regions.

Lakshmanan (2011) had a different understanding about broader economic consequences of transportation infrastructure. The author argues that the various macroeconomic models (Cost-Benefit Analysis, for example) cannot explain the causal mechanisms of transportation infrastructure's effects on the economy. Through reviewing recent theoretical developments, the author identified and summarized the affecting paths from transportation infrastructure to the economy, as shown in Figure 2.14. From a macroeconomic perspective, transportation infrastructure improvements lead to costs reduction, due to distance and congestion reduction. From a macroeconomic perspective, transportation infrastructure improvements can increase accessibility and reduce costs, and further result to broader returns including market expansion, trade performance improvements, technological shifts, spatial agglomeration, innovation and commercialization of new knowledge in urban clusters, etc..

### **2.4.3 Geographers' perspectives**

Geographers' topics concern about the topological implications of transportation infrastructure improvements and the resulting effects on the structure features of the

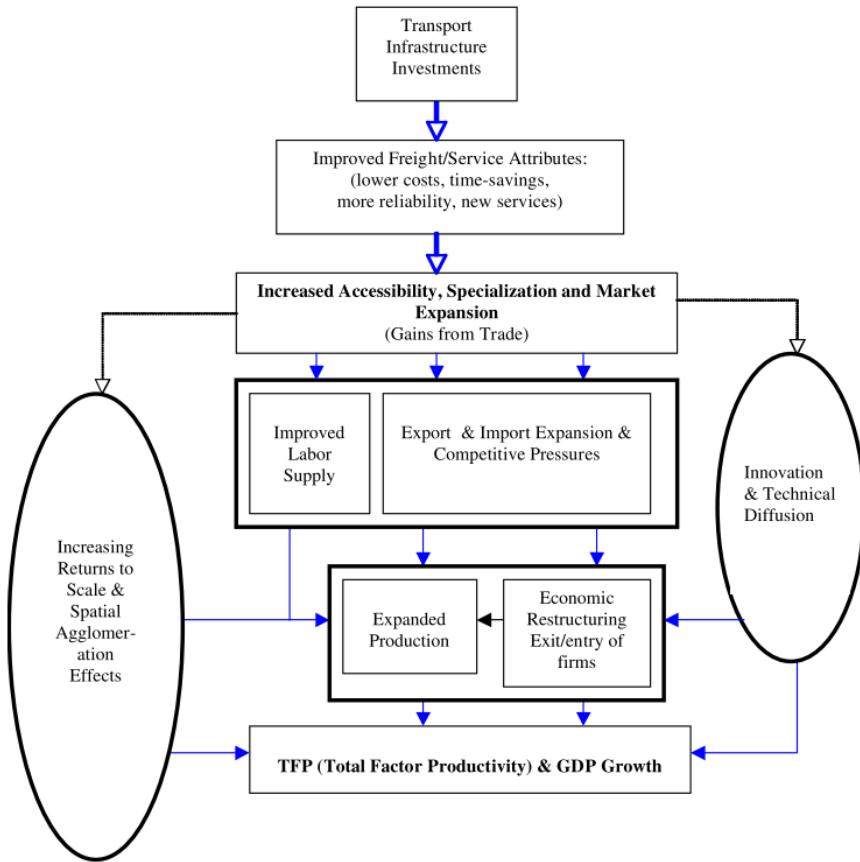


Figure 2.14: Transportation infrastructure and economy-wide benefits  
source: Lakshmanan (2011)

network. Different from other public infrastructure, transportation infrastructure has network features since it can enable the mobility of physical materials and people, therefore it generates economic or technology spillovers. Common research topics include connectivity/accessibility, spillover effects, agglomeration effects, firm location issues, and infrastructure investment demands prediction, as shown in Table 2.9. These studies normally are categorized into the research stream of Economic Geography or Transport Geography. Some of these studies also can be grouped to economics perspective studies, especially in the field of (New) Economic Geography. Selection of this stream of literature mainly takes the account of the geographical features of production and distribution resulting from the effects of transportation infrastructure.

Table 2.9: The role of transportation infrastructure-other perspectives studies

Main topics	Reference
Connectivity/accessibility	Calatayud et al. (2017, 2016); Legrand et al. (2013); Shepherd (2017); Vulevic (2016)
Spillover effects	Li et al. (2017); Yu et al. (2013)
Agglomeration effects	Head et al. (1995); Imi and Rao (2018); McCann and Shefer (2003)

### Connectivity/accessibility

The concept of connectivity is embedded in network analysis approach. Literature shows it is without a unified definition but presents diverse understandings in different domains. According to the summary of Calatayud et al. (2016), connectivity is defined as the availability and capacity of infrastructure and transport services in the domain of transportation; researchers in the field of SCM considers connectivity as the integration of information among different SC actors; in the filed of economics, connectivity refers to the ability to access other markets, or the effectiveness of trade procedures. In general, researchers use connectivity to evaluate how good a location is connected to other locations in terms of transportation services or trade facilitation. Several international organizations developed various connectivity evaluation systems to rank countries/regions. For instance, UNCTAD developed Liner Shipping Connectivity Index (LSCI) & Liner Shipping Bilateral Connectivity Index (LSBCI) to assess countries' global shipping services. The main indicators include number of ships, capacity of ships, number of services, number of companies that deploy container ships from and to a country's ports, etc. Lately, UNCTAD applied Port LSCI to evaluate how well ports are connected. In the academia, researchers in the field of transportation geography, transportation economics/engineering use connectivity, among with different kinds of metrics such as eigenvector centrality, degree of centrality, betweenness centrality, closeness centrality to measure the relative importance of a node in the entire network (Calatayud et al. 2017).

The common consensus is transportation infrastructure improves connectivity between locations. Based on this argument, researchers use different metrics of connectivity to study its links with transportation services, international trade, and so on. For example, Shepherd (2017) proved the positive association between transportation infrastructure and trade facilitation on the one side, and value chain connectivity on the other side with a focus on Sub-Saharan Africa (SSA). Applying network analysis approach and econometric analysis, the author calculated the correlations between value added trade (use eigenvector centrality as value chain connectivity) and LPI, LSCI, Air Connectivity Index, road length, OCED's Trade Facilitation Indicators (TFI) in terms of textiles & clothing and agriculture in the region. The result present evidences that improving infrastructure and trade facilitation can help African countries to better

connect to global value chains (GVCs). Besides, through substituting three/five closest countries' average data for national data, the author also validated that neighboring countries' infrastructure and trade facilitation indeed affect the country's participation in global value added activities. Therefore, transportation infrastructure have cross-border spillover effects, and this is an important result especially for landlocked countries. This may also indicate the significance of building economic corridors for landlocked countries to improve their positions in the GVCs.

Slightly different from connectivity, which is more often used to indicate the position of a location in a specific network, as pointed out by Vulevic (2016), "accessibility was commonly defined as the ease with which activities can be reached from a certain place and with a certain system of transportation". In some cases, connectivity and accessibility can also be used interchangeably. The other difference is accessibility is more often used to evaluate how transport systems facilitating individuals (for example, Legrand et al. (2013); Vulevic (2016)), while connectivity is usually applied in terms of goods movements. For the measurement of accessibility, Legrand et al. (2013) mentioned various perspectives exist, such as location accessibility, individual accessibility, economic benefits of accessibility, etc..

### **Spillover effects**

"Spillover effects" is a high frequency term in the literature and related closely to regional development studies, illustrating the potential effects of transportation infrastructure provision/investment on the adjacent areas. The discovery of "spillover effects" is because researchers found the economic returns of transportation infrastructure on a regional scale is normally smaller than on a national scale (Yu et al. 2013). This suggests economic returns of transportation infrastructure construction are not restricted to the region/country where investments were undertaken. To study the existence of spillovers, researchers in most cases conduct empirical studies at different administrative levels, considering spillovers in neighboring states, provinces, or districts.

In terms of the mechanisms, Yu et al. (2013) summarized there could be two sources. First, capital investments in transportation infrastructure in a region can help to improve the accessibility and increase its market size. Following Adam Smith's hypothesis of the "extent of the market", larger market scale can accelerate the process of labor division and specialization, which will improve the productivity and further prompt economic growth. Besides, some researchers also mentioned the role of economies of scale, adding some explanations to the market theory. In a summary, the first type source of spillovers come from the "network characteristics" of transportation infrastructure, and neighboring areas can also benefit due to the mechanisms of expanding market. "Network characteristics" is also the distinguish feature different from other public infrastructure. Second, positive or negative spillovers can arise due to factor mi-

gration. Improved transport infrastructure and accessibility can facilitate the mobility of production factors and skilled labors, therefore some more central-located (or advanced/developed) regions can "absorb" more resources and experience fast growth at the expense of geographical peripheral (or lagging) regions. In such situation, spillovers from transportation infrastructure could be positive or negative externalities for the region. In the case of China, the authors divided the whole country into four macro regions: eastern region, northeastern region, central region and western region (which is in line with the uneven development levels of the country), and conducted both a national and regional calculations for three periods: 1978-1990;1991-2000;2001-2009. The empirical results show that at a national level, transportation infrastructure has a positive total impact on national growth, while the marginal returns declined after some time. Spillover effects played a growing significant role in economic growth due to transportation network expansion in China. At a regional level, the evidences are more obvious, but regions have present mixed results of negative and positive spillover effects from the above two types. Especially for the eastern region, as the most developed one, since there is no little limitation for labor migration between regions, it showed strong ability to attract investments and production factors from the closer central and northeastern region, while the western region was little affected to larger geographical distance. The authors also predicted that industrial agglomeration effects induced by transportation improvements will further help to increase industry transfer to eastern region. Therefore, governments should take spillover effects into consideration to apply investment policies and pay more attention to cross-regional transport infrastructure construction instead of intra-regional.

Focusing on the land-based New Silk Road Economic Belt (NSREB), Li et al. (2017) confirmed the existence of spillover effects in 31 Chinese provinces along the NSREB and the surrounding areas using the data from 2005 to 2014. By applying a specialized spatial weight matrix, using the density of railway network and the density of highway network as variables of transportation infrastructure, the authors confirmed spillover effects along the NSREB, transportation infrastructure plays a critical role in promoting economic growth in these provinces and their surrounding areas. Besides, according to their work, the significance of highway infrastructure is much larger than railway.

### **Agglomeration effects**

The existence of agglomeration effects is a common consensus confirmed by the reality of logistics clusters and industrial clusters. Companies tend to locate with geographical proximity formulating clusters, which suggests that the sequential location choices are affected by the existence of previous ones, in particular the existence of firms in the same industry. Through formulating clusters, companies can gain extra economic benefits such as information spillovers or skilled labor, therefore economists also refer it as agglomeration economies. Generally, "agglomeration effects" is not a typical subject

in terms of the impacts of transportation infrastructure, instead it usually relates to the studies of firms' location and geography. Still, transportation infrastructure is an important reason explaining the mechanisms of agglomeration economies/effects. How transportation infrastructure contributes to the formulation of industrial clusters is the major object for reviewing following literature.

McCann and Shefer (2003) paid special attention to the relationships between transportation infrastructure, firm location, agglomeration and regional growth. The authors argue over the last several decades, the nature and characteristics of spatial transaction costs (information and transportation costs) have changed due to technology improvements and service level demands upgrades, therefore the role of transportation infrastructure becomes different. The authors believe the regional growth role of transportation infrastructure depends on how we understand agglomeration effects, and a spatial transaction costs perspective is a necessary perspective for discussion. There are three theoretical models developed to explain the phenomena of industrial clusters: pure agglomeration, industrial complex, and social network, distinguished by characteristics in terms of the nature of firms and their relations, as well as the transactions within the clusters. Among these three types, transportation infrastructure presents different levels of importance, as shown in Table 2.10. The heavily cited Marshall (1920) model of agglomeration explains the positive agglomeration externalities through three aspects: information spillovers, non-trade local inputs, and a skilled local labor pool. While McCann and Shefer (2003) regard this 'Marshallian Trinity' model as pure agglomeration, and pointed out it usually presents within urban areas in cities. New economic geography literature also present models of pure agglomeration, in which cases, spatial transaction costs only act as the same with trade tariffs. Domestic transportation infrastructure is the only influencing factor for intra-regional movements. Studies theorizing industry-geography behavior as argued by the authors more focused on pure agglomeration and social network, and in terms of industry complex model, its relative importance has been underestimated.

Table 2.10: Three models of industrial clusters  
Source: based on McCann and Shefer (2003)

Model	Characteristics	Theory/field	The role of transportation infrastructure
Pure agglomeration	Normally small-sized firms; transient inter-firm relations; intense local competition; within urban scale (cities)	Agglomeration model by Marshall (1920); New economic geography models	Domestic transportation infrastructure matters for facilitating intra-regional commuter movements
Industrial complex	Long-term and stable inter-firm relations; frequent transactions in the cluster; local scale and may extend across a sub-national regional scale	Classical (Weber 1909) and neo-classical (Moses 1958) location-production model; location theories to minimize inter-firm transport transaction costs	Transportation costs remain central in determining the attractiveness of alternative locations, as it is in the location-production and input-output models analyzing such phenomena.
Social network	Mutual trust relations between firms; inter-cooperation relations; small-firms over small sub-national regional scales; large vertically-integrated firms over larger regional spatial scales or beyond country boundaries	Work of Granovetter (1973); New industrial areas model by Scott (1988); industrial clustering model by Porter (1990, 1998)	Information transaction costs is the critical factor. Social network depends entirely on the social infrastructure, and physical infrastructure does not matter.

There are also empirical studies providing statistical evidences to validate the links between transportation infrastructure, firms' location, and agglomeration effects. By examining the location choices of 751 Japanese manufacturing plants invested in United States since 1980, Head et al. (1995) confirmed the existence of agglomeration effects at a national level. Both previous Japanese and local plants in the same industry attract successional greenfield investments /FDI. In terms of the mechanisms, through empirical investigation the author testified that agglomeration effects are not purely endowment-driven. Instead, the advantages of intermediate inputs and technological spillovers are more likely the explanatory reasons, compared to the state-level endowments characteristics including the level of infrastructure, natural resources or skilled labors.

Recent work by World Bank Group (Iimi and Rao 2018) investigated firm registry data in Liberia, offered empirical evidences proving the links between firm location, transport connectivity, and agglomeration economies. Six variables including rural access index (RAI), road density, share of roads in good condition, transport costs to large city, transport costs to port, and market access index are applied to measure transport connectivity. The authors solved two methodological challenges to validate agglomeration economies and spillover effects related to transportation infrastructure. Instrumental variable spatial autoregressive model is formed to address the empirical issues. Results show agglomeration economies exist, firms' location choices show significant externalities in neighboring districts. Firms in Liberia prefer to locate together. To solve the possible endogeneity of transportation infrastructure, the authors applied instrumental techniques to analyze the causality between good infrastructure and firms. In many cases, governments invest transportation infrastructure in places where firms are built, meanwhile, firms prefer to locate at places with good infrastructure, so it is hard to tell which comes first indicating there may be endogeneity. In this article, transportation infrastructure are less likely endogenous, implying that in Liberia firms chose to locate at places with good infrastructure instead of the reverse. This article contributes more to technical solutions and provides strong evidences that market access among the six transport connectivity indicators is a main driver leading to firms' agglomeration. Firm location studies should take fully consideration of agglomeration economies.

## 2.5 Summary of interim results

Literature shows researchers in diverse disciplines have three different understandings about the concept of the GLN. Researchers in the field of SCM regard GLN as a topological structure consisting of suppliers, factories, DCs, and customers. This definition is most commonly applied in the GLN re-/design studies from the perspective of manufacturers. The second group of scholars are in the fields of transportation science, shipping management, and geography. They consider the GLN as a global transportation/shipping system. The research perspective is from a specific freight forwarder or

the entire industry. The third group of researchers are either economic/transportation geographers or regional scientists. They understand the GLN as the geographical allocation of economic activities (i.e. value-added activities) at the global level. The main focus is to investigate the relations of transportation/logistics (nodes) with diverse aspects such as globalization, land use, fragmented production, regional growth, etc. Based on the three different understandings of the GLN, network re-/design process is conducted either from the perspective of a manufacturer or a carrier. Facing the changing world, network configuration optimization has become a strategic tool for enterprises to maintain competitiveness. Following these findings, in the next chapter a multi-layer framework for the GLN is built in section 3.2 to distinguish the differences between infrastructure network, transportation service network, and logistics network.

Location selection for production and distribution sites as the primary decisions in the GLN re-/design issues is widely studied as well. Three disciplines including management science, economic & transportation geography, and international business are identified as main research domains. Researchers in management science consider spatial economic costs and address the issue through operational research models. Economic/transportation geographers take into account of agglomeration economies and network features to investigate the concentration or de-concentration trend. In the field of international business, FDI location selection is the main addressed issue. Hence, the concept of location advantages embedded in Dunning's OLI paradigm is introduced to link countries/regions to MNEs. The perspective of countries' characteristics for attracting MNEs' investments is of critical importance as well. Based on these results, section 3.1 presents a framework of location selection process for MNEs, emphasizing the normally ignored external factors are also crucial determinants.

The study interests to investigate the BRI keep rising since its proposal. To produce a general impression on the BRI studies, a bibliometric analysis was conducted on the selected 90 articles. It is shown the research interests are allocated in diverse disciplines, including economic development, energy, policy & socio-cultural, etc. Articles focusing on logistics were analyzed and classified into three most relevant categories: logistics & transportation, international trade & business, regional development. In general, articles dealing with GLN re-/design issues are scarce. The few related ones focus on costs minimization for a specific commodity within a specific geographic scope, and concern little about the non-cost aspects such as macroeconomic factors. A framework of potential research topics about BRI is given as an outcome.

Considering the top priority of transportation infrastructure construction in BRI's implementation, it is also necessary to understand the role of transportation infrastructure. There is no doubt that it is the backbone to support logistics and trade. Economists also found out the broader economic consequences of transportation infrastructure investments, including agglomeration effects, market and production expansion, specialization, etc. From the perspective of geographers, transportation infrastructure construction improves connectivity/accessibility, causes spillover effects

and agglomeration economies. This means transportation infrastructure not only affects the area where it constructed, but also its neighboring areas. For the locations with advantages, locational agglomeration takes place very often to form logistics clusters, industrial clusters, etc. Following these findings, in the next chapter section 3.5 conducts a modeling process adapting a system thinking view to present the role of transportation infrastructure in shaping the structure of the GLN.

### **3 Theory development**

BRI is a trans-continental long-term development initiative. To investigate the potential effects of BRI on GLN, there are too many aspects requiring deep investigation. Considering its top priority is to connect the three continents physically, this research focuses on the role of transportation infrastructure to analyze BRI's impacts on GLN. Section 3.1 presents a framework of decision process of GLNs for MNEs, illustrates that firms' location decisions should consider both internal factors and external factors. The importance of external factors should not be underestimated, laying the foundation for further research. Literature shows the concept of GLN is mixed with transportation network, hence a multi-layer framework is established in section 3.2 to represent the relationship between infrastructure network, transportation network, and logistics network at a global level. These networks occupy different attributes and closely interact with each other. Changes in each part of them can cause consequent dynamic effects on the whole system.

To understand BRI's impacts on GLN, it is also necessary to have a comprehensive idea about the determinants and current trends of GLN. Section 3.3 summarizes the critical aspects that determine the pattern of GLN, and analyzes the fundamental role of transportation infrastructure in these aspects. This section does not focus on the determinants of location selection choices from a firm's management perspective. Instead, external factors summarized in the first section are the main focus, covering geographical features, macroeconomic environment, economies of agglomeration, as well as technology and innovations. Following this, section 3.4 analyzes the current key trends of GLN with special attention to the ones that relevant to the geographical structure of GLN. Trends in logistics industry and manufacturing industry are both covered. In addition, the trend of "firm-focal" to "port-focal" logistics shows that logistics nodes especially the hubs/ports become more and more integrated into global supply chains. This trend happening in the real world shows the connection between transportation network and logistics network, which in the academia is usually lack of emphasize. It also indicates that at a global level, hubs with good global access are preferable candidates for firms' location selections, therefore, transportation infrastructure plays an important role in the formulation and evolution of GLN. Section 3.5 following this idea applies a systematic thinking perspective, develops a system dynamics(SD) model to present the role of transportation infrastructure in the evolution of GLN.

### 3.1 Location decision process for GLN re-/design

Different from domestic logistics networks, the structure of GLN relates to multiple disciplines due to its broader geographical scope and the involvement of several countries and MNEs. From a micro-economic point-of-view, the spatial pattern of the GLN relates to individual company's re-/location selection decisions regarding their production and marketing. The re-/design of a single company's logistics network on a global scale needs to consider not only the company's own development strategies, but also its external environment. In the practical world, re-/location decisions are normally made through several steps: strategy setting, country/region selection, location selection. Based on the findings in previous chapter, a framework of decision making process for MNEs' location selection is present as Figure 3.1. In line with companies'

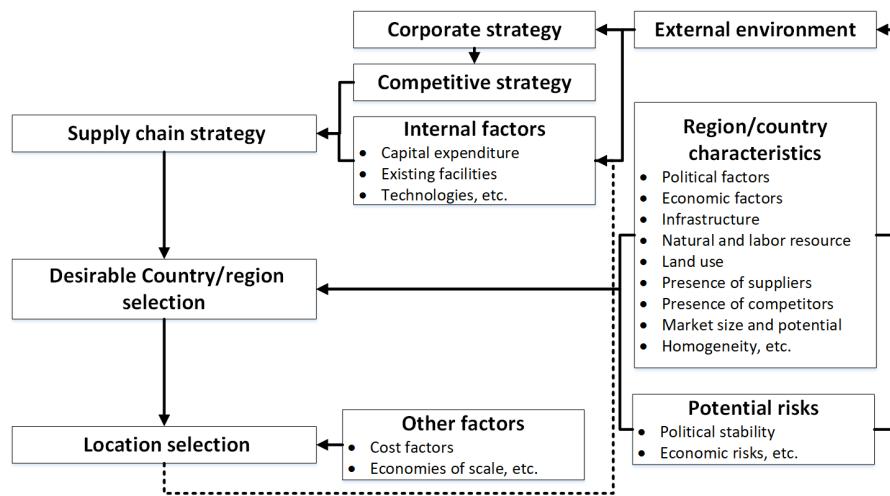


Figure 3.1: Decision process of global logistics networks

own supply chain strategies, decision-makers should select countries/regions first, then select the specific locations afterwards. Though supply chain strategies may vary from different companies, there are some common considerations when choosing the optimal country/region. Such considerations include trade climate and facilitation measures, countries' comparative advantages, status of connectivity and infrastructure, transportation service levels, etc.. From a macro-economic perspective, the current pattern of the GLN is the consequence of long-term evolution in line with the geographical distribution of factor endowments, regional and national economic development level, trade relations between economies, technology and innovations, as well as the status of infrastructure, especially transportation infrastructure, etc.. There are a lot of relevant concepts and topics, including international trade, foreign direct investment (FDI), regional development, transportation and logistics, geography and connectivity, and so on. BRI is an infrastructure-led development initiative with numerous support-

ive agreements with many countries. Hence, region/country characteristics especially infrastructure and economic factors are altering very fast. To investigate BRI's impacts on the GLN, it is necessary to integrate the micro-economic and macro-economic research perspectives. External factors that affecting firms' location selections are the starting point of research, which is also the commonly ignored issues in the field.

### **3.2 A multi-layer framework of GLN**

The current structure of GLN is the outcome of long-term evolution resulting from the interactions within several aspects. Literature shows GLN is a multidisciplinary research topic and researchers use it to express various concepts. To clarity the confusing interrelationships, a multi-layer framework is built as shown in Figure 3.2.

This frame can also helps to distinguish the differences between transportation infrastructure network, transportation network, and logistics network.

- Transportation infrastructure network

Based on geographical features of the entire Earth, transportation infrastructure network is the backbone enabling transportation & logistics activities.

- Global transportation network

Global transportation network represents the geographical allocation of physical movements. The main attribute is freight volume and direction. It does not directly reflect the designed capacity of transportation infrastructure network. Instead, the structure is determined by the transportation services offered by carriers, and the demands required by consumers (i.e. manufacturing industry). On a global scale, maritime shipping services determine its structure, since maritime shipping supports the vast majority of international trade.

- Global logistics network

GLN as shown at the top layer determined by MNEs' configuration in regards to their suppliers, plants, DCs, and customers. From a macro-economic perspective, GLN represents the geographical dispersion of production and distribution in various countries. This is in line with the concept applied in this research.

Interacted with each other, a single change of these involved aspects can cause structure changes of the GLN. The following sections explain the critical aspects and key trends determining GLN.

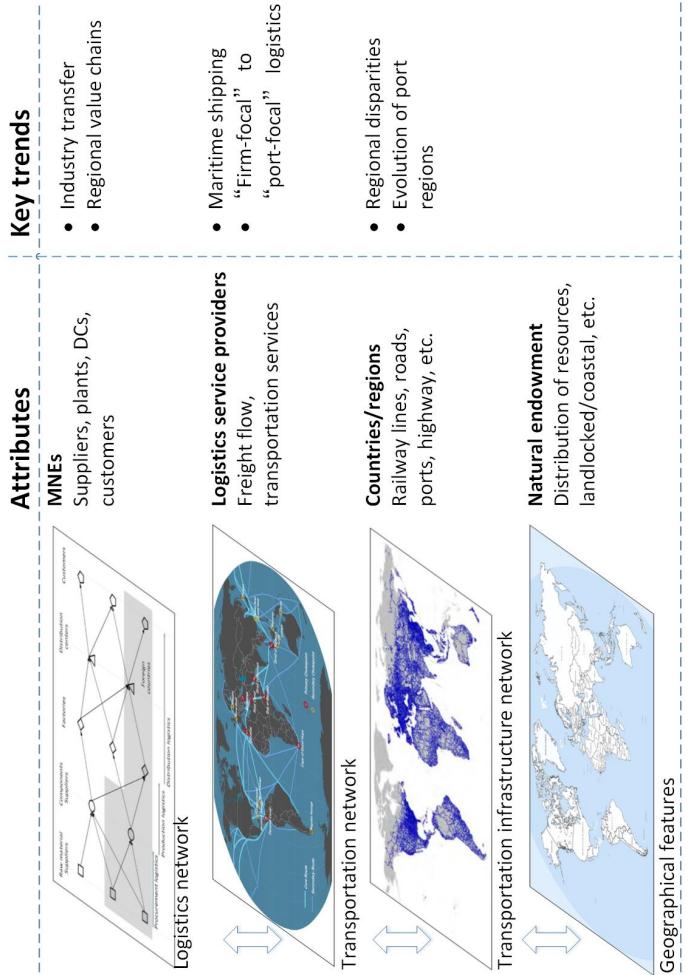


Figure 3.2: A multi-layer framework of GLN

### **3.3 Critical aspects determining GLN**

Generally speaking, the GLN represents the geographical dispersion of economic activities (value-added activities) on a global scale, consisting of nodes where economic activities undertake and links through which physical materials flow. In other words, the GLN is the topological structure of the geography of procurement, production, distribution, and consumption. Over the last several decades, the structure of the GLN has seen many changes, and there are several critical aspects determining its evolution. The most important one is the rapid process of globalization, which accompanies with the emergence of global production network (GPN). Actually, it is the formulation of GPN that pushed forward the concept of GLN. While sourcing the reason why global production became a reality, it is found that transportation infrastructure plays a critical role. Of course, there are many other aspects taking effects during the process. The following subsections summarized the critical aspects determining the pattern of GLN, from both historical and future point-of-view. Besides, how transportation infrastructure takes effects in these aspects are also mentioned to lay a solid foundation for the modeling section.

#### **3.3.1 Geographical features**

Though some researchers imagined that the world would become more and more "flat". However, at least in the following decades, to conquer the obstacles of natural geographical features remain a serious issue. Geographical features still are important factors determining the structure of the GLN. Such features include the geographic positions and the associated physio-graphic characteristics such as the depth, currents, winds (historically significant), and the distribution of coastlines and passages (Rodrigue 2017). These factors belong to natural endowment, along with other factors such as the distribution of natural resources are relatively stable determinants but have large impacts on the GLN. For example, "being landlocked" is a proven disadvantageous factor generating high transportation costs. Without direct access to oceans, landlocked countries have to import/export goods across at least one neighboring country, generating high import/export expenses. This creates obstacles for landlocked countries to participate in the global economy. In fact, majority landlocked countries are among the world's Least Developed Countries. The UNCTAD accounts 32 countries to the Group of landlocked developing countries (LLDCs) among the overall 48 landlocked countries. On the contrary, countries with long coastlines can acquire more chances to trade with other countries. Even within one single country, the coastal areas in most cases have better trade performance compared to inland areas. For example, China's eastern coastal cities such as Shanghai, Guangzhou are the most active economic centers, while the western inland cities like Xinjiang, Gansu are the poorest.

The current pattern of GLN is developed based on geographical features, and its evolution is restricted to them as well. Firstly, geographical features is the critical factor determining distance and transportation mode selection, considering the world-wide allocated origin and destination. The geomorphological features of the earth is also critical. In most cases it is more expensive to convey goods across mountainous areas compared to plains. Maritime shipping remains the predominant mode due to its capability to transport mass goods of long distances with cheaper prices. Secondly, constructing good quality transportation infrastructure can help to conquer the limitation of disadvantageous geographical features(Limao 2001). While, the cost of construct, update and maintain transportation infrastructure also heavily depends on those features, especially for the construction of railways and highways. In some extreme cases, it is impossible to build transportation infrastructure at all. Thirdly, the geographical distribution of factor endowment to some extent determines a country's possibility of industrial specialization. Natural resources for example are distributed unevenly in countries, as well as many other raw materials, and even population. In general, geographical features affect various aspects including countries' political, economic, cultural, religious standpoint, and form specific living habits of the local people. For instance, according to some researches, geographical features also affect the pattern of trade relations. Neighboring countries tend to have more imports and exports than countries with no common borders due to geographical proximity, common language and culture, etc. Trade between neighboring countries contributes to 23% of world trade in terms of value(Hummels 2007).

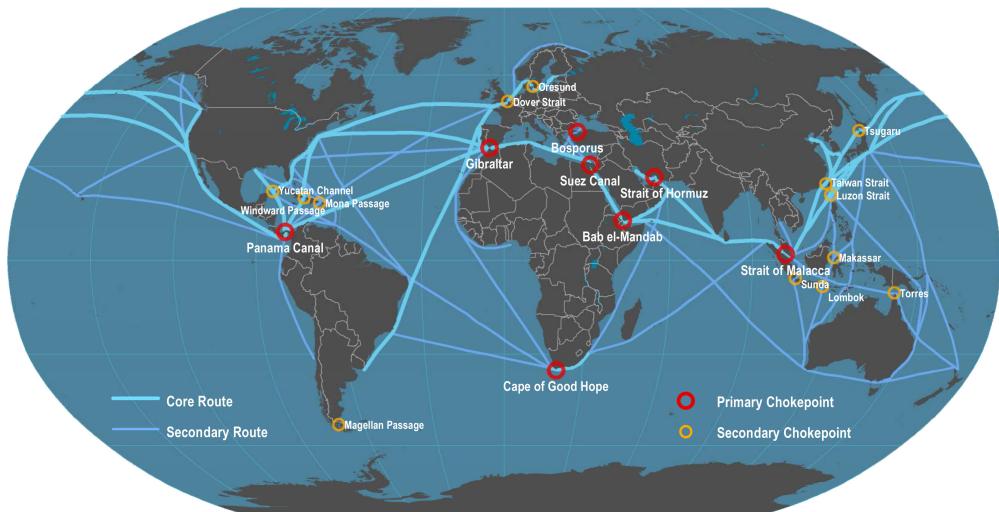


Figure 3.3: Main maritime transportation routes and strategic locations

Source: Rodrigue (2017), Figure 1

Considering the leading role of maritime shipping, as shown in Figure 3.3 there are nat-

urally shaped critical transportation routes and strategic choke-points. Those choke-points in most cases are located along the shipping routes between the largest trade partners, and can easily become the bottlenecks where congestion happens. The development of shipping industries is heavily relied on and limited to these features, and many evidences can show the effects. For example, to make full use of economies of scale, shipping companies prefer to use large vessels. While the key choke-points such as the Panama Canal, Suez Canal, Malacca Strait restrict the size of the vessels. Therefore, specific ship standards "Panamax/New-Panamax", "Suez-Max", "Malacca-Max" are set to accommodate these passages. In turn, those strategic choke-points have been regularly expanded and modernized to accommodate ever larger mega vessels. For instance, the latest expansion of the Suez Canal was conducted in 2015. The "New Suez Canal" has twin parallel navigation channels and capable to sail mega ships in both directions at the same time. The dredged 20-meter sailing depth allows super large ships with capacity of 24,000 TEUs to transit, which may further encourage shipyards to design and build even larger vessels with carrying capacity of 30,000-35,000 TEUs. Ports and terminals are faced with the similar capacity issues. It requires at least 15 meters of water depth for a port to handle mother vessels. Whether a port's natural endowment can satisfy this requirement is a precondition to become a hub, and infrastructure development is a crucial measure to realize the potential or conquer the disadvantages.

### **3.3.2 Macroeconomic environment**

Macroeconomic climate, especially the business environment where international trade and FDI undertake, is an essential influencing factor for the structure of GLN. Firstly, transportation and logistics activities are conventionally regarded as demands derived from production to support merchandise trade. International transactions of merchandise take place accompanying with border-crossing physical movements of raw materials, parts, semi-finished products and commodities. There are two ways to trade across national boundaries between companies: intra-firm trade or arm's length trade (Viswanadham and Kameshwaran 2007). The former refers to "trade between parent companies of a compiling country with their affiliates abroad and trade of affiliates under foreign control in this compiling country with their foreign parent group" (OECD 2010). The later means "cross-border transactions between unrelated firms" (Lakatos and Obnsorge 2017). Both kinds of trade generate transportation demand, and the pattern of international merchandise trade determine the transportation value, volume, and direction. In addition, the increasing share of intra-firm trade is a natural result of the fragmentation of production over the last several decades. Manufacturers separate the whole production process into several steps, and allocate these steps at several countries to minimize the total costs. This emerged the formulation of global production system, substantially changed the geographical dispersion of production, thereby the geography of distribution. Intra-firm trade also put forward higher level of transportation/logistics services compared to arm's length trade. To guarantee the

smooth production process, intermediate products should be delivered in time, secure, traceable, and with reasonable prices. This also put forward higher level of border-crossing trade facilitation measures, such as convenient and fast customs clearance, lower export/import tax, etc. Countries with good macroeconomic environment that facilitating trade hence become a preferable candidate location and have more chances to participate in the global economy. Besides, transportation/logistics costs is a component of trade costs, transportation costs reduction is expected to promote trade performance, which could further shift the structure of GLN.

Secondly, favorable business environment encourages companies to establish foreign subsidiaries to exploit comparative advantages and markets to pursue profitability. This is also the distinctive feature of MNEs, which configure their facilities in multiple countries through the form of FDI. MNEs locate factories abroad either to supply a foreign market through horizontal FDI, or to exploit comparative advantages across countries through vertical FDI (Ramondo et al. 2011). Horizontal FDI represents as replicate the same production phase across foreign countries, and vertical FDI represents as allocate the upstream or downstream production phase in the same value chain across foreign countries. In some cases both motives can exit in a firm's relocation behavior through FDI. Countries on the other side are also seeking ways to attract more FDI, to get more opportunities to get involved in the global value-creation activities. Thus, the ease of doing business and investment in economies is a critical determinant for MNEs' location decisions regarding their production and distribution sites. Economies with comparative advantages and large markets are preferable FDI destinations, and the geographical structure of GLN can be substantially changed as MNEs re-/locate FDI to more favorable locations.

Thirdly, the geographical structure of GLN represents the allocation of production and distribution sites, with respect to the allocation of consumption sites (i.e. markets), which is usually correlated with the level of economic development, determined by factors including income level, population, growth rate, etc. Production and distribution sites are selected by MNEs based on their target markets and external environments. The expansion of MNEs' logistics networks can also contribute to FDI and GDP increase in the destination countries. Hence, introducing FDI from MNEs is critical for economic growth of local countries/regions. Furthermore, the improved level of development can generate higher level of income and consumption, creates a positive feedback to market demands. Rich countries/regions are also able to conduct transportation infrastructure investments and improvements to enhance its competitiveness. There are many other factors affecting an economy's macroeconomic environment, such as political stability, foreign policy, weather condition, etc.

Over the last several decades, the world witnessed significant improvements of macroeconomic environment greatly promoted the globalization trend. A specific example is the formulation of various trade blocs, including monetary unions, customs unions, free trade unions. Economies with geography proximity build unions such as European Union, Association of Southeast Asian Nations (ASEAN), Eurasian Economic

Union (EAEU), and so on. The world has been economic integrated, and economies within the same trade bloc cooperate to facilitate cross-border trade and investment. However, in the current era, after several decades of globalization, the Western World starts to show a tendency of anti-globalization combined with nationalism. This leads to unilateralism generating a trend of trade protectionism, which can be traced back after the financial crisis of 2008. Two latest events clearly present the raise of anti-globalization trend, providing many uncertainties for predicting the future macroeconomic environment landscape. One is the trade war between the world's two largest economies: U.S.A and China. Though negotiations are taking place, while considering the so-called "Thucydides Trap", the world economy has come to the era of break and reordering, which afterwards may even be concluded as the second "cold war". The tension is not limited to the relation with China only. U.S.A withdrew from the Trans-Pacific Partnership Agreement (TPP), and signed the new "United States-Mexico-Canada Agreement" in November 2018 and December 2019 (revised version) to substitute the "North America Free Trade Agreement (NAFTA)". These measures all show the rising protectionism of U.S.A. and its willing to untie its economy with Asia. The tension is very likely to continuing its effects on the world economy for the next decades. The other is the "Brexit", refers to the exit of the United Kingdom from the EU, increased the dilemma of deepening European integration. The current economic integrated pattern between large economies may shift very quickly.

The anti-globalization trend in the West, however, enhanced the willing of Asian economies to be more integrated to counterbalance the negative effects on economy growth. On 4th November 2019, it is announced that the ten member states of ASEAN and its five free trade agreement (FTA) partners finally reached consensus to sign the "Regional Comprehensive Economic Partnership Agreement (RCEP)". The RCEP is forming the world's largest free trade area on the basis of "ASEAN+6" arrangement. Concerning free trade in the Asia-Pacific region, the RCEP agreement covers half of the world's population and one-third of the world's GDP. Similar organization such as Shanghai Cooperation Organization (SCO) includes the countries in Central Asia, South Asia, and so on. China also enhances its cooperation with Central and Eastern European countries, refers to the current China-CEEC (17+1). The Russian-sponsored customs union—the Eurasian Economic Union (EAEU) intends to enhance economic integration in Eastern Europe, Central Asia and Western Asia. China's promotion of BRI intends to reinforce globalization trend through infrastructure and economic cooperation. In such situations, globalization trend may continue but on a regional scale instead of global, or in other words, regional integration may turn to be a new trend in the following decades to describe the world macroeconomic environment. As a consequent, MNEs have to reconsider the macro-economic business environment, restructure their global supply chains to adapt to this new pattern. The geographical structure of GLN will face substantial changes as well.

### **3.3.3 Economies of agglomeration**

Agglomeration effects refer to the phenomenon that firms tend to locate proximity with each other to formulate clusters, since locating at the same place can bring up many economic benefits. Especially for the sectors in the same industry, exiting factories indicate this location has been equipped with supportive hard and soft infrastructure, preferable policies and regulations, as well as adequate supply of raw materials, intermediates, skilled labors, logistics service providers, etc. Besides, due to spillover effects, locating together is also helpful to acquire information and technology innovations, to keep the speed up with the competitors. Some also argue for the technology-intensive sectors, firms prefer not to locate near to its competitors. In terms of other sectors such as labor-intensive manufacturing sectors, it is a common phenomenon to locate closely to formulate clusters as industry complex. Many researchers offered evidences empirically and practically validated that agglomeration economies are critical factors for attracting new foreign plants (Barrios et al. 2006; Iimi and Rao 2018).

An important implication of agglomeration economies is that in terms of firms' re-/location behaviors, it is not enough to consider location selection from the perspective of a single firm's decision. Instead, it is a bunch of location decisions made by several firms in a period of time. In the globalized world, firms are specialized in a particular sector in the entire value chain, the upstream suppliers, the assembly manufacturers, and the downstream dealers require close integration and efficient communication. Especially for the current practice of Just-In-Time practice, geography proximity can help these firms to acquire fast responses to improve productivity. Meanwhile, it also contribute to savings for transportation, time and communication costs. The formulation of industrial clusters can also create a dynamic effects in a long-term view, implying that the former decisions of re-/location can cause a reinforcing effect for adding more location advantages to this place. Therefore, when considering firms' location selection behaviors, there is a kind of "inertia", which means the current main FDI absorption countries may continue to be the preferable FDI destinations. This can also somehow explain why some researcher argued that transportation infrastructure in peripheral regions/areas does not help to promote economic development. Capitals, technologies, skilled labors can be absorbed to the more developed core regions/areas.

Despite the geographical concentration trend of firms, some researchers observed and pointed out there is a gradually deconcentration trend in location behaviors (Hudalah et al. 2013). In the field of geography, researchers also use spatial divergence to describe this phenomenon, and spatial convergence refers to agglomeration/clustering effects. This maybe on the one side due to the capacity limitation of a place to support smooth operation of production and distribution, on the other side due to the firms' relocation to other preferable sites. For the first possibility, agglomeration economies indeed cause some negative effects in some conditions, including environmental issues, increasing land prices, congestion in transportation systems, intensifying competition between firms, lack of space, regional disparities, etc. When firms' production and distribution

activities exceed the capacity, these negative effects become more obvious that forcing firms to move away, showing a spatial divergence trend. For the second possibility, it is firms' willing to move to preferable places to seek larger profit margins.

In the logistics industry, it is not surprising that there are maritime clusters allocated around the world. For the economies in which maritime shipping is one of the supportive industry, its prosperity is heavily relied on the agglomeration of the associated sectors, such as ship building, ship repair, container terminals, etc. This is particular the case of countries/cities with geographical advantage that allocating along with ocean and sea, such as South Korea, Hamburg, Singapore, etc. Since maritime shipping remains the predominant mode in world trade, the allocation of maritime clusters is also a critical determinant affecting the spatial dispersion of production and distribution sites.

### **3.3.4 Technology and innovations**

Technology improvements and innovations may cause subversive alterations to the way of production, distribution, transportation and communication, thereby leading to substantial changes to the structural of GLN. From a historical view, it is an obvious conclusion. Containerized shipping is a typical example showing how innovations in transportation lead to structure change of GLN. Application of containers in shipping largely reduced the unit transportation costs, and enables firms to exploit comparative advantages in foreign countries (Hesse 2006; Rodrigue 2006). Though there is extra transportation cost due to remote distances, it can be covered by the savings from production costs reductions from the exploitation of comparative advantages (such as lower labor costs). As a result, the geography of production become dispersed as the fragmentation of production process (Cidell 2011). It is also argued that information and communication technologies improvements combined with increasing economic and social integration contribute to the emergence of global production networks (Hesse 2006). Just-In-Time (JIT) practice originated from Toyota Production System (TPS) as an innovation in production caused substantial changes that reshaping the structure of GLN. Manufacturers applying JIT manufacturing strategy (the current term: lean manufacturing) reduce their reliance on inventories, and require quick response from suppliers. Accordingly, logistics industry develops and offers "JIT logistics" services. Reflected on the structure of GLN, it is observed that the share of transporting intermediaries is increasing, as well as the delivery frequencies. Techniques such as RFID (Radio-frequency identification) is used to track the deliveries to enhance the security and responsiveness. In a word, JIT practice put forward higher requirements for logistic service providers in terms of delivery time, responsiveness, track and security, etc.. This also make the upstream suppliers and manufacturers more integrated and interdependent, which may lead them to locate geographically proximity to form industry clusters.

In the modern world, technological developments such as the Internet of Things (IoT), Automatic Identification Systems (AIS) are significantly improving the services of transportation. New developments such as Artificial Intelligence (AI), 5G, 3D printer, automation will definitely change the way of transportation, improve efficiency and productivity, reshape the pattern of global economy, as well as the structure of GLN. A good example is the automation trend of container terminals, which also refers to the trend of digitization in ports. With 97% of world container terminals remain manual, the automation process is still at a very early stage (UNCTAD 2019a). Fully automated terminals account for 2%, and the share of semi-automated terminals is around 2% (Drewry Maritime Research 2018; UNCTAD 2019a). Higher level of automation can largely improve efficiency and enhance competitive advantages of ports. For instance, Qingdao port is the first fully automated terminal in Asia, applied hydrogen energy and 5G technology putting into operation since May, 2017, the efficiency has been improved by 30%, and the average number of containers loading and unloading reached 36 from 24<sup>1</sup>. In the following years, it is expected that port terminals experience a digitization transformation, which could improve the overall efficiency of port operation and reduce the possibility of congestion. Obviously, ports with rapid automation process acquire more advantages to take leading positions as international hubs. This may lead to more intensified port competition and further concentration of shipping market. Automation trend also happens in the manufacturing industry, the initiative of "Industry 4.0" proposed by German is a strategic development path for advanced production and logistics. The expectation is higher productivity, higher efficiency, higher level of automation, which will substantially change the landscape of GLN as well. All these technological advances and innovations require the accommodated update of transportation infrastructure.

### 3.4 Key trends affecting GLN

Determined by the above mentioned aspects, and developed along with the globalization trend, the contemporary GLN is a complex. There is no unified law to summary its pattern. In line with globalization trend, the formulation of global production systems requires the support of low-cost long-distance transportation services. Maritime transportation and containerized shipping hence sustain the predominant mode, leading to the prosperity of the shipping industry. Meanwhile, economies with different development levels specialized in various sections and thus formed diversified trade connections. For the manufacturing industry, business expansion of MNEs to foreign countries accompanies with FDI location selection decisions. As the development of MNEs, relocation of their production sites also takes place. This tendency of relocation is closely related to the evolution of global production network and the shift of countries' comparative advantages. Due to the fragmentation of global production

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<sup>1</sup><https://www.chinadaily.com.cn/a/201912/18/WS5df98d12a310cf3e3557ee93.html>, accessed on Feb.20, 2020

systems, different stages of production units are highly dependent. Relocation activities of some production units can cause a sequence of relocation behaviors of the other units because of agglomeration economies. This reflects to a larger scale is the phenomenon of industry transfer, which is actually the reconfiguration of value-added activities accompanying with economies' position alteration in the global value chains. An important trend that connects the logistics industry and manufacturing industry in terms of the structure of GLN is the transformation from "firm-focal" to "port-focal" logistics. This refers to the fact that ports as important logistics nodes have been more and more integrated into global supply chains. Locations with advantageous logistics function become preferable candidates for firms' location selections, which is particularly true for the selections of distribution centers (DCs). This section discusses the key trends affecting the structure of GLN, covering critical trends both in logistics industry which mainly focusing on maritime shipping industry, and in manufacturing industry with special attention to the trends related to re-allocation of production and distribution sites.

### **3.4.1 Maritime shipping: the predominant mode**

Theoretically, there are several transportation modes-railway, road, air, sea, inland waterway, pipelines applicable for international shipments; and alternative transportation mode options can increase the flexibility. The truth is maritime shipping takes the predominant role in global merchandise trade. It supports around 90% share of international trade over the world (Rodrigue 2017). Many reasons can underlie the leading role of maritime shipping. The primary one of them is its capability to convey substantial cargoes for long distances in a relatively low cost. Application of containers can help to achieve economies of scale, which further reduces the costs. The other reason is its capability to connect noncontinuous countries. Adjacent countries can apply surface modes like road, rail and pipelines, while maritime and air shipping are the only options between noncontinuous countries. It is particularly the case of island countries. However, landlocked countries have no coastlines, nor the access to the shipping network, though goods from them can also be transferred by sea through its neighboring countries.

In addition, though on a global scale maritime shipping remains the leading mode, there is a different picture on a regional scale. As calculated by Hummels (2007), trade data of U.S. and Latin American shows there are 90% of trade going through surface transportation modes between land-neighboring countries. This indicates that country pairs with common borders and land access prefer to transport by surface modes like truck, rail, and pipelines. Country pairs contribute most to the global trade are nonadjacent partners, and have to use ocean and air modes, in line with the pattern of world economy. Possible reason of this situation is that the largest economies with close trade relations are allocated across ocean, or the reverse, being blocked from ocean shipping is an obstacle for the landlocked countries to build trade

relations and grow. Despite the reasons behind, with respect to the leading role of maritime shipping, the structure of GLN to a large extend can be figured out through the analysis of global maritime shipping.

### **Concentration of shipping market**

As the development of world economy and maritime shipping, especially after the innovation of containerization, today's shipping market turned out increasing monopolistic structures, partly due to specialization and partly due to consolidation through mergers and acquisitions (M&A) as well as shipping alliances formulation. Large shipping companies quickly increased their market share. According to the latest data, the combined market share of the top shipping company increased from 29% in 2006 to 33% in 2019, and the share of the top 10 container shipping lines accounts for up to 90% (UNCTAD 2019b). The market enlargement accompanies with the formulation and consolidation of large shipping alliances. Nowadays, the three shipping alliances including 2M, Ocean Alliance, and THE Alliance occupy almost 80% of the worldwide container carrying capacity (Merk et al. 2018).

Shipping companies as customers obviously gained increasing bargaining power over ports or terminal operators during this expansion process. Many shipping companies invested in terminals. Carrier-controlled terminals gradually increased from 18% in 2018 to 38% in 2017, as shown in Figure 3.4 (Merk et al. 2018). One port may have several terminal operators hold share by different carriers. Under such circumstances, the competitiveness of ports is increasingly relied on the decisions of carriers and shipping alliances. Meanwhile, the capacity of vessels deployed gets larger and larger to achieve economies of scale to lower the unit shipping costs. The size of shipping vessels dramatically increased. In 2017, the maximum capacity of container ships achieved 21,100 TEU, comparing to 4,814 TEU in 1990, 8,160 TEU in 1997, and 15,550 TEU in 2006 (Merk 2017). According to the latest news, the current largest mega-ship "HMM Algeciras" acquire a capacity of 23,964 TEUs. The application of mega-ships increased the reliance of terminals/ports on carriers further, since one decision of calling at a different port instead of the initial one can cause a large amount of market lost. In fact, carriers are trying to expand their business from almost every aspect through vertical integration in the entire logistics chain, as shown in Figure 3.5. Hinterland logistics business becomes part of the services offered by carriers, through carriers' share acquisition of inland logistics companies. For instance, in May 2018 MSC acquired the majority stake of Laumar Terminales Ferroviarias, the Spanish Valencia-based railway operator. This purchase helps MSC to develop the railway network of the Iberian Peninsula connecting to its port terminals. This indicates that the integration of inland logistics may possibly turn to be one source of competitiveness of ports and carriers.

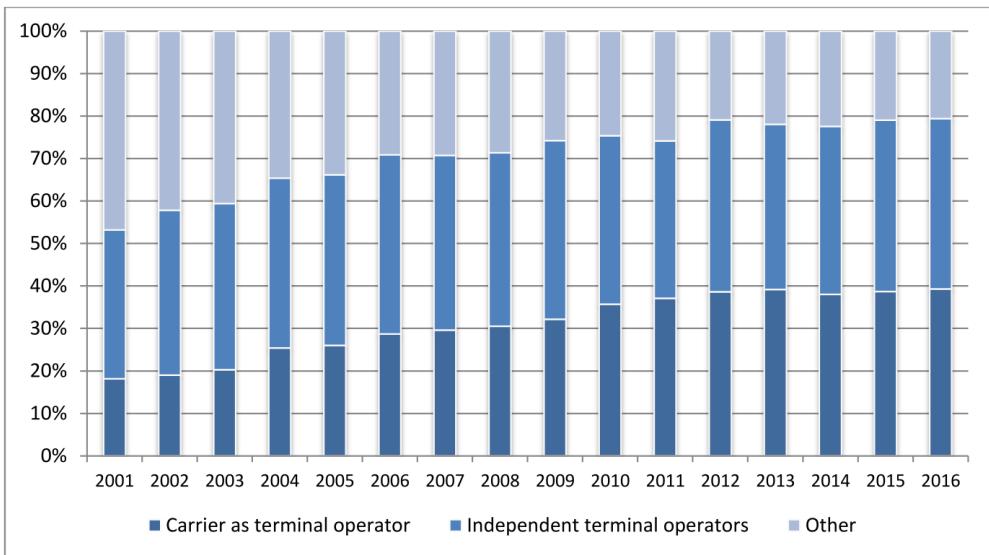


Figure 3.4: Emergence of carrier-dominated terminals, 2000-2016)

Source: Merk et al. (2018), Figure 14

Carrier	Shipping, Short-sea	Terminal	Logistics	Equipment	Towage	Rail	Barge	Truck
<b>Maersk</b>	✓	✓	✓	✓	✓	✓	✓	✓
<b>MSC</b>	✓	✓	✓			✓	✓	✓
<b>CMA CGM</b>	✓	✓	✓	✓		✓	✓	✓
<b>Cosco</b>	✓	✓	✓			✓		
<b>Evergreen</b>	✓	✓	✓	✓		✓		✓
<b>Hapag-Lloyd</b>	✓	✓	✓	✓				
<b>ONE<sup>8</sup></b>	✓	✓	✓	✓	✓	✓	✓	✓
<b>Yang Ming</b>	✓	✓	✓					✓
<b>HMM</b>	✓	✓	✓			✓		✓

Figure 3.5: Vertical integration of selected carriers in the maritime logistics chains)

Source: Merk et al. (2018), Figure 14

## **Hub-and-spoke shipping networks**

The market concentration of maritime shipping, the application of mega-ships, combined with the increasing dominance of carriers over ports, all contribute to the current geographical structure of global shipping network. The application of mega-ships reduces the frequency of deliveries, at the same time carriers only need to call at a relatively fewer number of ports during its voyage to save port fees. For instance, in terms of the shipping between North Europe and Far East, weekly liner shipping reduced to 17 in the second quarter of 2017, compared to 21 in 2015, 26 in 2012, and 35 in 2006 (Notteboom et al. 2017). While the average number of port calls per loop decreased as well: 4.9 in 1989, 3.84 in 1998, 3.77 in October 2000, 3.68 in February 2006, and 3.35 in December 2009 (Ducruet and Notteboom 2012).

As a consequence, the shipping flows become more and more concentrated at some certain ports. Competition between ports become more intensified , since each call can generate a relatively larger volume at the port. According to the calculations of Notteboom et al. (2017), each port of call on a weekly basis can generate annual container volume about 300,000 TEU for the North Europe- Far East shipping. Ports differentiate into hub ports and feeder ports according to its competitiveness, determined by many factors including geographical positions, port efficiency, port infrastructure endowment, carriers, terminal operation, hinterland transportation, etc. These competitive ports evolved to be hub hubs, burdening the function of handling mega-ships, while the others function as feeder ports supporting the hubs.

Global shipping network thus represents as a "hub-and-spoke" structure, or as a "core-periphery" structure in line with carriers' organization schemes (Liu et al. 2018). It comprises a well-connected hub port as transshipment node and the surrounding feeder ports on shorter routes. Moreover, the "hub-and-spoke" structure is the general form in different regions that separated by oceans. In other words, there are several regional "hub-and-spoke" shipping networks, implying port competition happens normally not on a global scale but restricted to a certain sea area. As calculated by Wang and Wang (2011), the global shipping network consists of 44 regional hub-and-spoke systems. Figure 3.6 shows the regional hub-and-spoke network structures in Asia, Europe, Africa, and Oceania. By the way, there may be more than one hub port existing in a specific region.

The structure of hub-and-spoke network also brings forward immense pressure on ports and terminals in regard to space, equipment, labor, technology, infrastructure, etc. Though terminal operators are seeking ways to enhance ports' positions to be hubs, some hubs become incapable of handling the growing size of vessels, or the growing numbers of vessels docked at the port. Hence, though facing the fact of overcapacity in the shipping industry, for some ports the concentrated traffic exceed their capacities. Congestion becomes a serious problem causing extra costs and time of deliveries. Other negative issues include space limitation of hinterland and environmental impacts.

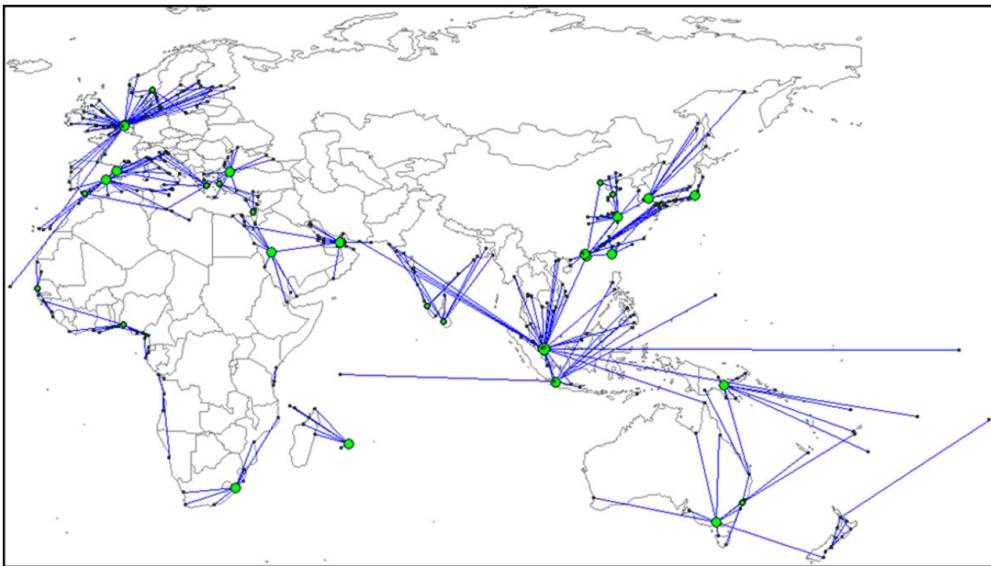


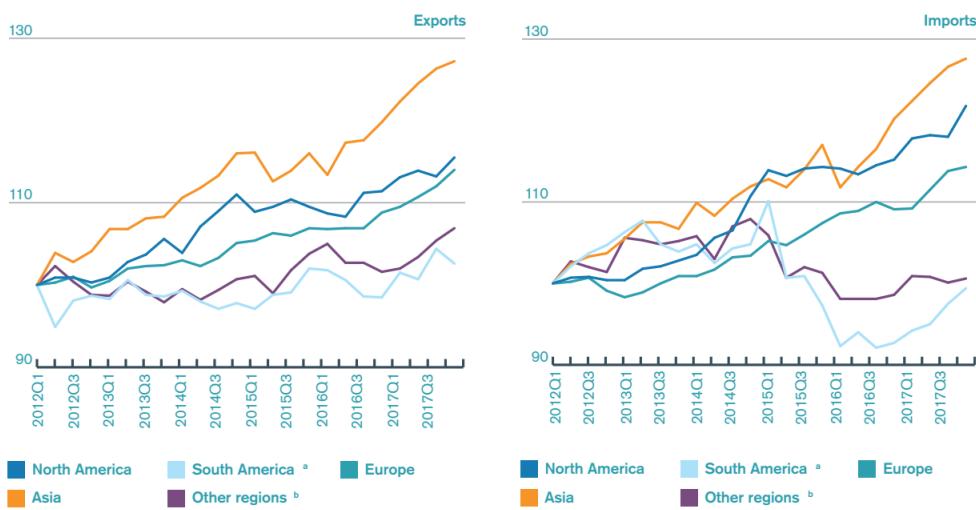
Figure 3.6: Regional hub-and-spoke networks in Asia, Europe, Africa, and Oceania  
 Source: Wang and Wang (2011)

There are some other trends that may affect the structure of GLN as well. For example, the application of "IMO 2020 Sulfur Regulation" to reduce pollution put forward new challenges for both shipping companies and port terminals. Main bunkering ports need to adapt quickly to offer low sulfur fueling oil (LSFO) to maintain the market. It is the same for carriers. During this adaption process, it is possible that carriers use slow steaming to reduce emission, therefore shipping volumes may be less concentrated. Besides, the shipping freight rate is heavily relied on oil prices, which is determined by many factors including the current unstable macroeconomic environment and the IMO2020 regulation.

### 3.4.2 Regional disparities: Asia's rising

In accordance with the world trade pattern, the regional distribution of international freight transportation is not evenly allocated. As shown in Figure 3.7, exports and imports volume both present an increasing trend in recent years, though world economy is struggling to recover after the financial crisis. On a regional scale, Asia contributes most to the world merchandise trade, following by Northern America and Europe. According to the statistics released by WTO (2018), in 2017 Asia achieved the highest growth rate for exports as 6.7% and imports as 9.6% after two years' slow expansion. Trade performance of North America also recovered with growth rate of 4.2% for

(Volume index, 2012Q1=100)



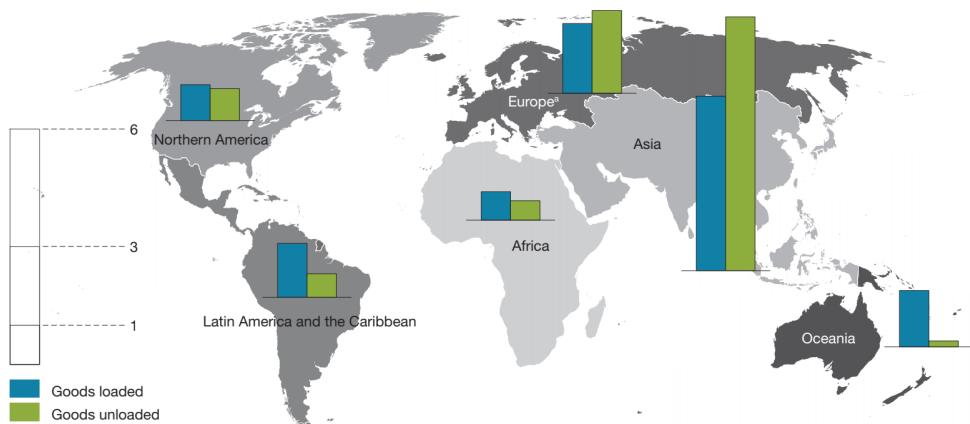
<sup>a</sup> Refers to South and Central America and the Caribbean.

<sup>b</sup> Other regions comprise Africa, Middle East and the Commonwealth of Independent States (CIS), including associate and former member states.

Figure 3.7: World merchandise exports and imports by region, 2012 Q1 to 2017 Q4  
Source: World Trade Statistical Review 2018 (WTO), Chart 3.3

exports and 4.0% for imports. European economies grow at a moderate speed with growth of 3.5% and 2.5% respectively for exports and imports. Germany is the third largest contributor of world merchandise trade, one of China's export destinations and U.S.A's import origins.

The growing trend and regional unbalanced contribution to global freight volume can also be recognized in the pattern of international maritime shipping volume. Derived by the surge of international trade in 2017, maritime shipping volume grew at the fastest rate in five years (UNCTAD 2019a); accounts for around 80% in volume and more than 70% in value of global merchandise trade (OECD/ITF 2017). Figure 3.8



<sup>a</sup> Incl. the Russian Federation and the French overseas departments.

Figure 3.8: Goods loaded and unloaded in billions of tonnage

Source: UNCTAD (2018)), Map 5.1

presents the regional distribution of goods loaded and unloaded in seaports. Asian imported goods account for 41% of world maritime trade and the share of exported goods is 61% in 2017 (UNCTAD 2019a). Manufactured goods are exported most, while fuels exports raised 31% which is more than twice the growth rate of other shipped goods (UNCTAD 2018).

The rapid growth of Asia is mainly attributed to the fast development of Eastern Asia, as shown in Figure 3.9. In general, the total GDP of Asia is near to the level of transition economies. Eastern Asia records most of the growth because of China. Southern Asia, western Asia, and south-eastern Asia are at the similar level; while Central Asia are left far behind. Regional inequity is also true at global and even national level. For instance, the world has witnessed China's rapid GDP growth since it conducted economic reform and joined the WTO. While, regional disparities quickly becomes an issue. China's coastal areas concentrate the majority of manufacturing industries, while central and western regions are relatively lagging and underdeveloped.

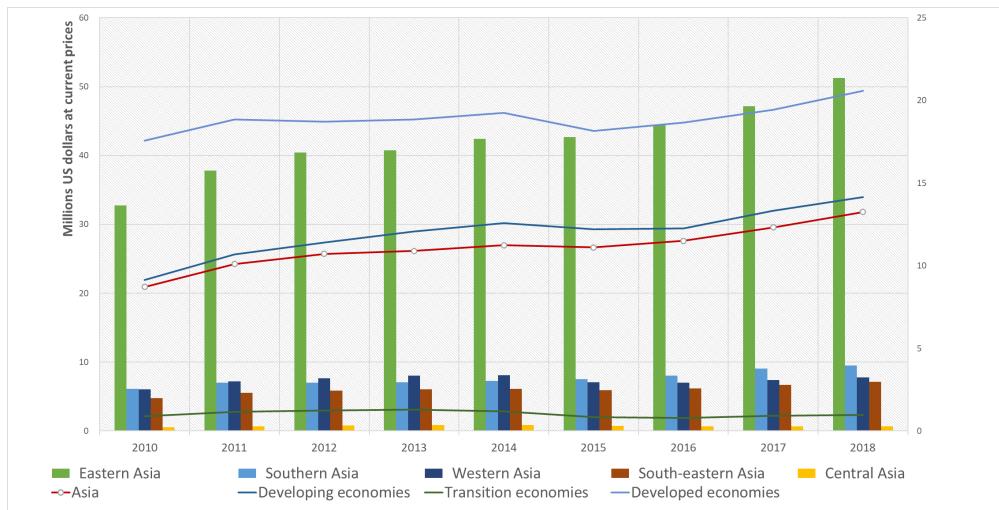


Figure 3.9: GDP of Asian regions  
Source: based on data from UNCTAD



Figure 3.10: Main world import flows, 2017  
Source: UNCTAD (2018), Map 1.2

The other prominent trend is the trade dependence between intra-regional economies. Trade relations can reflect the allocation of manufacturers and customers. Figure 3.10 shows the main trade directions between economies, showing that China and U.S.A. are the largest trade partners in 2017. Intra-regional trade accounts for a large share in the world economy. Trade volume within Asia between mainland China and its neighboring countries/regions such as Hong Kong Special Administrative Regions (SAR), Japan, Taiwan province, Korea is almost the equivalent amount of that within Northern American between U.S.A and Mexico as well as Canada (UNCTAD 2018). Besides, statics in 2017 also shows among the total European exports, 68% of them were undertaken within the same region, this is the highest proportion compared to other regions. In addition, the trade of intermediate goods remains dominant in Asian intra-regional trade, implying a high level of regional integration in production.

### 3.4.3 Value chain restructure and relocation

Global value chains (GVCs) represent the geography of value-added activities spread across multiple countries. The rise of GVCs, which accounts for over two-thirds of world trade (WTO 2019), has substantially changed the nature of the world economy. In the dynamic world, the structure of GVCs are changing over time along with firms' relocation behaviors, closely related to the structure of GLN. Over the last several decades, the formulation and expansion of GVCs as one aspect of globalization have led economies more connected and interdependent with each other. The commonly perceived idea is GVCs expanded during the 1990s and early 2000s, pushing forward world trade and investment, diversification, knowledge diffusion and jobs creation. Some authors also observed this value chains expansion process decelerated in the 2000s (Constantinescu et al. 2015). This argument was concluded considering the recent slowdown of world trade and growth. Some researchers believe after the second wave of globalization and rapid expansion of GVCs, it has entered a relatively "mature" and steady stage. They suggest that the expansion process slowed down, incentives provided by the innovations in technology and trade liberalization over the last decade have been reaped already (Kauppinen et al. 2017). Recent research conducted by Gaulier et al. (2020) offered an opposite view. An important trend of GVCs expansion is the increasing transport volume of intermediate goods compared to raw materials or finished goods, a result of the fragmented production process. By taking the price effects into consideration, the authors found that the trade of intermediate goods in volume actually is growing at a subdued rate and showed no sign of reversal. WTO (2019) pointed out that the financial crisis affected the expansion speed of GVCs, and since then there is a quick recovery during 2010-2011, afterwards the growth has mostly slowed until the year of 2017. Still, countries participation in GVCs has not recovered to the pre-crisis levels.

One critical characteristics is the participation levels of countries in GVCs are uneven, as shown in Figure 3.11. Despite being called "global" value chains, the truth is value

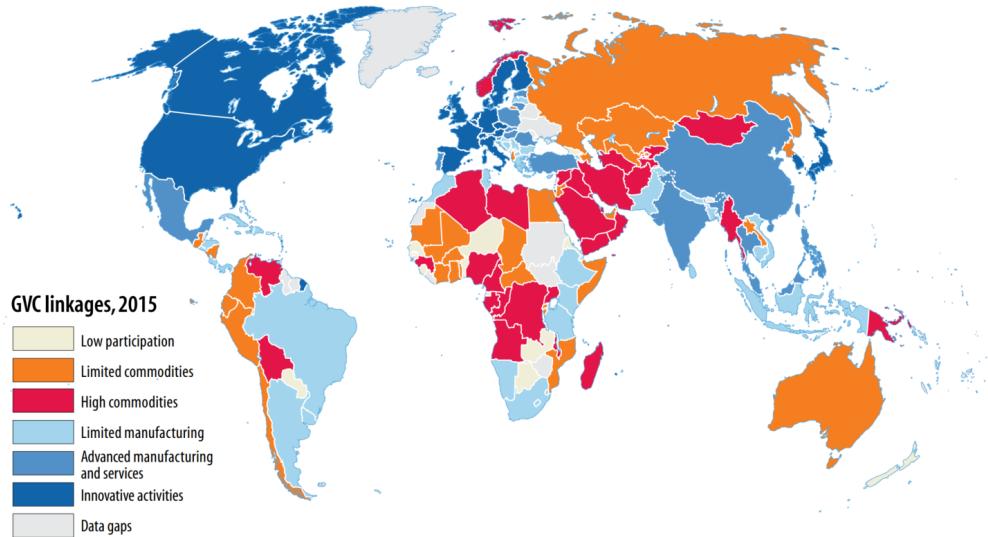


Figure 3.11: Countries' participation in GVCs

Source: World Bank Group (2019), Map 1.1

chains are both "global" and "regional". The former refers to the idea of "Factory World", based on the fact that sourcing of production inputs along the supply chains are global. This is especially true for electronic products and automobiles. The final products are assembled in factories near to markets, sourcing parts & components from multiple economies. The later refers to the fact that the world value-added activities are mainly clustered in three regions: North America, Western Europe and East Asia (Ioannis 2019; UNIDO 2017). The general pattern of GVCs represents hub-and-spoke structures in the three regions over the last several decades, and along with time the pattern has changed a little bit (Meng et al. 2019; WTO 2019). In 2000, U.S.A., Germany, and Japan were the hubs accounting for the largest supplier and customer of value-added trade. The statistics in 2017 show that China experienced dramatic growth and has substituted the first position of Japan as the main hub of Asia.

By comparison of intra-regional and inter-regional value-added trade, it is also found that the level of regional integration has altered as well. In 2000, Europe has the highest degree of economic integration, followed by North America and Asia. Nowadays, Europe remains the most integrated region, while Asia has surpassed North America, especially for production activities that requiring more than twice border-crossings (refers to complex GVC activities<sup>1</sup>). Whether GVCs are "global" or "regional", are closely linked to the relocation of factories, determined by the length of GVCs. On the one side, both Europe and North America experienced a decrease of intra-regional value-added activities and increase of inter-regional GVC activities (especially with

<sup>1</sup>Simple GVC activity refers to production with one border-crossing.

Asia). This offers an evidence showing the increasing "global" aspect of value chains. For instance, China is the global supply hub of ICT products. This is because China has received large scale of FDI from U.S.A.'s and Japan's ICT sectors due to relocation, confirmed by the fact that half of China's ICT exports were produced by foreign-owned enterprises (WTO 2019). On the other side, value-added trade became more concentrated among regional trading partners, and important direct linkages between regional hubs (such as Germany and U.S.A.) gradually disappeared (WTO 2019). As mentioned by (Ioannis 2019), this may because of the application of Just-In-Time practice, raising the needs to closely integrate many near-located suppliers to secure supply chains. The achievement of regional trade agreements in Asia promoted the GVCs integration as well.

In line with the trade pattern, inter-regional value-added trade in Asia shows an increasing trend. The scale of "Factory Asia" is expanding, as more lower middle-income countries were integrated into Asian production network (WTO 2019). Hence, regional economic integration in Asia is strengthening. The rise of China has dramatically changed the landscape of GVCs at both regional and global levels. On a regional scale, China took the place of Japan to be the main hub in Asia, built value-added linkages with almost all the Asian economies such as Japan, South Korea, China's Taipei, etc. On a global scale, China has become the main suppliers of many emerging economies such as Russia, Brazil, India, etc. (Meng et al. 2019). In recent years, as the development of technologies & skills, China is at the stage of industrial structure upgrade with increasing share of high-tech intermediate exports and imports. This to some extend decreased its level of GVCs participation, since the initial imported intermediaries are gradually being substituted by domestic production. Economic growth also lead to the increase of labor and production costs, hence some assembly factors especially the labor-intensive sectors may move away from China to less competitive economies. In the circumstances of regional economic integration, emerging economies with competitive advantages (such as lower labor and land costs) in Asia therefore are optimal alternatives. For instance, Samsung has gradually closed its three factories in China since 2018 and relocated its capacities to Vietnam and India. This is partly due to the fierce competition with China's domestic producers, partly due to cost saving motives.

At present, with respect to the rise of protectionism and the turbulent macro-economic environment, some countries especially U.S.A. are seeking ways to keep factories from relocating to foreign lands, and taking measures to recall foreign factories to move back. Also, the longer the length of GVCs is, the vulnerable the supply chain is (Ioannis 2019). Since the commerce of trade war, U.S.A. stopped many supplies to China's producers. A typical example is the sanction on Huawei, no more chips will be sold to China. Despite the harsh measures of the administration, it is still difficult to cut off all the economic connections between U.S.A. and China. In July 2018, Tesla Motors launched its plan to invest over \$1.4 billion to build its first foreign factory in Shanghai—Tesla Giga Shanghai. As a country with the most aggressive electric vehicle policy, China offered very preferred incentives. Besides, China is the largest

market in the world and occupies self-contained supply of parts & components. The new factory has been into practice since December 2019. As claimed by Tesla, it will reduce the price of its Model 3 by 20% in 2020 to promote buying. Considering the trade war initiated by U.S.A., relocating to China or other Asian economies may be one way to avoid high export taxes. It is hard to predict how the GVCs will evolve in the future, but it is very likely that Asian economies will enhance the economic integration as a solution. In such situation, firms' relocation behaviors are more likely to take place at a regional level.

### **3.4.4 "Port-focal" logistics: ports integration into GSCs**

A very important trend of GLN is the more and more intensified linkages between ports and global supply chains (GSCs). In the academia, most studies of GLN are commenced from the perspective of corporate strategy; and port studies are usually limited to the research domain of maritime logistics & business. Ports and maritime shipping aspects hence are largely being ignored in the research of GLN design/redesign or SCM issues. As pointed out by (Martín-Alcalde et al. 2016), adapting the firm research perspective to deal with logistics and SCM issues, it is a natural result that the traditional studies use optimization theories such as operational research as methods. Whereas, maritime shipping remains the predominant mode in the globalized era. Therefore, ports are crucial nodal points to pass through physical materials serving global production and distribution activities. The important role of ports in the global supply chains should not be underestimated.

The role of ports in the GLN has gradually evolved. Since the Age of Discovery, ports have become commercial and business centers, especially for the traditional maritime powers. In the modernized world, due to the leading role of maritime shipping in the world trade, seaports as the interface between land and sea thus are pivotal transportation nodes. As the development of global production systems, the role of ports gradually shift from pure transportation nodes to more and more integrated logistics platforms. Value-added activities are being integrated into port function and become one source of competitiveness. Globalization trend has altered the centre-stage position of ports to elements in value-driven logistics chain systems (Verhoeven 2010). As proposed by UNCTAD (1999), ports now evolved to be the "Fourth-generation ports", see Table 3.1. This theory clearly presents the evolution process of ports, and the integration of value-added activities into port function. As shown, third-generation ports become logistics platforms for trade since 1980; and the fourth-generation ports are integrated to a network through common port/terminal operators or common administration.

Moreover, Mangan et al. (2008) introduced the concept of "port-centric logistics", defined as the "provision of distribution and other value-adding logistics services at a port". The authors argued a port's transition from simple transshipment hub to

Table 3.1: Fourth generation of ports

Source: Verhoeven (2010), cited UNCTAD (1999)

A.First generation	Prior to 1950	Sea approach, transfer of goods, temporary storage, delivery
B.Second generation		Includes A plus industrial and commercial activities which have given added value to the goods. The port is a handling and services center
C.Third generation	Since 1980	Includes A plus B plus structuring the port community, plus strengthening links between town and port and between port users, plus extension of the range of services offered beyond the port boundary, plus an integrated system of data collection and processing. The port has become a logistics platform for trade
D.Fourth generation	Since 2000	Network of physically separated ports (terminals) linked through common operators or through a common administration

important logistics node was heavily relied on port users' supply chain strategies. The outcome of this work is the identification of some suggested roles of ports facing different supply demand characteristics (short or long lead time; predictable or unpredictable demand). The book of Adolf and Liu (2014) builds the similar idea as "port-focal" logistics but applying a contrary perspective. Instead of seeking strategies for ports, Adolf and Liu (2014) offered solutions for companies. The book presents the idea of "port-focal" logistics in contrast to "firm-focal" logistics. The "firm-focal" logistics refers to the conventional inbound-factory-outbound logistics chain; while the "port-focal" logistics integrates all modes of logistics and supply chains covering all kinds of transportation modes. Ports in this circumstances cover seaports, water ports, land logistics centers or dry ports, etc., are the core elements for designing production and distribution strategies. The significance of this theory is the authors put forward a new model for decision-makers when considering SCM issues, connecting the conventional management science aspects and the normally ignored ports' roles. The idea of "port-focal" logistics not only suggests the core role of ports in GLNs, but also offers the strategy for companies to configure industrial and logistics facilities in the ports. Port-focal industrialization of supply chains can be established to pursue companies' profitability.

These studies reveal the fact that ports are becoming an integral part of global supply chains, filling in the missing linkages between global maritime shipping network and GLNs. In fact, many policy-makers obviously know the benefits of integration very well. As mentioned in the work of Mangan et al. (2008), UK's administration promotes companies to locate DCs to sea ports. In emerging countries, building Free Trade Zones

(FTZs), industrial parks, export/import zones, ect. are commonly applied measures to promote both the growth of ports and the development of economies. Intensified connections between ports and industries can generate benefits for both local economy and companies. In such circumstances, port performance and efficiency are important determinant for firms' profitability through the effects on the whole supply chains. This on the one side suggests that competitive ports can be attractive locations for firms to configure their facilities; on the other side, explains that why ports are so important for regions/countries to build their industrial bases in hinterlands.

Under the framework of BRI, ports infrastructure construction are important projects to establish the MSR. In many developing countries, ports projects are combined with construction projects of FTZs, industrial parks, logistics parks, etc. as well as cooperation agreements related to trade and industrial development. Apart from sea ports, the construction of SREB offers opportunities to develop dry ports or land logistics centers. These critical nodal points, with preferable business environment and regulations, are potential candidates to absorb investments as the basis for further specialization and development.

### **3.5 Modeling the role of Transportation infrastructure**

Summary from above sections, the current spatial structure of the GLN are the consequence of long-term interaction between many elements. These elements are closely interrelated as well. Little change of one element may lead to changes of some other elements. These changes may lead to a sequence of alteration of other elements, just like "butterfly effects", therefore alter the pattern of GLN. The construction of a seaport, as an example, can lead to multiple effects to the structure of GLN in several directions. First of all, a new function-well seaport offer access to other seaports, may lower the cost to access other places. These benefits can encourage trade (import and export). Secondly, the new seaport can offer job opportunities and produce tax revenues for the local government. These can promote the economic growth. Thirdly, if the region/country where the seaport constructed occupies some comparative advantages (such as rich raw materials, lower cost labors, technologies, etc.), the access to the global maritime shipping network can create weights to these comparative advantages and attract investments. As described above, one important trend of the GLN is the increasing integration of ports into the global supply chains. Companies are preferable to configure their facilities to sites near to or even in ports. Industrial investments may help this place to specialize in some sections and participate in the global value chains. Fourthly, due to the pursuit of economies of scale and agglomeration effects, companies are likely to construct at the same place and these behaviors may create industry clusters, logistics clusters, etc.. Fifthly, the formulation of industry clusters will create more import and export volumes of this port, hence further prompt the regional economic growth rate. Of course there is a space limitation. The formulation of clusters

is gradually taking place around this seaport, while space and resources are limited. Therefore, if the demands keep increasing, there is inevitably congestion in this nodal point. Then the next developing direction may be different depends on the local governments. When the market demands surpass the service supply, local governments can help to invest and update the port, such as equipment or technology update, to improve the efficiency and capacity. Thus, it is observed that a self-reinforcing feedback loop exists in this process, stimulated by transportation infrastructure improvement and circulated back. If the local governments can not respond properly and timely, it is possible that the port lose its competition and attraction for further investments. This forms the balancing feedback loop, which indicates congestion has negative effects on further growth. The exist of the self-reinforcing and balancing feedback loops illustrate the dynamics in the entire system. In addition, due to spillover effects, the improvements of this single seaport may have positive or negative effects on economic growth of the adjacent areas. For example, the new port may intensify competition in this region, attract shipping lines from the existing ports around and alter the initial shipping routes. This is just a simplified example, and each stage of consequences need time to take place. Moreover, in each stage, there are many other reasons may lead the whole thing going to the different directions depends on individual cases. Construing a new seaport does not always promote trade and specialization. It may also create some other negative externalities, such as environmental issues, land use issues. This example is just to represent the dynamics generated from transportation infrastructure improvements in the evolution process of the GLN.

Transportation infrastructure improvement is the top priority in the framework of BRI, and it is implemented on a trans-continental long-term scale. From a historical view, there is no such large-scale infrastructure construction projects ever. It is not merely constructing a single seaport or a section of rail links, it covers numerous countries and regions. Therefore, many factors may interact dynamically at the same time at different locations. The geographical structure of the GLN may alter significantly. To have a better understanding about this evolution process, and identify BRI's impacts on the GLN, it is critical to investigate the relationships between transportation infrastructure and the GLN, as well as all the potential critical aspects. With the consideration of dynamics, this section applies system dynamics to model the role of transportation infrastructure in the GLN, to lay the theoretical ground for further analysis. Section 3.5.1 presents the modeling process. Section 3.5.2 analyzes the feedback loops in the system.

### **3.5.1 Modeling the role of transportation infrastructure in the GLN**

On the one side, the pattern of the GLN is determined by individual companies' facilities location decisions, representing the geography of production and distribution on a global scale. On the other side, transportation infrastructure investments are normally decided and conducted by governments. Though some researchers emphasized

the role of transportation infrastructure in logistics, trade and FDI, economic development, firm locations; few studies connect these two sides directly and pointed out the role of transportation infrastructure in interacting with the GLN. One reason is that transportation infrastructure is usually constructed as a single project, the economic benefits restricted to where it undertook and spillover to its adjacent areas. The magnitude and significance is limited to one country/region, and cannot spread to a global scale. While BRI is the largest transportation infrastructure construction policy ever, covering three continents and may continue to expand its geographical scope. Under this circumstances, investigating the role of transportation infrastructure can be the start point for analyzing BRI's impacts on the GLN.

The system dynamics model intends to capture the dynamics existing within the connections between transportation infrastructure and the GLN. It mainly illustrates the causal mechanism that explains how transportation infrastructure affects the geography of production and distribution through several directions. The model uses arrays to illustrate the direction from one element to the other, with the plus sign to indicate the positive effects and the minus sign to refer to the negative effects, is as shown in Figure 3.12.

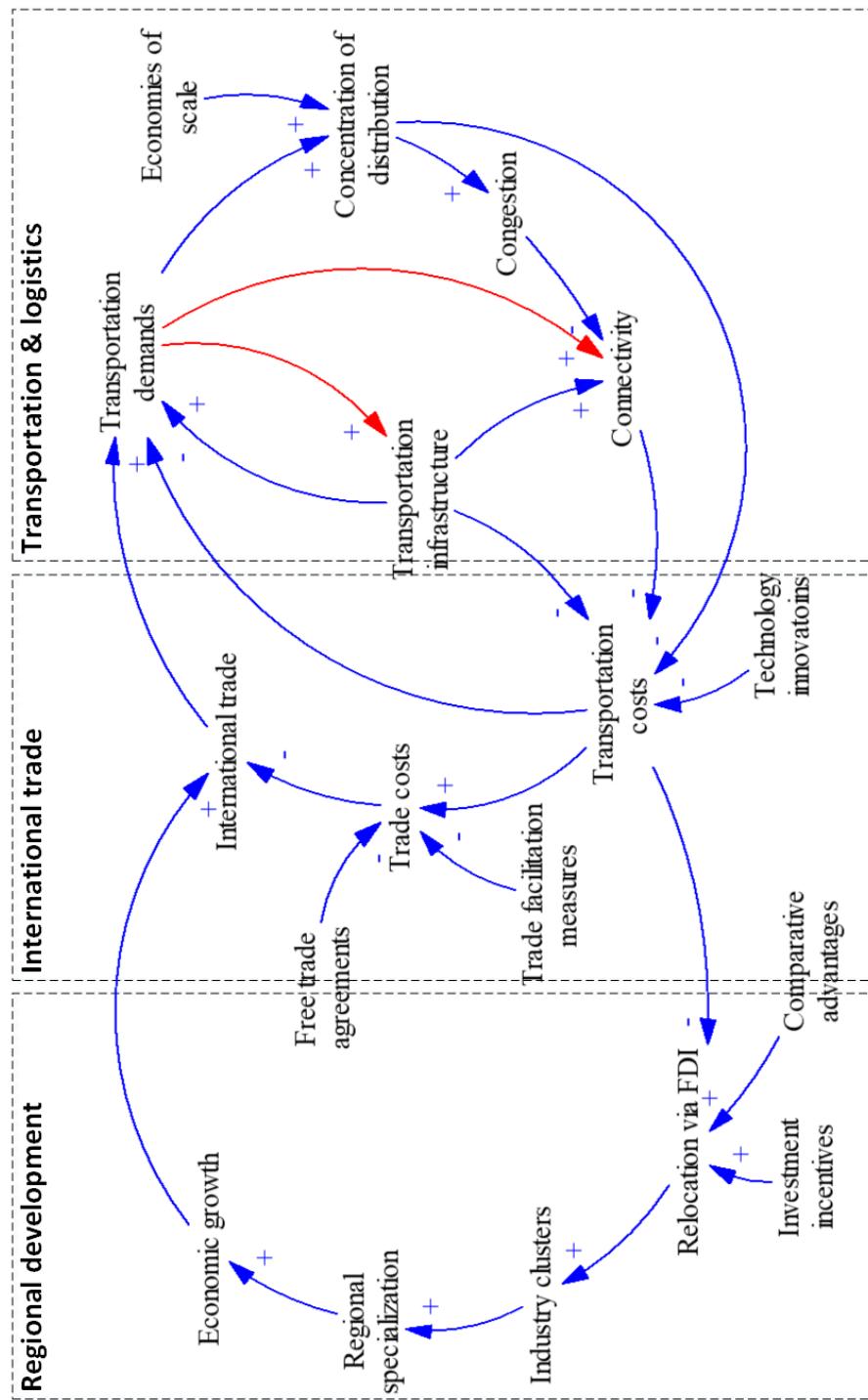


Figure 3.12: System dynamics modeling of the role of transportation infrastructure

In this model, there are several stakeholders interacting with each other that require careful interpretation: industries (ie. manufacturing companies), governments, and logistics service providers. Industries decide where to invest or re-/locate a new factory to expand their business to target markets. Their objective is according to their corporate strategies, usually is pursuing profit margins or expanding markets. Local governments determine whether infrastructure improvements are needed and also are responsible for setting policies like investment incentives, trade facilitation measures, etc.. Their aim is to better restructure social resources, attract investments and prompt regional development. Logistics service providers need to offer competitive transportation solutions to industries on the basis of transportation infrastructure and channels. It is obvious that these stakeholders need to cooperate with each other to achieve a better outcome.

From the standpoint of transportation infrastructure, improving it have positive effects on enhancing connectivity, transportation services; and can reduce transportation costs. In terms of its interaction with transportation demands, this model agrees with the argument that transportation demands are integrated demands instead of merely derived demands. The conventional wisdom believes that transportation demands are derived from production activities, to facilitate movements of raw materials, intermediaries, and finished commodities. While some researchers like Hesse and Rodrigue (2004) argue that transportation demands can also be induced by transportation infrastructure. Once there is newly established or updated infrastructure, there may be induced demands. The typical example is road construction in urban cities, widen a road does not always indicate less congestion, since more citizens may choose to drive on this road. It is the same for physical movements. A new port can induce the corresponding transportation demands. Also, it is worth noting that transportation infrastructure not always induce new demands. Over-construction also exists, this link only refers to that the relationship from transportation infrastructure to transportation demands is positive. A worth-noting relationship is the positive effect from transportation demands to transportation infrastructure, illustrated as the dotted line in the Figure 3.12. This dotted line emphasized the strategic importance of policy-makers, who should notice and make efforts on improving infrastructure when transportation demands surpass the capacity of the current.

Transportation services improvements have positive effects on inducing transportation demands as well, and will increase transportation costs in most cases. Transportation services improvements such as decreasing delivery time, usually requires higher costs. The higher level of transportation services corresponds to higher costs. This is in line with the practice. For example, air transportation offer the fastest delivery services with stability and security, and it is also the most expensive transportation mode compared to maritime shipping and railway transportation.

Connectivity, in this model, refers to the available accesses to other locations. Transportation infrastructure improvements can improve the connectivity. This is true especially for construction projects like highways, roads, pipelines. For railways, air,

maritime freight transportation, the connectivity also depends on whether service providers offer direct or indirect logistics services. Still, with no doubt that available transportation infrastructure generally improves the connectivity due to its network features. Connectivity improvements also have negative effects on increasing transportation costs, and have positive effects on inducing more transportation demands.

Transportation costs as the critical element link industries and logistics services providers, and are the main reason elaborate why companies re-/locate their facilities to new sites. Influenced by many factors such as connectivity, transportation infrastructure, transportation services level, and technology innovation factors, transportation costs are negatively related to companies' FDI location selection decisions. MNEs separate their production procedures into several stages, and allocate each stage at different locations to pursue the maximum benefits via comparative advantages. These advantages are usually relatively cheaper raw materials and labors. The most critical factor enables these behaviors is the relative lower transportation costs. Savings from comparative advantages can cover the costs generated by extra transportation of intermediaries and distribution of finished commodities to markets. While companies' sites relocation represents as the form of FDI, therefore further reduction in transportation costs in a specific location increases the FDI attractiveness of this site.

Transportation costs as a main component of trade costs, positively related to trade costs. Trade costs, especially in the international trade circumstances, are also affected by artificial trade barriers such as export/import taxes. Governments apply trade facilitation measures to reduce the barriers, and also sign free trade agreements with other economies to form beneficial trade relations. Obviously, reducing trade costs can largely improve trade performance.

MNEs' relocation site selections not only consider transportation costs, there are some other determinants. Two of the most significant factors are local investment incentives, and the comparative advantages. Companies relocate their production sites to pursue lower costs of production. Investment incentives and comparative advantages especially the production factor endowments can enable them to achieve the goal. Individual firm's relocation decisions on a larger scale cause the fragmentation of production, and the emergence of global production networks. For this specific site, economies of agglomeration may stimulate more firms to invest at this same place due to two main reasons. One possible reason is the reliance between upstream suppliers and manufacturers. Relocation of manufacturers may stimulate relevant upstream suppliers to form an industry cluster. The other reason is the competition between manufacturers in the same industry. Manufacturers tend to locate near to each other to take advantages such as supplier, labor, technology, customers, etc..

For this specific location, the formulation of industry clusters also enhances specialization, which further contributes to the regional development and economic growth. Trade performance improvements positively contribute to economic growth, but how large the contribution is depends on many other factors, such as the added value of

the exporting commodities, industrial structure, etc..

Economic growth indicates higher GDP, in many cases also refers to higher level of income, higher level of consumption. These are positively related to transportation demands and international trade. Higher consumption level implies more merchandise trade, more exports and imports. In the conventional trade predication models, GDP and growth rate are usually considered as determinants of trade volume or import/export volumes between country pairs. Therefore, it is observed that there is a circulation among transportation infrastructure, transportation costs, relocation via FDI, regional specialization, and economic growth. The next section will analyze the feedback loops in the system in details.

The negative externalities of transportation infrastructure indicates the growth limitation, and forms the balancing feedback loops in the system. The commonly mentioned negative effects include environmental issue, land use limitations, congestion, etc.. Congestion happen when the increasing transportation demands cannot be satisfied by the current transportation system. Logistics service providers have a tendency to concentrate distribution flows to pursue economies of scale, since the fixed costs of transportation constitute a large part. The more goods they delivery, the cheaper the unit transportation cost is. The phenomenon of concentration of distribution is typical in maritime shipping industry, which intensifies the competition between seaports. In such cases, some transit hubs reach very high throughput, while some ports experiencing decreasing operation volumes. For these important ports, concentration of distribution combined with increasing shipping demands lead to congestion. A wise local government should understand the situation and seek ways to expand its capacity or increases its efficiency. Thus, congestion requires for better transportation infrastructure, better connectivity, and higher level of transportation services.

### **3.5.2 Feedback loops analysis**

In the entire system, there are feedback loops—reinforcing loops and balancing loops—working together determining the dynamics. In the reinforcing loops, the alteration of any element will leads to the further alteration of this element at the same direction. For instance, in the feedback loop "transportation demands→concentration of distribution→transportation costs→transportation demands" in Figure 3.13(a), increment in transportation demands have positive effects on concentration of distribution to pursue economies of scale, and this will decrease the unit transportation cost. Reductions in transportation costs are positively related to further increment of transportation demands. On the reverse, a balancing loop indicates the alteration of any element within the loop will lead to the further alteration of this element at the opposite direction. Use the loop "Transportation demands→concentration of distribution→congestion→connectivity→transportation costs→transportation demands" as the example, shown in Figure 3.13(c). Increment in transportation demands will

lead to concentration of distribution, this has a positive effect on congestion. More congestion leads to less connectivity, and will increase transportation costs. Increment in transportation costs will lead to reductions in transportation demands. Therefore, a reinforcing loop is a positive feedback loop suggesting the system is enhancing at the same direction, while a balancing loop is a negative feedback loop indicating the system is in a relatively stable situation. Reinforcing and balancing loops exist at the same time and interact with each other, and there is no start and end in the loops. When reinforcing loops have stronger effects than balancing loops, the system represents a self-reinforcing status, showing a growing or recession tendency. In the opposite case, the system represents a relative stable status.

Based on the system dynamics model developed in the last section, this section analyzes the feedback loops that illustrate the dynamics to explain how transportation infrastructure affects the GLN via its impacts on international trade, economic growth, and the geography of production and distribution. To investigate the role of transportation infrastructure, this section compares the feedback loops without and with the condition that transportation demands can drive transportation infrastructure investments and connectivity improvements. The comparison is conducted considering transportation & logistics, international trade, and regional growth.

Figure 3.13 presents the feedback loops determining the dynamics of transportation & logistics. Under ideal conditions, transportation demands have positive effects on transportation infrastructure and connectivity (shown as arrows in red color in the Figure 3.13(b)). This indicates when transportation demands of a specific location (country/region) surpass its supplying of transportation services, local governments and service providers respond rapidly to this situation and adapt more efforts in improving transportation infrastructure and connectivity. While in the real world, this is not always true. Increasing transportation demands not always have positive effects on transportation infrastructure and connectivity. The different dynamics of these two cases to some extend can represent the role of transportation infrastructure in transportation & logistics.

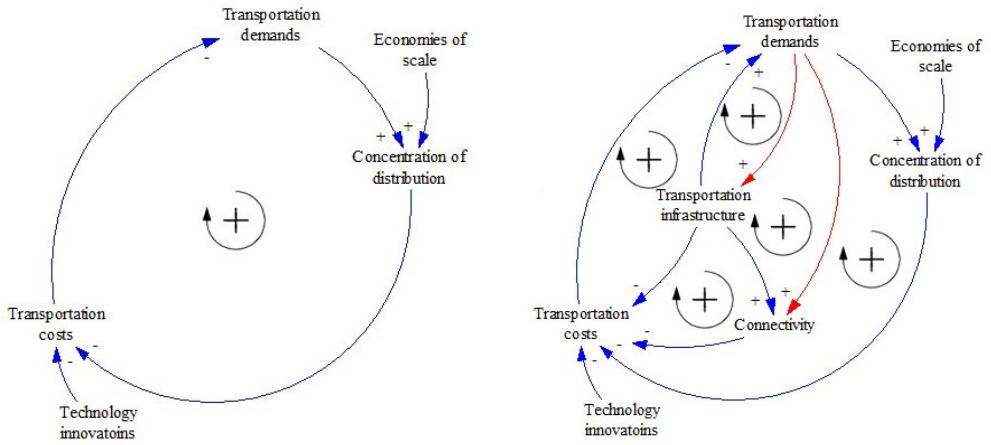
Figure 3.13(a) and Figure 3.13(c) illustrate the loops determining the dynamics of transportation & logistics when the role of transportation infrastructure is not considered. Figure 3.13(a) shows the reinforcing loop. More transportation demands will form the concentration trend of distribution flows due to economies of scale to lower the unit transportation costs, and reductions in transportation costs will induce more transportation demands. However, as presented in Figure 3.13(b), the concentration trend will lead to congestion at a bottleneck, and decrease the available connectivity services, which may increases the transportation costs, and at last leads to cut down in transportation demands. The dynamics of transportation demands are thus determined by both loops, and when the reinforcing loop is stronger than the balancing loop, it indicates the transportation demands are increasing, and transportation costs are decreasing. Otherwise it indicates congestion becomes the limiting factor of the increment of transportation demands.

Considering transportation infrastructure, in the loops it represents as the two arrows from transportation demands to transportation infrastructure and connectivity in Figure 3.13(b). Comparing to Figure 3.13(a), there are 4 extra loops that indicate the role of transportation infrastructure.

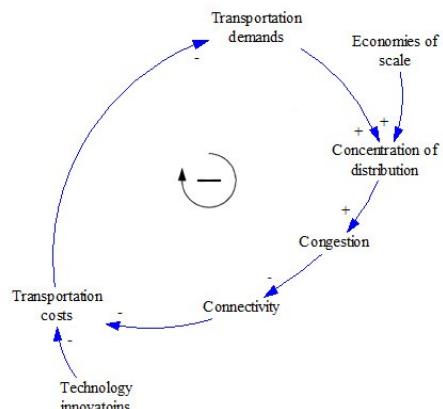
- "Transportation infrastructure → transportation demands → transportation infrastructure" forms a reinforcing loop, represents that improved transportation infrastructure induces more transportation demands, and more demands stimulate more supplying of transportation infrastructure.
- "Transportation infrastructure → transportation costs → transportation demands → transportation infrastructure" forms a reinforcing loop. It represents that transportation infrastructure improvements lead to reductions in transportation costs, and transportation costs reduction induce more transportation demands, which stimulate more supplying of transportation infrastructure.
- "transportation demands → connectivity → transportation costs → transportation demands" represents that increasing transportation demands induce more supply of connectivity services, and better connectivity causes price convergence and leads to reductions in transportation costs, which lead to more transportation demands.
- "transportation infrastructure → connectivity → transportation costs → transportation demands → transportation infrastructure". This loop indicates transportation infrastructure improvements are positively related to connectivity enhancements. Better connectivity indicates reductions in transportation costs, and may stimulate more transportation demands. Transportation demands lead to more supplying of transportation infrastructure.

Under the condition that transportation infrastructure and connectivity improvements are the solutions for satisfying increasing transportation demands, the system comprises 5 reinforcing loops and 1 balancing loop. It indicates the system have a stronger tendency to self-reinforce if the 5 reinforcing loops are able to counterbalance the congestion effects.

The role of transportation infrastructure in determining the dynamics of international trade represents in Figure 3.14. Including the consideration of transportation infrastructure, there are 4 reinforcing loops suggesting international trade volumes are highly relied on transportation costs, since it is a large component of trade costs. Reductions in transportation costs due to improvements in transportation infrastructure and connectivity as well as concentration of distribution can promote international trade and thus increase transportation demands, represents as Figure 3.14(a). The balancing loop in Figure 3.14(b) represents that congestion leads to increments in transportation costs and trade costs, negatively influences the volumes of international trade, which leads to decrements in transportation demands. Following this trend, the con-



((a)) 1 reinforcing loop without transportation infrastructure  
((b)) 5 reinforcing loops with transportation infrastructure



((c)) 1 balancing loop

Figure 3.13: Feedback loops determining the dynamics of transportation costs

gestion situation can be released, which makes this loop a balancing loop. In this system, trade performance is mainly determined by the dynamics of transportation costs. Of course, there are some other factors affecting trade costs, such as free trade agreements, trade facilitation measures, which is not fully investigated since they are irrelevant to transportation infrastructure.

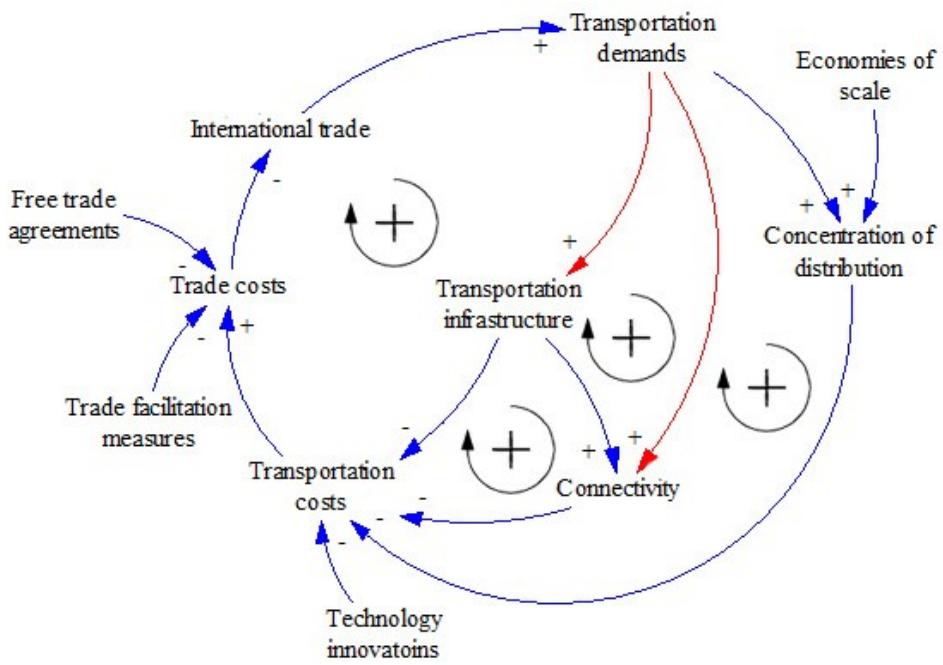
The role of transportation infrastructure in determining the dynamics in regional development represents in Figure 3.15. There are 4 reinforcing loops (see Figure 3.15(a)) suggesting that for a specific location(country/region), better transportation infrastructure and connectivity, comparative advantages, as well as preferable investment incentives all help to attract firms' relocation through FDI. There is also a tendency to form industry clusters due to agglomeration effects. In a long-term run, this can help this location to specialize in a section or industry, promotes regional economic growth, and thus induces more international trade and transportation demands. Figure 3.15(b) represents the balancing loop suggesting congestion have negative effects on the regional specialization and economic growth.

## 3.6 Summary of interim results

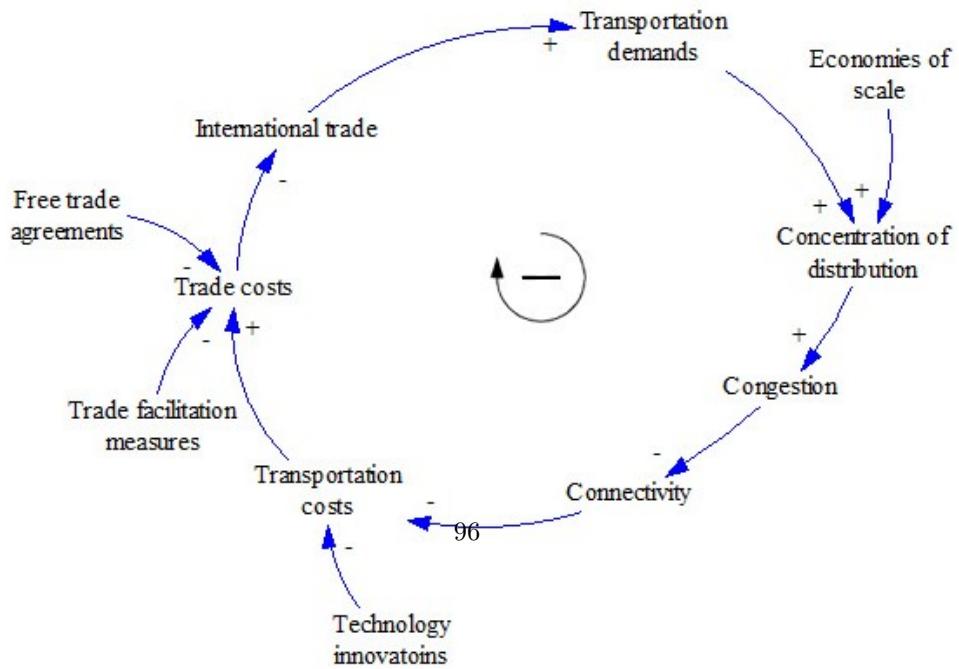
Location selection for MNEs' facilities is a multidisciplinary topic. Though most of the studies address these issues from enterprises' point-of-view, it is also necessary to consider external factors. This is especially important for companies with multinational orientation/engagement. Section 3.1 presents the decision process of MNEs, which forms the basis of investigating the impacts of BRI on the GLN through its impacts on external aspects such as region/country characteristics, access to transportation systems, etc..

The multi-layer framework of GLN in section 3.2 presents clearly the connections and distinguishes between transportation infrastructure network, global transportation service network, and global logistics network. The framework clarifies the ambiguous definition of the GLN, and unified the three identified understandings of GLN into one framework. The close interdependence between the three networks also lays the foundation for further analysis of BRI's impacts on the GLN through improving transportation infrastructure network and enhancing transportation services network.

Section 3.3 analyzes the critical aspects affecting the GLN. Critical aspects include geographical features, macroeconomic environment, economies of agglomeration, technology and innovations. These aspects can induce substantial changes to the pattern of the world economy, international trade, industrial development, logistics and production, etc. Geographical features are the basis of the current pattern of the GLN and also limit the future evolution direction of the GLN. Transportation infrastructure construction can to some extent diminish the disadvantages of geographical features

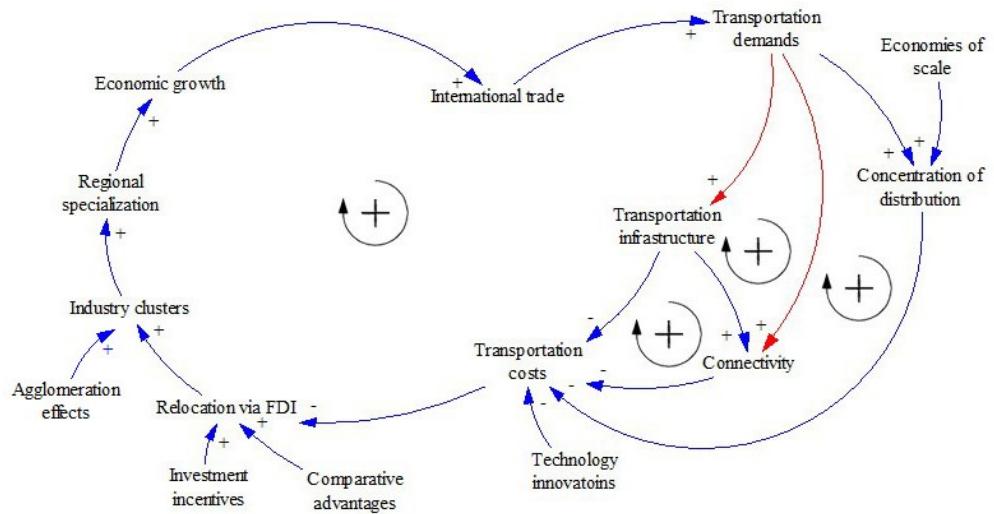


((a)) 4 reinforcing loops

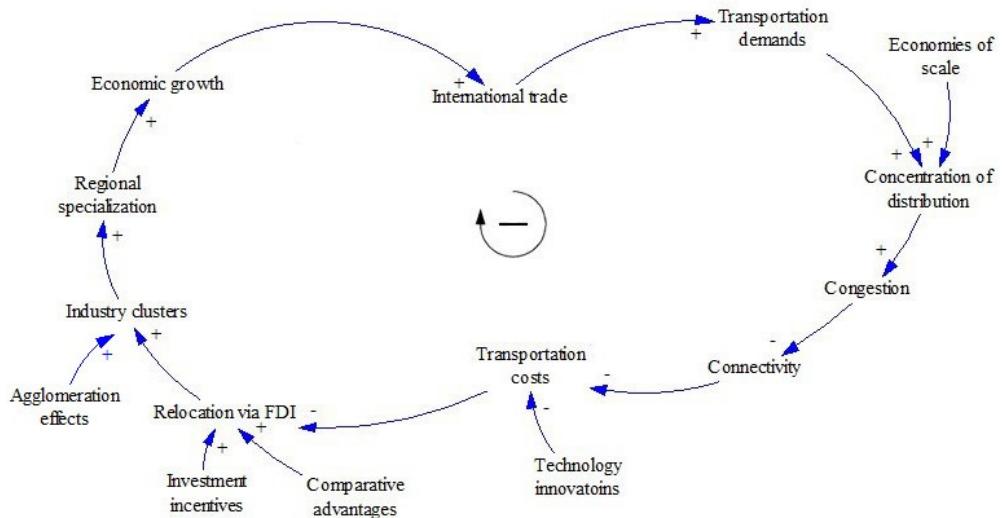


((b)) 1 balancing loop

Figure 3.14: Feedback loops determining the dynamics of international trade



((a)) 4 reinforcing loops



((b)) 1 balancing loop

Figure 3.15: Feedback loops determining the dynamics of regional development

like being landlocked, and help to realize the potentials such as the advantage of good geographic location. Macroeconomic environment is a critical aspect with many uncertainties affecting the GLN. Just at the eve of the second "cold war" between U.S.A and China, globalization trend may continue at a regional level instead of global. In other words, regional integration will affect the future pattern of the GLN in terms of cross-border trade and investment. Economies of agglomeration as a common acknowledged law explains why building logistics/industrial clusters are beneficial for individual companies. This is also the reason of industry transfer phenomenon, represented as the relocation behaviors of a bunch of enterprises that are either interdependent or competitive with each other. Technology and innovations are decisive factors. The innovation in containerized shipping has substantially changed the logistics industry and pushed the emergence of fragmented production systems. In the future, advanced technologies and innovations such as AI, 3D printer, 5G will definitely change the form of production and distribution.

At present, the GLN represents as a complex with several key trends summarized in section 3.4. First, maritime shipping can represent the vast majority of the GLN due to its leading position. Shipping market becomes more and more concentrated by establishing shipping alliances, applying mega vessels, acquiring port terminals, integrating land-side logistics services, etc.. Port function has been divided into hub and feeder position bringing intensified competition. The global shipping network has divided into several regional hub-and-spoke structures. The shipping network pattern of course is relied on the world trade pattern. On a global scale, regional disparities are increasing as long as the rapid rise of Asia especially the Eastern Asia. This pattern shift somehow is closely related to value chain restructure over the last several decades along with MNEs' relocation. To a large extent, economies' participation level in GVCs represents their position in the world economy. The world's three main factory regions: North America, Western Europe, and East Asia have become more interdependent due to the world-wide sourcing of production inputs on the one side. On the other side, value chains are enhancing its "regional" feature as well. Inter-regional value-added trade is increasing within Asia, along with the expansion of the scale of "Factory Asia". As the fastest growing region, facing the rising anti-globalization trend in the West, economic integration on a regional scale could be a solution for future development. In the logistics industry, "port-focal" logistics has substituted "firm-focal" logistics becoming the major trend emphasizing the role of transportation infrastructure especially ports in forming the GLN. The increasing integration level of ports into GSCs reveals its increasing significance for attracting MNEs' investments, as well as for local specialization and growth.

With a solid foundation, section 3.5 builds the model that illustrates the role of transportation infrastructure in driving the dynamics of the GLN reshaping. Interacted with many aspects including transportation & logistics, international trade, and regional development, improvements of transportation infrastructure can cause a sequence of changes within these aspects reshaping the structure of the GLN. More importantly, these three aspects are interdependent with each other as well. Little change of one

single element can lead to changes of a bunch of other interrelated elements. Hence, it is more suitable to adapt a system thinking view to model the dynamic process. The feedback loops analysis carefully explains the reinforcing and balancing feedback effects in the model, illustrating the possible effects of transportation infrastructure on the GLN. This provides theoretical basis for analyzing BRI's impacts on reshaping the GLN through transportation infrastructure projects in the next chapter.

## 4 BRI's impacts on the GLN

China proposed to build the "Belt" and "Road" in 2013, and then Chinese authorities released implementation plans, had meetings and negotiations with BRI countries. In the 'Vision and Actions' document, Chinese government stressed this initiative is inclusive and open, with no specific geography boundary is given, nor the involved country list. According to the official website BELT AND ROAD PORTAL<sup>1</sup>, until the end of January in 2020, there are 138 countries and 30 international organizations signed co-operation agreements with China under the frame of BRI. These numbers possibly will continue to grow in the future. [need update] Including China, these 85 BRI-involved countries can be categorized into five groups according to the classification of United Nations (UN) Regional Groups of Member States: Africa (8), Asia-Pacific (42), Eastern Europe (23), Latin America and Caribbean (7), Western Europe and others (5). As present in Figure 4.1, most of them are Eastern European and Asia-Pacific countries. It is estimated that the BRI covers around 2/3 of the world's population, and 1/2 of the world's GDP.

This trans-continental development policy improves physical connectivity, facilitates economic cooperation and regional development. China may have its own motivations, while BRI's practice is inevitably changing the pattern of the world economy as well as the structure of GLN. With physical connectivity between Asia, Africa, Europe as the top priority, transportation infrastructure projects are planned, in progress and completed under the frame of BRI. Though BRI involves all the transportation modes, due to its large scale and broad scope, this research focuses mainly on BRI's impacts on the GLN through its effects on transportation by sea, railway and road. After given a general analysis of BRI's impacts on the GLN in Section 4.1, MSR's overseas port infrastructure investments are investigated in Section 4.2, following by two case studies referring to the ports of Piraeus and Gwadar in Section 4.3 and 4.4 to present how ports infrastructure improvements combined with transport corridors can change the structure of maritime shipping network through port hierarchy alteration, hinterland connectivity improvement. The development of the port city itself such as trade and regional economic growth is also discussed. Section 4.5 introduces the construction of New Eurasia Land Bridge focusing on the operation of CR Express, to discuss the impacts of land connectivity on the GLN. A case study of Khorgos Dry Port city is conducted in Section 4.6 to discuss land dry port growth potential and how land connectivity improvements can be impetus for the regional economic growth.

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<sup>1</sup>[www.eng.yidaiyilu.gov.cn](http://www.eng.yidaiyilu.gov.cn), accessed on Feb.18th, 2020

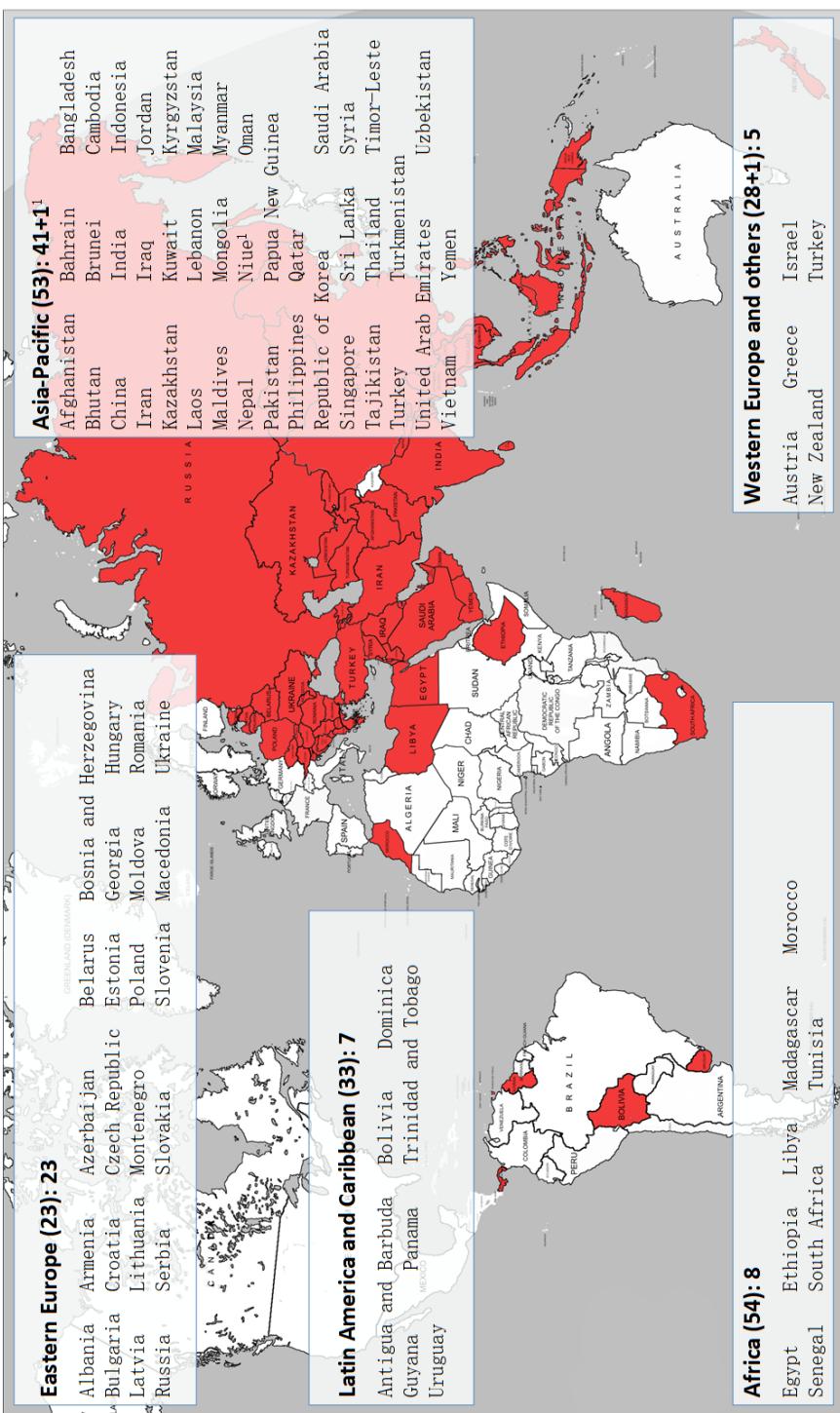


Figure 4.1: BRI countries

<sup>1</sup>Niue is not a member of UN. It is grouped into Asia-Pacific countries since it is located in the South Pacific Ocean.

## **4.1 Analysis of BRI's impacts on the GLN**

Normally, infrastructure investment plans are framed based on the prediction of the future transportation demands. If the current capacity of the infrastructure can accommodate the predicted demands, then there is no need for investment. On the reverse, if the predicted transportation demands surpass the maximum capacity of the transportation infrastructure, there is a demand for investments to either expand the capacity or establish new facilities. However, in terms of transportation infrastructure investments, the real world does not 100% coincident with the theory and planning. One common case in implementing investment plans is the lack of capitals for investments. In this situation, the increasing demands cannot be satisfied by the supplies of the current transportation infrastructure, while capitals are not available. Possibly there is a congestion that limits the smooth circulation of physical materials. This is the balancing feedback loop analyzed in the previous section. To conquer such issues, the most useful solution is to seek capitals to promote the level of transportation infrastructure. An unexpected situation is the real transportation demands are not coincident with the prediction results. Possible reasons are the misapplication of prediction methods. Some researchers applied regression models using history data and the average growth rate to predict future demands. Some researchers used origin-destination method to forecast the bilateral transportation demands.

While, in the author's opinion, all these predictions could fail to guide the future transportation infrastructure investment plans. The key problem is they assume transportation demands are derived demands from production and marketing activities. Indeed, the conventional wisdom deem transportation demands as merely derived demands. The only purpose is to satisfy the requirements of transporting raw materials and intermediaries from suppliers to manufacturers, then transporting finished commodities from manufacturers to consumers. But many evidences show that good transportation infrastructure itself could attract transportation demands. Improved transportation infrastructure and better access to other locations are strong driving forces to generate more transportation demands. An obvious example is the construction of roads in urban cities. To conquer the traffic jam issues, governments construct new roads or expand the capacity, while once the new infrastructure finished, larger scale of traffic jam emerged. Therefore the idea of dealing with traffic jam is to manage both the infrastructure supply side and the demand side. It is the same with freight transportation demands. New transportation infrastructure can either offer alternative accessibility or improve the current capacity. Based on this, logistics service providers can provide alternative services and improve service levels.

Manufacturers in such situations are driven to apply the improved services, and therefore traffic volumes increase accompanying with growing transactions. Besides, the level of transportation infrastructure is crucial location advantages for attracting FDI. New/improved infrastructure offers access to suppliers and markets, driving firms' relocation decisions. This is particularly true for countries/areas with comparative

advantages such as fundamental factor endowments and cheap labors. Firms' relocated facilities in this location will further generate more demands for transportation. Hence, transportation demands can also be induced, and the attracted demands should be taken into consideration when setting up the investment plan. The author agrees with the idea of Hesse and Rodrigue (2004) that transportation demands are both derived and induced, especially for the locations where poor infrastructure becomes the main obstacle for development.

Keep this notion in mind, and considering the dynamics described above, the author argues the role of transportation infrastructure should not be underestimated. In the context of the BRI, the large scale and wide scope of infrastructure investments will have significant impacts on the GLN both temporally and spatially. In a short term, better transportation infrastructure in the context of the BRI motivates logistics service providers to change their original transportation routes and modes, reshaping the transportation network. In a long term, transportation infrastructure promotion will motivate companies' relocation behaviors, which further ensure more transportation demands creating a reinforcing effect. In other words, the BRI's implementation will reshape the global production network as well, therefore changing the GLN substantially.

These impacts have several consequences on the topological structure of the GLN from spatial perspective. First, the relative importance of some logistics nodes in the GLN is changing, especially for the nodes burdening transshipment functions. In the global shipping network, BRI's investments in port infrastructure can largely improve the relative significance of some ports, and consequently, the competitiveness of the competitors is decreasing. This is especially the case in the context of the current shipping industry. Ports competition becomes more intensified because of the more concentrated shipping markets, the application of large shipping vessels and the formulation of shipping alliances. Shipping companies' change of one single port choice can cause a large scale of market share shifting due to the large vessels they are using. With respect to the BRI, new ports along the MSR are planned, in progress, constructed, and ports with strategic location are the main focus. The competitiveness of the original leading ports will be reduced if the competitors' infrastructure level is improved. The most direct and significant changes may happen in the transshipment ports: some current transshipment hubs will probably turn to be feeder ports or even worse, and some ports will emerge as new transshipment hubs. As its main feature, transshipment hubs heavily rely on transshipment services rather than export/import from domestic economies. Some transshipment hubs occupy a large market share mainly due to their outstanding geographic positions. For those ports, situations can rapidly alter once the competitors occupying the same geographical advantages but have better infrastructure. A possible example is port of Singapore situated at the Malacca Strait. China invested Melaka Gateway project in Malaysia situated at the Malacca Strait proximity to the port of Singapore. Probably it will function as a competitor to Singapore port. On the contrary, some ports occupy strategic important geographic position but with only a small market share due to poor infrastructure. Port infrastructure investments can

to the large extent help to realize its potential. The construction of the Piraeus port is a convincing case. The updated port infrastructure and the modernized equipment quickly drew a lot of shipping volumes. Piraeus port rapidly grew to be the leading port in the Mediterranean Sea. Besides, China's state-owned company COSCO Group is a main investor, and meanwhile it is one of the largest shipping service providers. Shipping companies in the current are more and more involved to be terminal operators, which makes them acquiring more bargaining power over port authorities. As a main investor, COSCO and its alliances may prefer to call at the terminals it invested through altering its shipping routes. These combined impacts will definitely change the port hierarchy and the structure of the global shipping network. In terms of inland logistics nodes, BRI's investments will definitely improve the significance of some dry ports. Investments in improving land connectivity focus on not only nodes such as railway stations, but also links such as railways, highways, pipelines requiring substantial capitals. Compared to maritime shipping, land transportation supporting the world trade only constitute a small portion. Literature shows that the main reason of this situation is because land transportation is more expansive and incapable to transport massive products for long distances. While the increasing number of the operated CHINA RAILWAY (CR) Express may offer an alternative option. Possibly it is because previously there is no available land transportation services connecting the world's largest trade partners. BRI's investments can fill up the gap, connecting Asia and Europe through the landlocked countries. Land logistics nodes in these economies can acquire access to the global transportation network, creating previously non-existing traffic volumes. Local governments should make full use of these nodes to develop local logistics industries, and possibly some inland nodes can develop to be logistics clusters.

Second, the relative significance of logistics routes are altering, mainly presented by the competition between different shipping routes, the competition between maritime shipping and railway transportation, as well as the sea-rail intermodal transportation alternatives. In the global shipping network, BRI's vision in improving maritime connectivity through investments in ports along the MSR established alternative shipping passages. The traditional shipping lane from China to Europe is from Chinese ports through the South China Sea via Malacca strait to Indian Ocean, heads to Northern European ports such as Rotterdam, Antwerp, Hamburg. BRI's investments in Piraeus port enable shipping companies to transship in the Mediterranean Sea, and shorten the nautical miles. In the summer time, shipping companies can also go through the Arctic Ocean to reduce the delivery time. Apparently, the emerging maritime shipping passages in the vision of the BRI will affect the relative competitiveness of the initial shipping passages as well as some ports. In the context of the BRI, competition between maritime shipping and railway transportation can also alter the structure of the GLN. Currently, in the general scale, land transportation can hardly compete with maritime shipping. Yet, some logistics nodes can be affected due to the operation of CR Express, especially the origin and destination nodes. For instance, the block train "Yu Xin Ou" starts from Chongqing (an inland city in western China) going through inland countries arrives at Duisburg, Hamburg, etc. The initial products conveyed are

electronic products, but soon automotive industries including Mercedes-Benz, Audi, Porsche started to use the vehicle transportation services. Obviously, in such cases railway transportation is more competitive than maritime shipping in the eyes of these customers. Ports that previously conducted these roll-on/roll-off services therefore experienced market share loss. In the future, maritime shipping will doubtless remain its predominant position. While, railway transportation have large potentials, especially for transporting time-sensitive commodities. Consequently, stations along the CR Express have the potential turning to be important inland logistics nodes, altering the geography of distribution. Another important changing trend is due to the alternative sea-rail intermodal transportation routes. For instance, the construction of the CPEC and Gwadar port in Pakistan can offer an alternative sea-rail transportation route to avoid Malacca Strait. This is possibly increasing the relative importance of Gwadar port, and reducing the strategic importance of Malacca Strait and the associated ports. The other example is the construction of China-Europe Land-Sea Express Line and Piraeus port. Apparently, the competition between transportation routes will also affect the relative importance of some logistics nodes, in line with the above discussion.

Third, except for the structure changes of logistics nodes and routes, in a long-term view BRI's implementation will shift the geography of production and distribution on a regional scale, resulting in substantial alteration of the GLN. This will reflect as some regional-scale industry transfers leading by industries that producing highly time-sensitive commodities such as electronic industries. As described in the last chapter, transportation infrastructure is an important determinant motivating companies' relocation behaviors. MNEs are motivated to relocate their facilities to pursue competitive advantages. Relatively lower-cost labors and resources are deemed as important source of competitive advantages. Countries/regions where occupying low-cost labors and resources can be the destinations of the next wave of industry transfers, only if the occurred costs of transporting physical materials for extra miles can be covered by the savings of the cheaper production costs. In some cases, these countries/regions may be even closer to the suppliers/markets but being prevented to attract FDI due to poor infrastructure and access. Besides, good infrastructure and connectivity themselves can be part of the competitive advantages. Through promoting the development of logistics industries, good infrastructure can lead to the reductions of transportation costs and therefore the reductions of total costs. In the Eurasian continent, many countries especially those in Central Europe and Southeast Asia possess such competitive advantages. BRI's implementation in transportation infrastructure projects can help to improve both domestic connectivity and the access to global transportation systems. These will help to realize the potential of competitive advantages to attract foreign investments. While the logic of configuring a new facility should consist with the trend from "firm-focal" logistics to "port-focal" logistics. This suggests areas proximity to critical logistics nodes are the preferred options for MNEs, especially for their distribution centers (DCs). Hence, theoretically the relative competitive logistics nodes including ports and inland railway stations could be the destinations of FDI from MNEs, if these places also occupy comparative advantages. Among these nodes which

in close proximity to target markets and suppliers will be the most attractive candidate locations. The operation and good adaption of inland railway services also offer more flexible options for MNEs to relocate their facilities in inland countries/areas. Those situated along the busy transportation routes such as CR Express should seize the opportunities to conduct open policies to attract FDI. Landlocked countries and inland areas including China's western cities have the potential to evolve to be new growth engines. Additional, a single MNE's relocation behaviors can quickly evolve to a small-scale industry transfer. In the globalized world, the upstream and downstream of a supply chain are connected closely. Relocation of manufacturers can lead to the relocation of its suppliers, and in many situations also its competitors. Due to agglomeration economies, enterprises in the same industry tend to locate at the same place to take advantage of common suppliers, labors and markets, also in favor of technology and knowledge exchange. Hence, relocation of a single MNE can possibly lead to a wave of industry transfer. This will further form industry clusters and help the local economy to accelerate the pace of specialization. In the context of the BRI, this is very likely to happen. Except for the large scale, the other important reason is BRI's transportation infrastructure projects usually are combined with cooperation projects in constructing industry parks, logistics parks, special economic zones, etc. This form of cooperation can offer the associated open policies, supportive services, tax-free incentives, etc.

In the current era, there are many uncertainties about the future macroeconomic prospect. Despite the anti-globalization tendency, represented by trade war between USA and China, and the "Brexit" in EU, BRI's implementation reinforces the tendency of economic integration on a regional scale. Globalization trend will continue at least at a regional level. With respect to the enormous infrastructure investments along the BRI countries, the coastal countries/areas will continue take the advantages of ocean access, but the position of some certain ports may alter. The disadvantages of inland countries/areas may eliminate a bit due to the physical connectivity improvement by railway and highway construction. These inland economies located along the SREB may experience trade and FDI promotion, if these economies acquire comparative advantages and the local governments can offer supportive policies and measures. Possibly in these places, a sustainable development pattern can be build if sector specialization takes place to form industrial complex. The following sections discusses BRI's effects on sea and land connectivity, and conducts case studies to validate the arguments.

## 4.2 MSR's overseas port investments

Improving maritime shipping connectivity is important content in realizing BRI's purpose of improving physical connectivity. The idea of jointly building the "Road", which refers to the "21st-Century Maritime Silk Road (MSR)", reveals China's aim of

promoting maritime shipping connectivity through infrastructure construction and regional cooperation. As described above, China's vision for building the MSR has been extended to the blueprint of the three "blue economic passages" and even expands to the Latin America. It seems that the scope of the MSR will not be extended further in the following years , since this current vision almost covers all the possible shipping routes heading from China's coastal line.

Port infrastructure along these shipping routes becomes the undisputed strategic focus. As framed in the implementation plan 'Building the Belt and Road: Concept, Practice and China's Contribution' (2017), 'multiple ports' is one of the top strategic priorities. It refers to a number of cooperative ports that guarantee the security and smooth of maritime transportation. Through the establishment and modernization of a number of important ports along the passages, China intends to improve the shipping connectivity between Asia, Africa, Europe, and also Latin America. Under the framework of the BRI, China encourages companies to invest overseas port construction projects along the maritime economic passages. Meanwhile, Chinese local authorities of coastal provinces, territories and cities are also enhancing the competitiveness of ports, as well as regional ports cooperation. Though this implementation plan was released in 2017, the importance of overseas port infrastructure was emphasized much earlier in the context of BRI. Currently there is no specific list from Chinese authorities telling people which port was or will be invested labeling the BRI or MSR, and only fragmented news and information can be found. Still, through investigating China's overall oversea port investments before and especially after 2013 from articles as well as online gathered information, and focusing on the ports along the planned shipping routes can also conclude the results in a practical way.

### **Port investment projects**

From the news and the collected information, many ports along the MSR has received considerable investments from China. In fact, China gets involved in overseas port investments since 1978 (Chen et al. 2019) far before the year of BRI's release. To the author's knowledge, there are four relevant studies paid attention to BRI's overseas port infrastructure investments, referring to Chen and Yang (2018); Chen et al. (2019); Gradview Institution (2019); Wang et al. (2019); Yang et al. (2019). However, these valuable articles do not present a consistent outcome regarding the information of the invested overseas ports in years. This may because China's overseas port investments news is too mass, fragmented, and also continuously updating. The conclusions, on the contrary, all confirm the promoting effect of the BRI on overseas port investments. Actually, even before the implementation of BRI, Chinese enterprises have already involved in terminal investments. The general spatial allocation of China's investment for overseas ports is shown as Figure 4.2.

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<sup>1</sup>Kaohsiung port is considered as an oversea port investment project in the paper since it is not located in Mainland China.

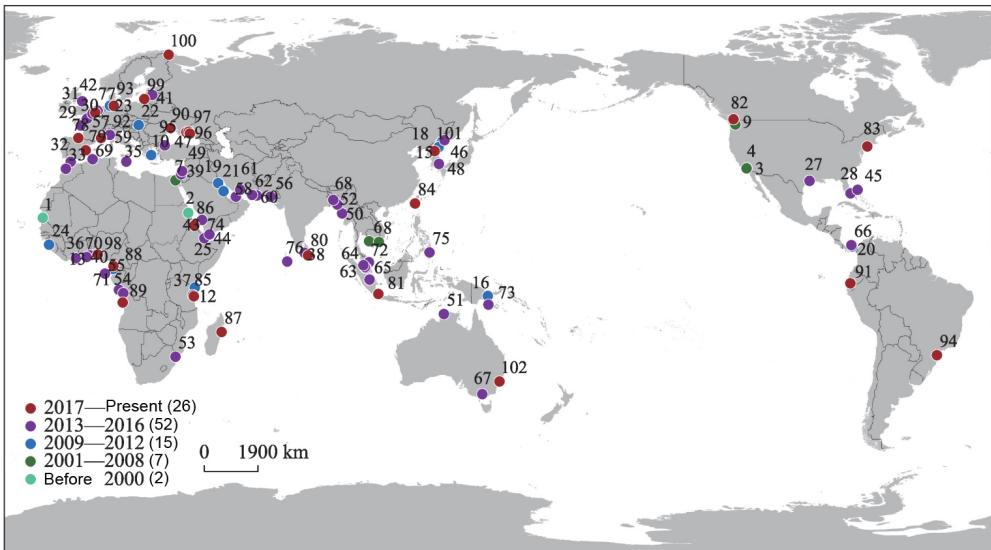


Figure 4.2: Spatial pattern of China's investments for overseas ports

Source: translated from Chen et al. (2019)

- 1.Nouakchott; 2.Sudan; 3.Long Beach; 4.Los Angeles; 5.Antwerp; 6.Shinoukville; 7.Said; 8. Vung Tau; 9.Seattle; 10.Piraeus; 11.Bata; 12. Mombasa; 13.Tin Can; 14.Rajin; 15.Sonbong; 16.Chongjin; 18.Tanchon; 19.Shuaiba; 20.Balbao; 21.Dammam; 22. Csepel; 23.Bremen; 24. Conakry; 25.Djibouti; 26.Kuantan; 27.Houston; 28.Miami; 29.Montoir; 30.Le Havre; 31.Dunkirk; 32.Tanger; 33.Casablanca; 34.Fos; 35.Marsaxlokk; 36.Abidjan; 37.Bagamoyo; 38.Colombo; 39.Ashdod; 40.Lome; 41.Riga; 42.Newcastle; 43.Doraleh; 44.Aden; 45.North Abaca; 46.Zarubino; 47.Kumpot; 48.Busan; 49.Haifa; 50.Kyaupkyu; 51.Darwin; 52.Chittagong; 53.Maputo; 54.Matadi; 55.Sao Tome; 56.Qasim; 57.Rotterdam; 58.Khalifa; 59.Vado Ligure; 60.Gwadar; 61.Qeshm; 62.Chahbahar; 63.Jambi; 64.Melaka Gateway; 65.Singapore; 66.Margarita Island; 67.Melbourne; 68.Dhaka; 69.Cherchell; 70.Tema; 71.Pointe Noire; 72.Kelang; 73.Moresby; 74.Jizan; 75.Davao; 76. Maldives; 77.Zeebruge; 78.Bilbao; 79.Valencia; 80.Hambamtota; 81.Tanjong Priok; 82.Vancouver; 83.New York; 84.Kaohsiung<sup>1</sup>; 85.Dar es Salaam; 86.Massawa; 87.Tamatave; 88.Kribi; 89.Luandar; 90.Yuzhny; 91.Dosorja; 92.Marseille; 93.Hamburg; 94.Paranagua; 95.Taman; 96.Temryuk; 97.Novorossiysk; 98.Lekki; 99.Klaipeda; 100.Kirkenes; 101.Wosan; 102.Sydney

Table 4.1: China's oversea port projects  
 Source: collected from various resources

<b>Country</b>	<b>Port</b>	<b>Company</b>	<b>Shareholding/contract</b>	<b>Year</b>
Netherlands	Rotterdam	COSCO	47.50%	2016
Belgium	Antwerp	COSCO	20%	201?
		China Merchants Ports	5%	201?
	Zeebrugge	COSCO	85%	2017
		Shanghai Port	25%	2014
France	Dunkirk	China Merchants Port	45%	2013
	Le Harve	China Merchants Port	25%	2013
	Montoir	China Merchants Port	25%	2013
	Marseille	China Merchants Port	25%	2013
	Nantes	China Merchants Port	25%	2013
Spain	Valencia	COSCO	51%	2017
	Bilbao	COSCO	39.78%	2017
Italy	Puerto Valllo	COSCO	40%	2015
	Naples	COSCO	50%	
	Genoa			
	Vado Ligure	COSCO	40%	2016
		Qingdao Port	10%	2016
Malta	Marsaxlokk	China Merchants Port	25%	2013
Greece	Piraeus	COSCO	100%	2016
	Thessaloniki	China Merchants Port	10.80%	2018
Latvia	Riga	China Harbour Engineering	A coal terminal	2016
Turkey	Ambarli	China Merchants Port	26%	2017
		COSCO	26%	2017
		China Investment Corporation	13%	2017
	Kumport	CMHI COSCO	65%	2015
Morocco	Casablanca	China Merchants Port	49%	
	Tanger Med	China Merchants Port	20%	
Israel	Haifa	Shanghai Port	Franchise	2015
Sri Lanka	Colombo	CMHI	85%	2011
	Hambantota	CMHI	64.98%	2014
Djibouti	Djibouti	China Merchants Ports	23.50%	2013
Panama	Panama	Land Bridge Group	Franchise	2016
Pakistan	Gwadar	China Overseas Port Holdings	Franchise	2015
UAE	Caliph	COSCO	Joint operation	2016
	Abu Dhabi	COSCO	90%	
Singapore	Singapore	COSCO	49%	2016
Malaysia	Madeleine Island	Petro China Co Ltd.	50.90%	

Egypt	Said Damietta	COSCO ChEC	20%	
Australia	Darwin	China Lanqiao Group	Franchise	2015 2015

According to the statistics, China participated in two overseas port investments before 2000, seven from 2001 to 2008, 15 during the year of 2009 and 2012, and surged to 52 between 2013 and 2016, 26 from 2017 until present (Chen et al. 2019). In total, China has participated in 102 overseas port investment projects through diverse entry paths. This investment pattern shows the dramatic increasing trend of port investments after 2013. It is also observed that the invested ports are dispersed globally, but since 2013 they are more concentrated along the MSR in Europe, Central and Southeast Asia, especially the China-Indian Ocean-Africa-Mediterranean Sea passage. This proves that the proposal of the BRI in 2013 is indeed a critical driving force in shifting the pattern of China's overseas port investments. It is after the release of the BRI that this number surges, and the investment scale probably will continue to grow. Focusing on BRI's investments in ports, though risks and challenges exist due to the differences in cultural, region, politics, in recent years, China has engaged in a large amount of oversea ports. The port projects along the MSR presents in Table 4.1. These ports are along two south blue economic passages. The Arctic passage is a new planned route, along which enterprises are considering to construct the port of Klaipeda (Lithuania) and the port of Kirkenes (Norway) as regional nodes.

To get involved in foreign ports, Chinese enterprises have four entry patterns including: infrastructure construction projects, port operation right transfer, port equity acquisition, and terminal management operation (Chen et al. 2019). Port infrastructure construction projects under the framework of BRI normally apply the build-operate-transfer (BOT) mode, often seen in newly established ports. The construction projects normally include not only the infrastructure in the port area, but also the hinterland infrastructure construction such as the hinterland transportation infrastructure, economic cooperation park, logistics park, international economic and trade park, etc. For the ports where basic public infrastructure is insufficient, the projects also cover the construction of electricity and water supply infrastructure. Port operation right transfer is in the form of port franchise transfer, port and land lease. Equity acquisition is the major pattern in terms of overseas port investment through contracts and joint venture. Chinese overseas ports equity acquisition are mainly conducted by two state-owned enterprises (SOEs): China COSCO Shipping Corporation Limited, and China Merchants Group. The former has invested almost 30 ports in the world, eleven port terminals are along the MSR. Most of the port projects are in European countries, such as the port of Piraeus, the EUROMAX container terminal in Rotterdam. Except for these two SOEs, some local port groups have taken internationalization as their development strategy, such as Qingdao Port International group, Ningbo-Zhoushan Port group, Dalian Port group. In terms of terminal management operation, there are only few cases. Qingdao Port International group acquired the operation right of the crude oil terminal of Kyaukpyu port in Myanmar.

## **China's "Port-industry-city" mode**

Some port infrastructure projects under the framework of BRI adopt China's special "Port-industry-city" (PIC) mode on the build-own-transfer (BOT) basis. This kind of projects is most suitable to the developing countries, and combined with the construction of special economic zones (SEZs). As a developing country, China has fundamental experiences in turning its coastal cities to new growth engines by PIC mode. The basic idea of PIC mode is through the construction of port infrastructure to develop the city by investments attraction and industrial specialization. The first phase of PIC mode is to take advantages of good geographical conditions to construct a deep-water port, and establish an integrated transportation system based on the port to better connect to global suppliers and markets. Following this, the second phase of PIC mode is the development of industry clusters. With the construction of the associated special economic zone (SEZ), the local governments take measures to attract FDI to develop industries such as petrochemical, ship building, automotive manufacturing and form industrial park around the port. Based on the industrial specialization, the export-oriented production can guarantee the throughput of the port, meanwhile the labor-intensive, capital-intensive and knowledge-intensive industrial chains are developed with the port as the core. Gradually, it comes to the last phase which is the "City" development, including the other associated industries, such as real estate, food and culture industry, medical, finance, etc. Moreover, the fast growth of this single port city can largely stimulate the restructure of the production factors in the inland cities, to further expand the scale of industrial specialization and benefit from agglomeration economies. A core port city can help to develop its surrounding cities through spillover effects at the same time. Through the PIC mode, the port is largely integrated into the global supply chains, and the port city can be developed to be a new growth pole as well. The most representative successful examples are the Zhoushan port in Shanghai and Shekou port in Shenzhen. Due to the success of Shenzhen, PIC mode is also called "Shekou mode".

Along the MSR, many are developing economies and seeking for growth opportunities. Adopting the PIC mode, the invested port cities can instantly promote its connectivity to global markets; improve its living welfare through water, electricity and communication infrastructure. The construction of the hinterland transportation infrastructure and the industrial parks can offer jobs and help to accelerate the speed of industrial specialization to maintain a sustainable growth prospect. This development path is in line with the theory developed in the previous chapter. Hence, it is not only the port infrastructure matters. The following sections discuss two case studies: Piraeus port and Gwadar port. The former one experienced dramatic growth proved the role of infrastructure in reshaping the GLN, while the latter one adopting the PIC mode has not yet seen a growth sign. The two cases have their own particularities embedded in totally different business environment, it is also of value to investigate through which way to realize the potential of transportation infrastructure to the largest extent.

### **4.3 Case study: Piraeus port and Land-Sea Express Line**

Being targeted as a strategic node along the MSR, the port of Piraeus is the largest Greek port and a successful flagship project of the BRI. Statistics show the throughput of Piraeus port has increased from 880,000 TEUS in 2010 to 4.9 million TEUs in 2018<sup>1</sup>, rising to 32th from 93rd in 2010 in the world rankings<sup>2</sup>. Greek local economy also witnesses a recovery trend from the debt crisis after eight years of decline. These significant achievements, especially the rapid growth of Piraeus port, are undoubtedly driven by the large amounts of infrastructure investment from China within the frame of the BRI.

The strategic importance and the current success of Piraeus port make it too unique a case to ignore. Chinese authorities emphasized that the port of Piraeus is a critical node along the MSR, the intention is to develop it as the main transshipment hub to reach European markets. As a strategic node along the MSR, Piraeus port is located at the crossroads of Africa, Asia and Europe, occupying advantageous position and natural characteristics. However, around 2008 in the context of economic crisis Piraeus port did not seem like a promising project regarding its continuously loss. Greece was suffering from debt crisis therefore short of capitals to upgrade its port infrastructure. The government started to privatize parts of the state-owned assets and Piraeus port is one of them. On the other side, COSCO as an international logistics service provider was seeking opportunities to deploy terminals and ports world-wide to optimize the structure of their global shipping network. As a joint result, China's capitals started to enter into Piraeus port since 2008. Until Chinese President announced the vision of the BRI in 2013, Piraeus port as a strategic node was quickly being integrated into part of the BRI. After that, further infrastructure investment plan were approved in 2013, 2016 and 2019 respectively, and Piraeus port step by step evolved to be a leading port in the Mediterranean Sea. Lately on Nov.11, 2019, Chinese President Xi officially visited Piraeus port, and emphasized "we look forward to strengthen Piraeus's transshipment role and further boost the throughput capacity of the China-Europe Land-Sea Express Line"<sup>3</sup>. The potential of Piraeus port will be further realized under the more intensified infrastructure and economic cooperation between China and Greece. The success also reminds some other European countries. Italy for instance becomes the first as a member of G7 signed a Memorandum of Understanding about the BRI. In 2016, COSCO Group acquired 40% share of port of Vado Ligure, which is also located in the Mediterranean Sea. Besides, to enhance the connectivity to Central and Eastern European countries, Piraeus port is designed to connect to Budapest—"heart of the Europe" by land. Agreements have been achieved between China, Hungary, Serbia, Macedonia, and Greece to build the China-Europe Land-Sea Express Line. However,

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<sup>1</sup><http://www.chinadaily.com.cn/a/201904/17/WS5cb6c159a3104842260b6b75.html>, accessed on Nov.11, 2019

<sup>2</sup>Data source: Lloyd's List-One Hundred Ports 2019.

<sup>3</sup><https://www.reuters.com/article/us-greece-china/china-greece-agree-to-push-ahead-with-coscos-piraeus-port-investment-idUSKBN1XL1KC>, accessed on Nov.11, 2019

Belgrade—Budapest high-speed railway project as a critical component does not go through smoothly. After the official claim by leaders of the three involved countries in 2015, it is still optimistic to expect it to be completed before 2023. Yet, applying the existing backward railway line, goods from Chinese port transshipped via Piraeus port can arrive Budapest in around 26 days, saving 5—6 days compared to the traditional sea route. It can be predicted that as a new intermodal China-Europe transportation route, the efficiency will further be enhanced after the construction and modernization of the China-Europe Land-Sea Express Line. So it is the transshipment role of Piraeus port.

The project of Piraeus port is not only a concern for Greece and China, it also poses some threats to both the other ports in the Mediterranean Sea and even some traditional large ports in the Northern Europe. Shipping companies in this context are motivated to alter their shipping routes since through Piraeus port can help to save some nautical miles compared to the classic routes destined to Northern Europe. At the same time, the rising of Piraeus port could also be a development opportunities. One possible case is that ports cooperating with Piraeus or offering direct services can benefit from the rising traffic. Considering all the effects on port competitiveness, shipping routes, land and sea connectivity, intermodal possibilities, and so on, obviously the regional shipping network is reforming a new order. Combining the model developed in the previous chapter, it suggests that some companies are possibly motivated to relocate their facilities to near to Piraeus port and even form industry clusters in a long-term time horizon. A notable fact is Hewlett-Packard (HP) announced its decision to relocate a major part of its distribution center (DC) from Rotterdam to Piraeus (Van Der Putten and Meijnders 2015). Other companies including Huawei, ZTE, Sony, Samsung Electronics, Dell, Lenovo, and LG also expressed the same interest to use Piraeus port to reach Southeastern and Central European markets (Source: various online news). Most of these companies market for electronics, the value of which are time-sensitive. This leads to a higher requirements for quick and reliable logistics services. Companies' relocation behaviors are a positive feedback of the port project, and ensures more traffic volumes via Piraeus port. This is in line with the theory developed in the previous chapter. More interesting questions would be: except for relocation of DCs, whether infrastructure promotion of Piraeus port will further motivate relocation of manufacturing sites? And even create a trend of industry transfer on a regional scale? In this section, a detailed case study investigating the port of Piraeus and the China-Europe Land-Sea Express Line is conducted to analyze the importance of transportation infrastructure in reshaping the GLN.

### **4.3.1 Introduction of Piraeus port and Express Line**

#### **Piraeus port**

How China's capitals enter into Piraeus port is a long story, and there are two main reasons behind the current success. One major reason is the severe debt crisis challenges faced by Greek economy since 2009, which pushed the progress of its port privatization and port governance structure reforms. The other reason is the global market expansion demand of China's state-owned enterprise COSCO Group. The takeover of Pier II & III of Piraeus port happened in 2009 indicating it's not originally due to the BRI, though soon being labeled as one of the flagship projects. On the one hand, with the continuously worsening fiscal situation finally the sovereign debt crisis flared up, Greece's economy experienced several consecutive years of decline. To conquer the crisis, further port governance reforms as part of Greek structural economic reforms were put on the agenda. Before this, Greece has applied "port devolution" model in 1999 to reform its port system, converted port of Piraeus (PPA) and Thessaloniki (ThPA) to state-owned port corporations (Pallis and Vaggelas 2017). However the following years did not witness a success of this transformation. In the context of booming global maritime trade, Greek ports suffered from short of investments especially for transshipment installations and inland infrastructure. The debt crisis since 2009 motivates Greek governments to further reform its port system. As a measure, the authorities started to privatize part of the state-owned ports. On the other side, China's enterprise COSCO Group as an international logistics service provider was seeking opportunities to deploy their ports and terminals world-wide to optimize the structure of their global shipping network. In 2008, Greece launched the public tenders for Piraeus container terminal Pier II (operation) and Pier III (greenfield), as well as Thessaloniki container terminal (Pallis and Vaggelas 2017), with the intention to transfer the country to a focal point of global maritime transport. In fact, port of Piraeus and Thessaloniki were on the lists of Athens Stock Exchange since 2003 and 2001 respectively (Pallis and Vaggelas 2017). At that time, Piraeus port though occupying an advantageous position yet continuously loss did not seem like a promising project. COSCO's subsidiary—COSCO Pacific Ltd.(currently COSCO Ports)—with a total sum of 4.3 billion euros won the bid for 30-year concession of Pier II and planned Pier III. According to the agreement, COSCO needs to upgrade Pier II and construct Pier III, and the concession can be extended to 35 years if Pier III was completed on time before 2014 (Kampanis 2018). Then Piraeus Container Terminal SA (PCT) was formed in 2009 as an overseas subsidiary of COSCO Pacific to commences operation of Pier II. Greece state-owned entity Piraeus Port Authority (PPA) started the operation of Pier I since 2011. After that, the two operators PPA and PCT negotiated and revised the concession agreements twice respectively in 2012 and 2014. During this period, massive capitals were invested to upgrade Pier II and construct Pier III. A new deep-water dock was built and the state-of-the-art cranes were purchased so that the terminal could accommodate the largest container vessels



Figure 4.3: Current map of Piraeus port

Source: Piraeus Port Authority S.A.

(Meunier 2015). In 2013, a extra 230 million euros investment as part of the agreement of the concession was made to construct the west side of Pier III in 2015. The aim was to finish the construction of Pier III measuring 340,000 square meters with four deep-water berths exceeding 18.5 meters, expected to handle three million standard containers annually. Promotion in port infrastructure and equipment turned out to be a strong driving force for growth. According to the news, during the transition period between Oct.2009 to Jun.2010, the port was set to lose about ten thousand euros. The delivery trucks waited in line and stuck five miles away even causing complains from the local residents. This also reminds a disadvantage of Piraeus port for its limited availability of inland area, which indicates requirements for higher port efficiency to reduce congestion. After the formally took over, except for infrastructure promotion, COSCO also made efforts on marketing and management. Finished the construction of two piers, PCT nowadays occupies eight container berths with annual handling capacity of 6.3 million TEU (COSCO SHIPPING PORTS Limited 2018). Yet, this is not the whole story.

In 2016, COSCO Group's subsidiary COSCO Ports acquired 67% share of PPA transferred its role from a terminal operator to the main owner, regulator manager and operator of the port. COSCO Group as the only bidder at the final stage offered a total amount of 368.5 million euros (280.5 million for 51% at the first stage) with commitment of extra 350 million euros invested within one decade (Pallis and Vaggelas 2017). This agreement was signed between COSCO Group and Hellenic Republic Asset Development Fund (HRADF), a new Greek institution found in 2011 responsible for privatization programs. Until this stage, it is clear that the port of Piraeus

did not adapt the commonly used landlord model or private ports model. According to Pallis and Vaggelas (2017), Piraeus port applied "master concession" privatization since the state only occupies the land ownership, which is seldom adopted in Europe. According to the 2018 annual report of PPA, capitals were invested to build a new oil pier, expand the car terminal and passenger port, and so on. In 2018, Greece signed with China the Memorandum of Understanding on cooperation in jointly building the BRI.

Lately on Nov.11, 2019 in Athens, Chinese President Xi Jinping accompanied by Greek Prime Minister Kyriakos Mitsotakis, officially visited Piraeus port as a flagship project and also a very successful example of the BRI. During his visit, President Xi emphasized "we look forward to strengthen Piraeus's transshipment role and further boost the throughput capacity of the China-Europe Land-Sea Express Line"<sup>4</sup>. The new investment plan of 611.8 million euros from COSCO was also claimed to be approved by the Greek Committee of Planning and Development of Ports (ESAL), indicating further construction, modernization and upgrade of Piraeus port. According to the plan, COSCO Group will construct a new No.4 container terminal with three berths to increase the capacity with designed annually 3 million TEU. Two new cruise berths will be built as well, then Piraeus port can accommodate the largest cruise ship with a capacity of 4,000 passengers. The target of the investment plan is to expand the capacity of its container terminals to handle 10 million TEUs, and also make it an important cruise home port in Europe. The future vision of Piraeus port in the frame of BRI is the European leading container transshipment hub with 10 million TEUs, seal-and-intermodal transportation bridgehead, international logistics distribution center, Mediterranean or even European ship repair center, and the largest transshipment port for vehicles in the Mediterranean Sea.

### **China-Europe Land-Sea Express Line**

The China-Europe Land-Sea Express Line is a new transportation passage project initially announced in 2015, intending to further increase hinterland connectivity to enhance Piraeus port's position as a gateway. As shown in Figure 4.4, the "sea" part refers to the shipping route section from Chinese ports via Suez Canal to port of Piraeus. The "land" section is currently planned to connect Piraeus port as the south end, going through Skopje in Macedonia and Belgrade in Serbia, and destined at Budapest in Hungary as the north end (see Figure 4.5). From the view of physical connectivity, this project creates an alternative sea-rail intermodal transportation route for goods convey between China and Europe. Through this route, Chinese goods transshipped at Piraeus port can easily access countries in Central and Eastern Europe by land. After its completion, this link can also seamlessly access Germany's high-speed railway network reaching Western European markets. Compared to the

<sup>4</sup><https://www.reuters.com/article/us-greece-china/china-greece-agree-to-push-ahead-with-coscos-piraeus-port-investment-idUSKBN1XL1KC>, accessed on Nov.11, 2019

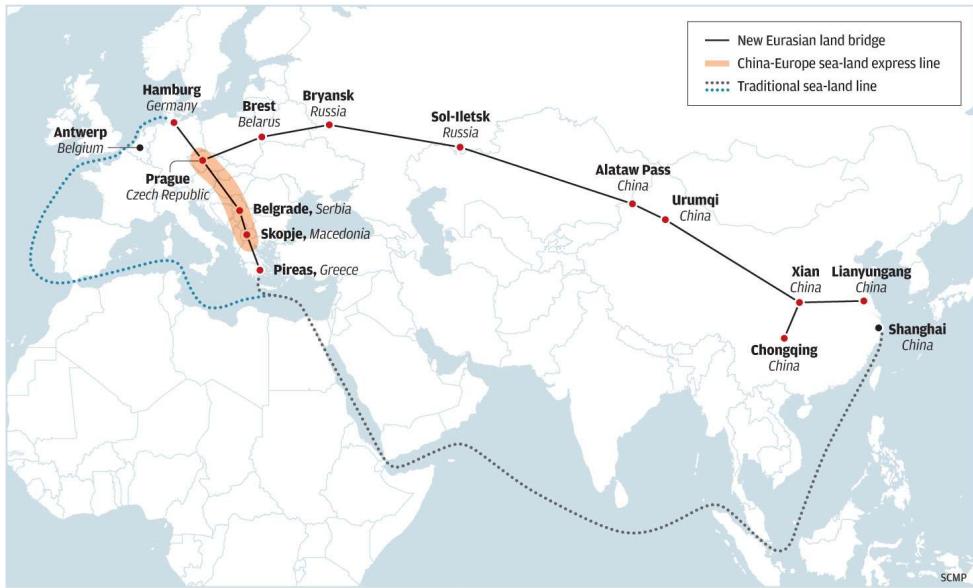


Figure 4.4: China-Europe Land-Sea Express Line vs. traditional sea routes  
 Source: South China Morning Post, Sept.23, 2016

traditional shipping routes via Rotterdam or Hamburg, the Express Line can decrease the delivery time for 7—10 days.

The prototype of the current Express Line traced back to the agreements between China, Serbia and Hungary on modernizing the Budapest—Belgrade railway. In November 2013, Chinese Premier Li Keqiang attended the annual meeting for China-CEE Cooperation. Premiers of the three countries jointly claimed the high-speed railway project through upgrading the Budapest—Belgrade section with a total length of 350 kilometers. The infrastructure promotion intends to reduce the delivery time from the original eight hours to less than three hours. It took eight hours by train due to the backward equipment and the aging railway line, blocking the mobility of passengers and cargo. To conquer the problem, the agreement includes the modernization of the existing line and the construction of a second line adopting European Railway Design Standardization, to form a double-line electrified high-speed railway for both passengers and freight. This is the first Chinese large-scale railway project in Europe in the context of BRI, and also the first multinational project under the framework of China-CEE 16+1 Cooperation<sup>1</sup>. A year later, Macedonia agreed to extend this section to connect to Piraeus port via its capital Skopje. Hence the concept of China-Europe Land-Sea Express Line is a updated version based on the Budapest—Belgrade railway

<sup>1</sup>On April 12, 2019 Greece claimed its entry in the Cooperation between China and Central and Eastern European Countries (China-CEE, or China-CEEC) transferred it to "17+1".



Figure 4.5: Map of China-Europe Land-Sea Express Line

Source: Xinhua, Dec.18, 2014

line.

However, there are many obstacles affecting the implementation of the construction, and the Hungarian section and Serbian section face different situations. The Budapest—Belgrade high-speed railway was formally claimed in November 2015 and with two years project cycle it was scheduled to complete in 2017. While in fact the smooth running of the project was delayed due to various political and economic interests concerns. Hungary is a member state of European Union (EU), therefore its involved infrastructure project attracted much attention from EU Commission. Though Serbia is not a member, the country has applied to join in 2009. EU Commission soon started the investigate of this large-scale railway project in regards to its tender procedure and financial viability, from both the Hungarian and Serbian sides. Compared to Serbia, projects in the Hungarian section become the main focus and face more complex situations, Serbian section's projects develop faster. The Serbian section is 184 km long comprising three segments. One of the segments Stara Pazova—Belgrade with a total length of 34.5 km started in November 2017. This segment is being reconstructed by China Communications Construction Company (CCCC) and China Railway International (CRI), founded by China Export-Import Bank. This segment is scheduled to The modernization of Novi Sad—Stara Pazova segment is undertaken by Russian RZD International<sup>1</sup>. The segment Subotica—Novi Sad with 108.2 km will also be financed by China Export-Import Bank, reconstructed by CCCC and CRI with a

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<sup>1</sup><https://www.railtech.com/infrastructure/2019/01/21/two-new-railway-deals-between-russia-and-serbia/>, accessed on Aug. 20, 2019.

duration of 33 months<sup>1</sup> The Hungarian section is 184 km long. To finance the project, a Chinese-Hungarian joint venture named Chinese-Hungarian Railway Nonprofit Ltd. (Kínai-Magyar Vasúti Nonprofit Zrt.) was set up. The consortium comprising China Railway International and China Communication Construction holds 85%, and Hungarian State Railways MÁV holds 15%. Chinese-Hungarian Railway Nonprofit Ltd. started to call for tenders on November 27 to modernize the 152 km section between Soroksár and the state border south of Kelebia. The left 15 km linking Soroksár and Ferencváros freight yard in Budapest is scheduled to release in 2019.

Despite the slow progress, Piraeus port connected to Trans-European Railway Network since 2013. The first container freight with Chinese goods from Ningbo port has transshipped at Piraeus to Budapest in the beginning of 2017, as a sign of the official opening of the China-Europe Land-Sea Express Line. Applying the "under construction" route it took 26 days. Actually, PCT as the main owner and operator of Piraeus port was also seeking ways to promote its hinterland connectivity. In the port area, there are four railway tracks constructed heading to nine countries in Central and Eastern Europe covering 1500 stations. Meanwhile, COSCO Group established OceanRail Logistics S.A. as an oversea subsidiary registered in Greece, to provide professional sea-rail intermodal and associated logistics services with Piraeus port as the hub. Lately in 2019, OceanRail Logistics purchased 60% share of Greek railway company PEARL S.A., 15% share in the Bilk container terminal near Budapest owned by Austrian Federal Railways subsidiary Rail Cargo Group. With the business expansion to Greek and Austrian rail freight market, efficient intermodal logistics services are available, and the transshipment role of Piraeus port will be further enhanced. Currently, the China-Europe Land-Sea Express Line is still in progress, it is optimistic to say it will complete before 2023.

#### **4.3.2 Success as a transshipment hub: port hierarchy**

The rapid growth of Piraeus port over the last decade is a good example to remind people the important role of transportation infrastructure. Investments in Piraeus port directly enhanced its competitiveness due to its improved capability to handle the largest container vessels, the increased port efficiency and capacity, as well as the good access to the hinterland transportation system. Figure 4.6 shows the container throughput growing trend of Pier II & III after PCT took over the operation since 2010. The latest statics from Lloyd's List "One Hundred Ports 2019" shows Piraeus port continued growth in 2018 with a strong pace, achieved a total amount of 4,908 million TEUs. Compared to the previous year, Piraeus port grew by 18.4%, and compared to the year of 2011 (1,68 million TEUs) the growth rate reached 173.9%. While compared to the pre-crisis year of 2007, the growth rate is 257.5% (Source: PortEconomics). The

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<sup>1</sup><https://www.railtech.com/infrastructure/2019/05/01/china-signs-two-railway-agreements-with-serbia/?gdpr=accept>, accessed on Aug. 20, 2019.

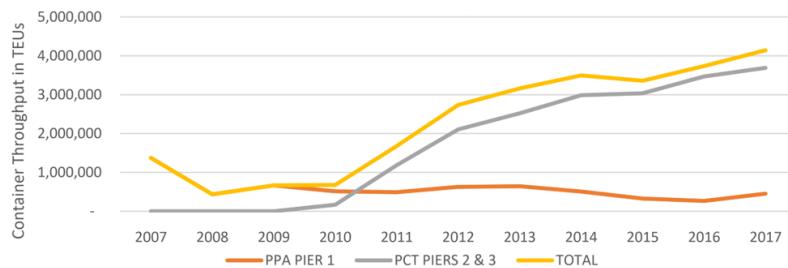


Figure 4.6: Piraeus port container throughput

Source: Plataniotis (2018)

result indicates Piraeus port not only completely recovered from the economic crisis, it has also gained large market share during this period.

Along with this significant growth the port hierarchy as well as the regional shipping network has completely changed. Over the last several years, Piraeus port has defeated the original transshipment ports in the Mediterranean Sea such as the port of Said and has surpassed the port of Algeciras in 2018 for the first time. The total throughput in 2018 is very close to that of Valencia port, the current largest in the Mediterranean Sea, which is 5.129 million TEUs. Piraeus port has become the second largest container port in the Mediterranean Sea and threatens the position of the Valencia port. As a competitor, Piraeus port and the other Mediterranean ports including the port of Said (Egypt), Gioia Tauro (Italy), Marsaxlokk (Malta), Algeciras (Spain), Tangier (Morocco) are all favored by their advantageous location. Ships only need a small route deviation to travel through the Suez-Gibraltar route. Undoubtedly, it is the advanced infrastructure and improved efficiency helped to release its potential. The competition relations somehow are slightly different among these ports. Due to geographic proximity (see Figure 4.7), port of Piraeus is a direct competitor to ports in the eastern Mediterranean along the Asia-Mediterranean shipping route. Figure 4.8 shows the annual change of container throughput of the top ten Mediterranean ports in 2018. In the context of the growing market, the average growth rate of the Mediterranean ports recorded 7.1%. As shown Piraeus port recorded the fastest growth rate among the top ten Mediterranean ports. Port of Valencia grew by 7.3%, maintained the average growth rate. While port of Gioia Tauro lost its competitive position with 4.9% decrease rate compared to 2017 and decreased by 33.2% (Source: PortEconomics) compared to 2007, indicating that Piraeus port may absorbed some of its transshipment volumes. Though there is no specific data yet, following this trend the port of Piraeus will possibly become the largest transshipment hub in the Mediterranean Sea in the following years.

In terms of the ports in the western Mediterranean especially the ones along the Strait of Gibraltar, such as the port of Algeciras and Tanger Med, the competition is mainly related to the selection between Asia-North Europe and Asia-Mediterranean shipping

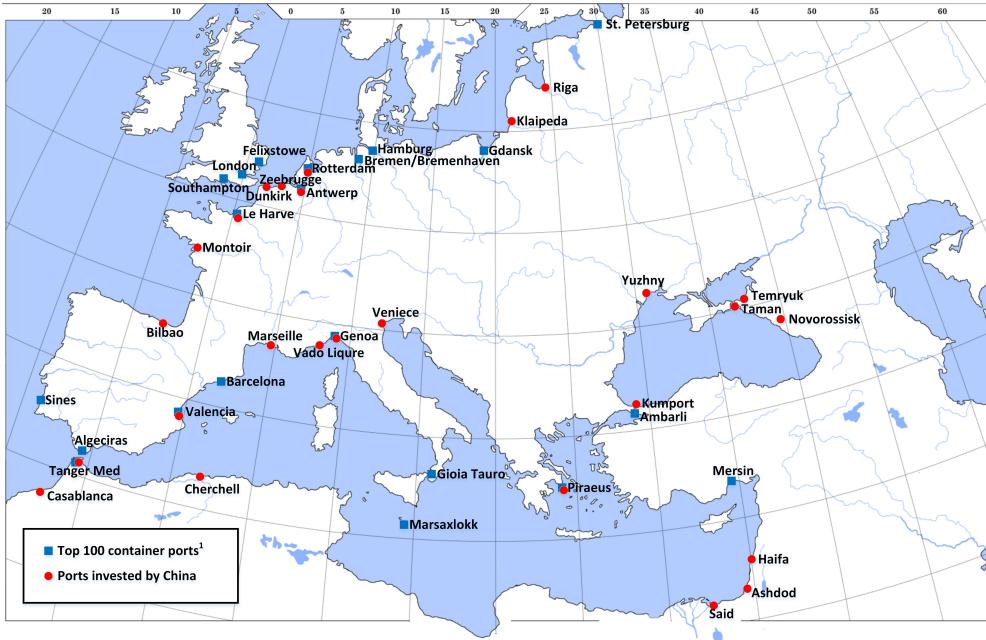


Figure 4.7: Geographical distribution of European ports

passages. Transshipping via the Mediterranean ports can help to shorten nautical miles, therefore market share shift from Asia-North route to Asia-Mediterranean is motivated. Currently, the market share of these two routes is present in Figure 4.9, Asia-North Europe route remains the predominant passage, in line with the leading roles of the ports in North Europe. While, Lloyd's list shows that the average growth rate of the North European ports recorded 3.6%, smaller than that of the Mediterranean Sea which is 7.1%. Ports in the Mediterranean Sea grow much faster than ports in the North Europe. Still, statistics show that the ports of Rotterdam, Antwerp, Hamburg and Bremen/Bremerhaven have maintained their leading positions. The largest two ports Rotterdam and Antwerp remain grew over the average rate, while port of Hamburg and Bremen/Bremerhaven witnessed a slightly fall back tendency. The port of Hamburg recorded 1.0% annual decrease and 11.7% (source: PortEconomics) decrease compared to the figure of 2007, and it is the only one shows a losing sign among the top ten European ports. The port of Bremen/Bremerhaven decreased by 1.3%. There maybe many reasons behind the fall, and in the context of the BRI, the rising of Piraeus port and the operation of CHINA RAILWAY (CR) Express can both be attributed as unfavorable factors regarding the future prospects of the port of Hamburg. On the one side, the rising of Piraeus port may due to the shift from Asia-North route to Asia-Mediterranean port, lead to the decrease of Hamburg and Bremen/Bremerhaven ports. On the other side, Hamburg is one of the most impor-

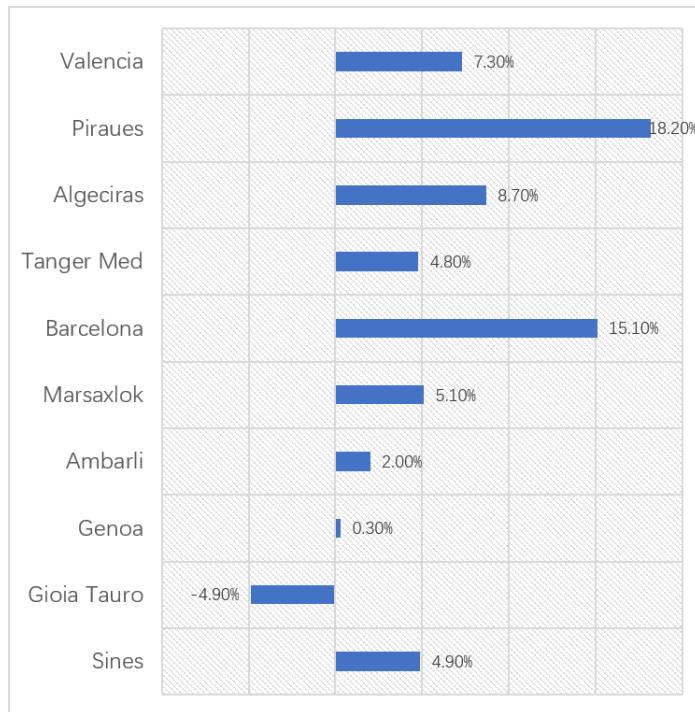


Figure 4.8: Growth rate of the top ten Mediterranean ports in 2018

Source: based on data from Lloyd's List "One Hundred Ports 2019"

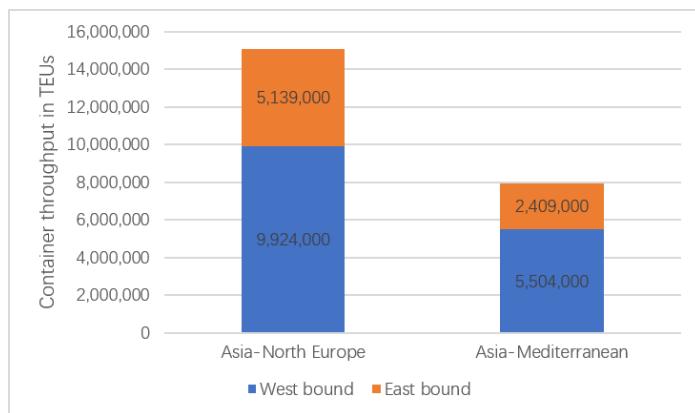


Figure 4.9: Container throughput of Asia-North Europe and Asia-Mediterranean routes in 2017

Source: data from World Shipping Council

tant destinations of CR Express, cargoes from China shift from maritime shipping to railway transportation. Since China is one of the largest customer of Germany, this transportation mode shift may also contributed to the decrease of Hamburg port. There are also opportunities for North European ports as well. The planned "Polar Silk Road" is the shortest shipping passage and already started the operation in the summer time. As the global warming trend, this could be an opportunity for future growth though currently it is not the main consideration. Once the "Polar Silk Road" can operate regular shipping business, the ports in the Northern Europe range will possibly experience considerable growth.

An important reason that Piraeus port can grow significantly is due to the increasingly concentrated shipping market and the critical role of its main customer—COSCO Shipping, which is also the parent company of its own terminal operators. Through many ways, like share acquisition or concessions for new terminals, shipping companies increased their influences on terminals. In Europe, carrier-controlled terminals account for 29% in 2017(Merk 2019). COSCO group is a main player among all the carrier-controlled terminal operators, over the last several years it rapidly increased its involvement in European terminals (see Figure 4.10). The market share of COSCO jumped from less than 1% to around 4%, recorded the fastest growth during 2007 to 2016; and this trend is increasing. Piraeus port is one of carrier-controlled terminals, and PCT is the only 100% owned terminal by the subsidiary of COSCO. In addition, after the 67% share acquisition of PPA, COSCO became the main manager of the port. As a natural result, COSCO redesigned their shipping network and chose to call at the port of Piraeus as the main transshipment hub. According to the online news, COSCO Shipping adopted over 30 container ships with capacity between 7,000 TEUs and 20,000 TEUs in 2017 to provide regular shipping services between China's ports and the Mediterranean ones. Moreover, through the formulation of alliances, shipping companies gained bargaining power over terminal operators. COSCO is a member of the Ocean Alliance, which indicates other members of the alliance can also benefit from the common interests (such as lower port fee) and being motivated to transship at the Piraeus port. Indeed, according to the statistics, the Ocean Alliance quickly turned to be the top customer of the Piraeus port, accounting for almost 69% of the total calls followed by 2M and The Alliance (Vaggelas 2019). The newly adapted Port Liner Shipping Connectivity Index (LSCI) can also prove that shipping companies indeed redesigned their network. Figure 4.11 shows the trends of the current best-connected ports in the Mediterranean Sea and Northern Europe. The port of Piraeus turned to be the best-connected port in the Mediterranean Sea in 2018. As a comparison, the connectivity of the port of Algeciras decreased suggesting the same trend that shipping companies have changed their shipping routes and transferred some of the services to the Piraeus port. Hence, the current rapid growth of Piraeus port mainly benefits from its advantageous geographical features, realized by the infrastructure promotion, enhanced by the market share shift dominated by COSCO. Considering the increasing volume of China-Europe merchandise trade, and the high market share of COSCO and Ocean Alliance in Europe, the traffic volume of the Piraeus port in the future is guaranteed. According to the latest statistics by International Transport Forum 2019,

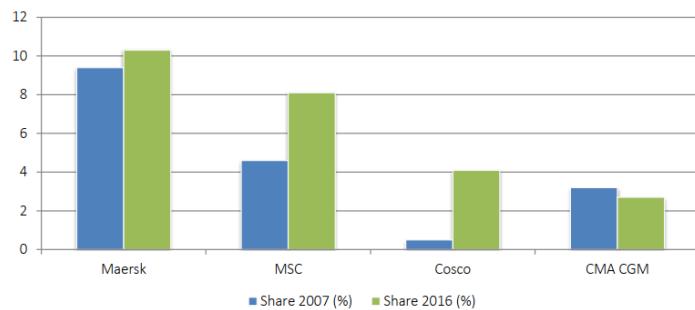


Figure 4.10: Market share (volume) of main carriers active in European terminals, 2007-2016

Source: Merk (2019), Figure 11

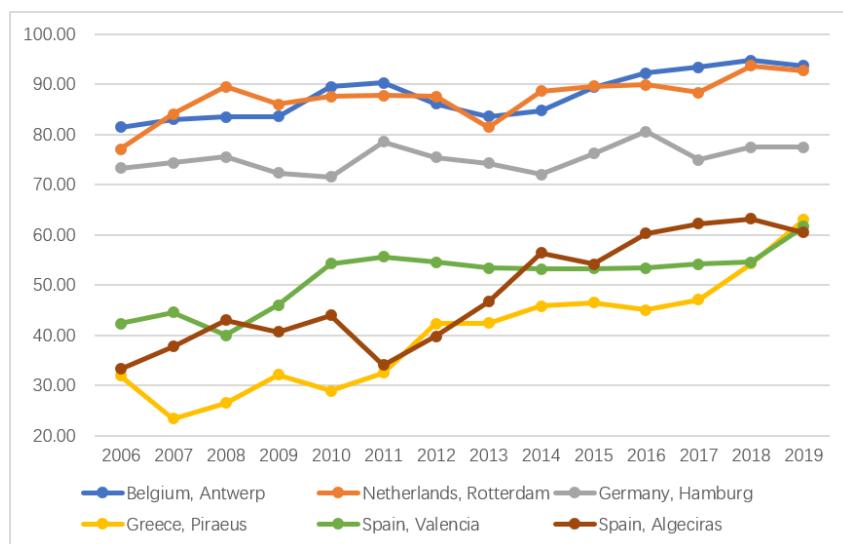


Figure 4.11: Best-connected ports in the Northern Europe and the Mediterranean Sea  
Source: based on Port Liner Shipping Connectivity Index from UNTCAD

Ocean Alliance accounts for around 35% market share on both the Asia-North Europe trade route and the Asia-Mediterranean route. Following this trend, Asia-North Europe shipping route will still be the predominant route in the following years, while Asia-Mediterranean route will continue to grow.

### **4.3.3 Future prospect: from transshipment hub to European gateway**

Piraeus port indeed has successfully enhanced its transshipment role in the regional shipping network. The growth mainly benefits from its good geographical position combined with its conventional maritime cluster advantages, realized by infrastructure investments. In the context of concentrated shipping markets, the competition between ports becomes more intensified than ever. The success of being a transshipment port implies strong competition of Piraeus port in the Mediterranean Sea. However, this growth mechanism also suggests its leading position can be easily replaced if investments flew into its neighboring competitors. It is worth-noting that Piraeus port is not the only port that received China's capitals. Under the frame of BRI, China promotes its state-owned enterprises to invest overseas ports along the MSR worldwide. European ports received Chinese investments are shown as Figure 4.7, though Piraeus port is the first European port that fully operated by COSCO. In addition, several other port terminals are seeking similar investors for construction/expansion plannings. Therefore, the position of Piraeus port as a regional transshipment hub is vulnerable. Facing the even severe competition, to a large extent the future growth prospect depends on its hinterland connectivity, a critical factor determining its position as a southern European gateway. This is because a transshipment hub requires only good connections with many feeder ports, referring to sea-sea transshipment which is determined mainly by carriers' port choices. The growth of a transshipment port does not rely on the profile of its domestic economy, and Greece does not occupy some manufacturing industries to guarantee the trade volumes as well. While a gateway port indicates good hinterland connectivity referring to sea-land transit that supports inland economic activities. Apparently, the port of Piraeus port is an increasingly important transshipment hub, yet a sustainable development strategy is to be a gateway for shipping traffic entering into or out of Europe. This is also the aim of China's vision for establishing Piraeus port embedded in the MSR, to achieve which many measures are taken including further capacity expansion, construction of the China-Europe Land-Sea Express Line, and the development of inland transportation services. Hence, whether Piraeus port can grow to be an European gateway, its hinterland transportation system is the most critical determinant. This also points to a port range competition issue (or a shipping passage competition issue): Mediterranean vs. Northern Europe. As mentioned above, transshipping at Piraeus port to reach European markets can help to shorten nautical miles compared to the conventional route destined at Northern European ports such as Rotterdam, Hamburg, Antwerp. Hence, the competition also took place between port ranges surrounding the Mediterranean Sea

and the Northern Europe. Whether the port of Piraeus can continue to grow to be the European gateway depends on how competitive it is compared to Northern European ports in terms of their hinterland logistics capabilities to serve European markets.

Currently, ports in the North Europe remain to be the gateways to reach European destinations. Shipping companies choose the Asia-North Europe route because the extra distance does not affect much on the total shipping costs. They apply large ship vessels to pursue economies of scale, which makes extra nautical miles add little to the unit shipping cost. Besides, North European ports maintained their competitiveness partly due to the greater handling capacity and efficiency, partly due to the good quality of hinterland transportation services. Nowadays, PCT operates eight berths of Pier II& III with annual handling capacity of 6,3 million TEUs<sup>1</sup>. PPA operates three container berths of Pier I with annual capacity of 1 million TEUs<sup>2</sup>. As a summary, Piraeus port can handle a total amount of 7,3 million TEUs. As a comparison, the port of Rotterdam as the European largest container port handled around 14,513 million TEUs in 2018. Though the current capacity of Piraeus port can completely satisfy the demands (4,908 million TEUs in 2018), the container throughput grows rapidly with a rate of 18.4%. To further enhance the competitiveness of Piraeus port, and prepare to be a gateway, a new No.4 container pier of three berths is under planning designed with annually capacity of 3 million TEUs. In the future, Piraeus port will be capable to handle over 10 million TEUs after the completion of the new terminal, but this capacity is still fewer than the actual throughput of Rotterdam port.

Furthermore, the construction of the inland transportation infrastructure can help the port of Piraeus to transfer to be a gateway as well. The main difference between a transshipment hub and a gateway port is the capability to transit goods via hinterland transportation systems. A transshipment hub is well connected to many feeder ports, while a gateway port is capable to convey goods to inland areas via its hinterland transportation network. Good hinterland transportation services especially the railway services are important sources of ports' competitiveness. To achieve this, good quality of railway infrastructure and equipment are required, as well as the access to inland areas. It is also necessary to have enough hinterland space to establish logistics platforms. This procedure normally comes with the development of logistics clusters proximity to the port area. However, Piraeus port does not have a competitive advantage in terms of land transportation infrastructure and services. Figure 4.12 shows the comparison of Greece's land transportation infrastructure and services to the countries along the China-Europe Land-Sea Express Line, as well as some of the best developed countries in Europe. As shown in Figure 4.12(a), the railway density of Greece is the lowest with only 17.4 km/1,000km<sup>2</sup>. It suggests that lack of railway infrastructure could be one of the main obstacles for the gateway development path of Piraeus port. Road transportation infrastructure is in a better situation, while it is not an efficient mode for transit containers from sea to land. In 2013 Greek government completed

<sup>1</sup><https://ports.coscoshipping.com/en/Businesses/Portfolio/OverseasTerminals>, accessed on Jan.11, 2019.

<sup>2</sup><http://www.olp.gr/en/services/sempo/item/605-infrastructure>, accessed on Jan.11, 2019.

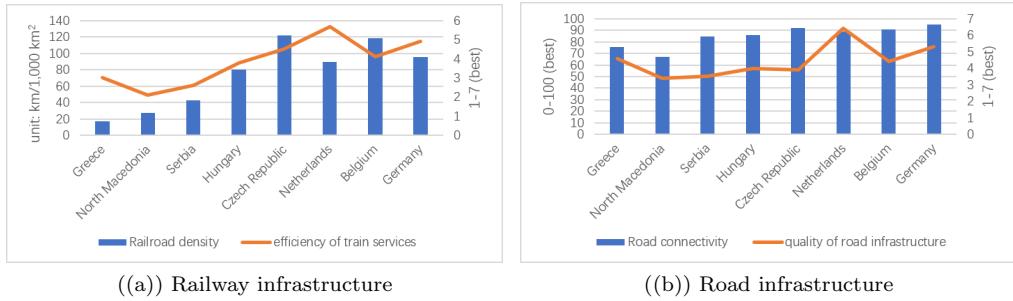


Figure 4.12: Land transportation infrastructure of Greece

Source: data from World Economic Forum (2019): Global Competitive-ness Index 4.0

the construction of the railway line from the port-belonged railway station Neo Ikonio to the national main railway freight center Thriassio. This infrastructure project was highly valued, even in the face of financial constraints Greek governments insisted to finish the construction. Their decision was proved correct, the available railway access attracted the American electronics giant Hewlett-Packard (HP) to relocate. HP set up its regional distribution center (DC) in Czech to reach markets in Europe, the Middle East and Africa (EMEA). Previously, electronic products imported from Chinese production bases mainly delivered to Rotterdam and Hamburg by sea, transit to the Czech DC by rail and then distribute to EMEA markets. Obviously, located at the crossroads of EMEA, Piraeus port with the improved railway access provided HP a better option for its EMEA distribution. HP signed an agreement with COSCO and Greek railway company Trainose to use Dock II as the transit hub. Therefore, HP relocated its main regional DC from Rotterdam to Piraeus. The delivery time reduced for 7-10 days, which is appreciated for the fast upgrading electronic products. The total transportation costs are also cheaper. This relocation process is in line with the theory in Chapter three. Transportation infrastructure is an important determinant of firms' relocation decisions. The relocation of HP on the one hand confirmed the gateway role of Piraeus port, and on the other hand guarantees the future traffic volumes. The plan of constructing the China-Europe Land-Sea Express Line is aimed to further improve its sea-rail intermodal capacity. Connecting the port of Piraeus to Hungary can largely reduce the drawbacks of Greek domestic poor railway infrastructure, and take the advantages of the good rail connectivity of Hungary and Czech. However, due to many reasons, the progress of updating the Belgrade—Budapest railway section is really slow. Still, the Express Line has been operated since 2017 based on the existing infrastructure. Currently, the Express Line offers scheduled services from Piraeus port arriving four container yards at Pardubice (Czech Republic), Bratislava (Slovakia), Budapest (Hungary) and Belgrade (Serbia) respectively covering over 1500 spots by trailers. Nowadays, it takes 2-3 days to the Balkan region, 4-5 days to the Central European destinations (Hungary, Austria, Czech Republic, Slovakia), and around six

days to Poland and southern area of Germany. Since its operation, the customers increased from two to current 780, and the frequency grew from three trains per week to 17 on average. In 2017, the Express Line managed 40,000 TUEs. After the upgrade of Belgrade—Budapest section, Piraeus port will further improve the access not only to the Central European countries, but also stretching to the Germany high-speed railway network. With the capacity expansion of the port and the improved inland transportation systems, Piraeus port is expected to maintain its growth rate and gain competitiveness as a gateway. This of course will further alter the positions of the existing leading ports in Europe, especially the current gateway such as the port of Hamburg.

#### **4.3.4 Industry clusters: relocation of automotive and electronics manufacturers**

Despite the competition between port ranges, a very critical factor that can guarantee the gateway position of Piraeus port is the development of industry clusters in the inland adjacent countries/areas. In a short-term view, the improvements of infrastructure in Piraeus port can promote the specialization in logistics industry forming logistics clusters. The improved position of Piraeus port is naturally interdependent with the formulation of logistics cluster in the hinterland area. Piraeus is a developed maritime cluster with shipbuilding enterprises, ship repair zone, car terminals, cruise business and high skilled experts and professionals, etc. To support its hinterland transportation, the associated hinterland logistics services are also required. Railway infrastructure construction induced growing logistics demands, in such context logistics service providers require rapid development. Manufacturers are motivated to set up DCs proximity to the port, since "port-focal" logistics replaced the initial "firm-focal" logistics as a major trend in the global supply chain. In reality, COSCO established a subsidiary named OceanRail Logistics S.A. in 2017 to offer sea-rail intermodal services with Piraeus port as the hub. Then it purchased 60% share of Greek railway company PEARL S.A., acquired 15% share of the Bilk container terminal belonged to Austrian Federal Railways near Budapest. It seems that COSCO take measures to acquire the hinterland rail logistics markets, but the real reason could be that the local logistics industry can hardly satisfy the increasing transit demands. OceanRail Logistics actively seeks cooperation with the local railway operators, such as Greek rail operator Trainose. There is large market potential for logistics service providers.

In a long-term view, digging it deeper with a systematic view, the substantial changes in regards to the geography of production is motivated to change as well. These substantial changes start from the formulation of logistics clusters, then may further lead to the formulation of industry clusters due to agglomeration effects if some conditions are fulfilled. In this individual case, electronics and automotive manufacturers are the leading industries that cause a sequence of dynamics, which could further enhance regional specialization in both logistics industry and manufacturing industry. In ad-

dition, due to spillover effects of transportation infrastructure, the economic benefits and the promotion effects for industry clusters may happen along the entire route proximity to Piraeus, especially the locations along the Express Line.

As one of the crucial manufacturing industry in EU, automotive industry has gradually relocated from western European countries to some emerging economies, especially the CEE countries. Since 2009 automotive manufacturers have started to close their facilities in western Europe and transfer their production capacities to the new EU member states (Deloitte 2016). Some researchers believe that automobile industry's relocation in EU took place much earlier, started since 1990s affected by changes in organization, production strategies, economic and political liberalization in Eastern Europe, and the CEE's integration into EU (Pavlínek 2019). A practical evidence is the automotive jobs creation and lost in EU during this process, as shown in Figure 4.13. Obviously, after several decades of relocation, nowadays CEEs occupy leading position in automotive manufacturing. Around one in three vehicles are made in the following CEE countries: the Czech Republic, Hungary, Poland, Slovakia and Slovenia (Deloitte 2016). This relocation trend does not seem to stop yet. According to the survey conducted by Deloitte (2016), 74% of the total 80 CEE automotive suppliers and manufacturers have plans to increase their production capacities in the next five years, while 97% of them do not consider relocation to other places. This indicates that the automotive industry clusters in CEE will continue to expand, and will produce more vehicles in the future. The prosperity of automotive industry can ensure that there will be enough transportation demands. In such situation, Piraeus port can acquire further growth opportunities if it connects well to the CEE countries.

Considering the relocation of automotive industry in CEE, from the timeline it cannot be concluded that these relocation behaviors are related to improvements of transportation infrastructure. Many studies argue that the relocation to CEE countries are mainly due to the exploitation of lower cost labors (Deloitte 2016; Lamppn and Lago-Peas 2013; Pavlínek 2019; PwC 2018), in line with the theory of comparative advantages. Based on this fact, the construction of railway links between CEE and Piraeus port becomes a plan intending to facilitate production and specialization. This is also the confusing part of the theory in transportation infrastructure causing controversial arguments. Some researchers believe that the role of transportation infrastructure is being overestimated, since many infrastructure investment plans are confirmed based on existing production bases. Therefore, the rise of freight volumes after the completion of transportation infrastructure does not indicate the positive externalities of infrastructure provision. Indeed, in many situations it is hard to tell which comes first, the provision of transportation infrastructure or the existence of manufacturers. Whereas, the story of the relocation of electronics manufacturers in Piraeus port replenish the opposite argument. After the operation of Piraeus port, apart from HP, many other electronics manufacturers also perceived the benefits of relocation as well. Including Huawei, ZTE, Samsung Electronics, Dell, Lenovo, Sony

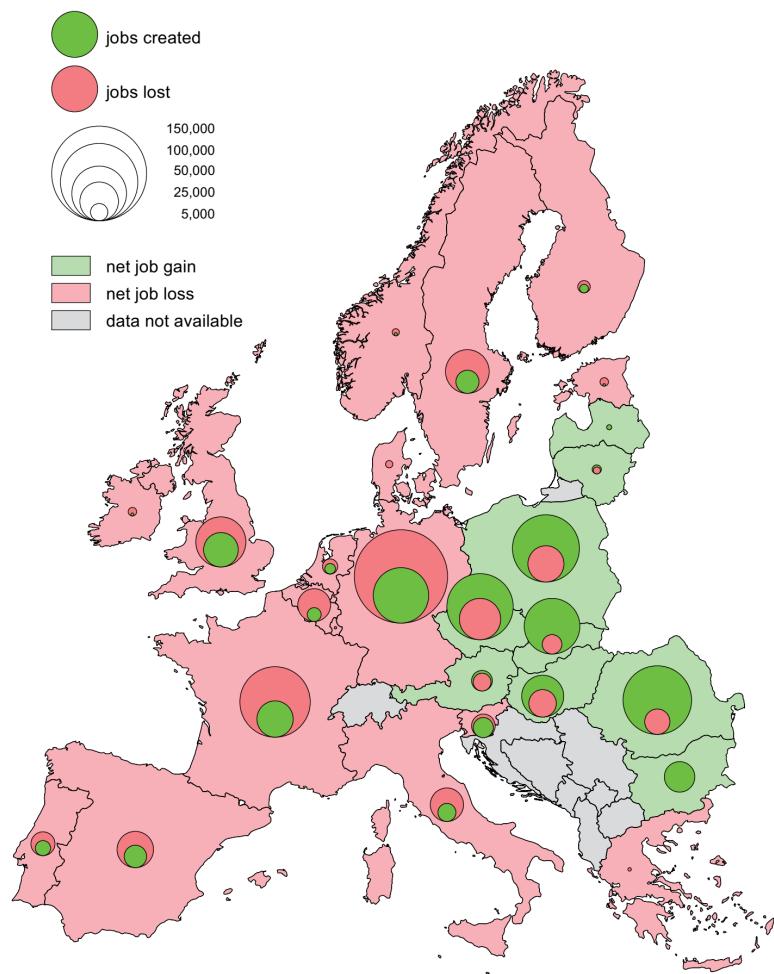


Figure 4.13: Automotive jobs created and lost in the EU+Turkey during 2005-2016  
Source: Pavlánek (2019)

and LG all expressed their interests to use Piraeus port as the gateway<sup>1</sup>. The reason why electronics manufacturers became the fast responsive customers maybe because the value of electronics is highly time-sensitive. Hence, it is the delivery time instead of the costs that determine the profit margins. Transportation infrastructure proved to be a critical determinant for firms' re-/location decisions. Factor endowments may continue to transfer to the port, and the Piraeus port or the adjacent areas can develop new electronics industry clusters. This may further induce more shipping demands and enhance its hub position in the shipping network, constituting a self-reinforcing effect.

## 4.4 Case study: CPEC and Gwadar port

Comparing to Piraeus port, in which situation port infrastructure insufficient is the only issue blocking further development, the growth of Gwadar port faces various challenges. Without maritime tradition and existing inland industries, the case of Gwadar port and CPEC is a good example to illustrate how a newly established port may affect the structure of GLN through various directions.

### 4.4.1 Introduction of CPEC and Gwadar port

#### CPEC

The China-Pakistan Economic Corridor (CPEC) is a flagship project and one of the six economic corridors under the frame of the BRI. It was first claimed in May 2013 during the visit of Chinese Premier Li Keqiang in Pakistan. The initial idea is to connect Kashgar in China's Xinjiang Uygur Autonomous Region to the port of Gwadar in south Pakistan. Then in April 2015, Chinese President Xi Jinping visited Pakistan, and agreed with the Pakistan side on the "1+4" economic cooperation pattern. It emphasized the strategic significance of constructing the CPEC, and confirmed the four key cooperation sectors: Gwadar, energy, transportation infrastructure, and industrial cooperation. After several negotiations, China and Pakistan approved the "Long Term Plan for China-Pakistan Economic Corridor (2017-2030)" that released in Dec. 2017. In this document, a macro guidance is provided for the implementation of CPEC and three plan time horizons are set. The short-term (2017-2020) projects address major bottlenecks to the country's economic and social development. The medium-term (2020-2025) projects intends to complete major economic functions consistent with the national development strategy "Pakistan Vision 2025", in which seven pillars are featured including regional connectivity, water, energy, food, inclusive

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<sup>1</sup><https://news.gtp.gr/2013/03/04/hewlett-packard-launches-transit-center-in-piraeus/>

growth, people first, etc. The long-term (2025-2030) goal is to realize the stimulating function of CPEC in Central Asia and South Asia. According to the plan, the CPEC covers China's Xinjiang Uygur Autonomous Region and the whole territory of Pakistan. It is a 3,000 kilometers corridor with highways, railways, oil and gas pipelines, fiber networks, and airports. The spatial layout is designed as "one belt, three axes and several passages". "One belt" refers to the core zone of the CPEC, a vertical belt area spanning Xinjiang, Pakistan's Islamabad, parts of Punjab, Sindh, Khyber-Pakhtunkhwa, Balochistan, AJK and Gilgit-Baltistan. The "three axes" means the three horizontal axes linking Lahore and Peshawar, Sukkur and Quetta, Karachi and Gwadar. The "several passages" refer to the railways and highways from Islamabad to Karachi and Gwadar. Five key functional zones from north to south are confirmed as well: Xinjiang foreign economic zone, northern border trade and business corridor, eastern and central plain economic zone, western logistics corridor business zone, and southern coastal logistics business zone. In general, it is a multi-sector cooperation proposal between China and Pakistan, consistent with the benefits of both sides. To facilitate the implementation, China and Pakistan established a ministerial-level team for CPEC planning named Joint Cooperation Committee (JCC). Nine joint working groups are established under JCC, respectively in charge of planning, energy, transportation infrastructure, Gwadar, industrial parks/Special Economic Zones, security, international cooperation & coordination, social and economic development, and agriculture.

As published on the official website<sup>1</sup>, under the framework of CPEC there are eight categories of Chinese finance projects: energy (17), infrastructure (5 road projects and 2 rail sector projects), Gwadar (8), other projects (2), rail-based mass transit projects (4), new provincial projects (4), special economic zones (9), social sector development projects (4). There are also two categories of projects financed by Pakistan government, including six western route projects and three related projects under Public Sector Development Program (PSDP). The 17 energy projects covering coal, hydro, wind and solar, can largely guarantee the electricity supply for the livings of local people and the smooth implementation of the other projects. The priority of energy projects is in line with the emphasis in the "Long Term Plan": the Phase-I objective is to address the shortage of electricity supply. This is also the prerequisite for improvements of connectivity with China and industrial parks after the year of 2020. Still, there are some transportation infrastructure projects conducted focusing on Pakistani domestic connectivity, including 5 road projects and 2 rail sector projects. Figure 4.14 presents the plan of the highways network in Pakistan. The Karakoram Highway (KKH) with a total length of 1,224 kilometers is the most important project, as it is the only land transportation route that connects China and Pakistan. It starts from Kashgar in Xinjiang, goes across the Karakoram mountain area and through the Khunjerab Pass, eventually ends at Gilgit-Baltistan in Pakistan. The Chinese section is 415 kilometers, and the Pakistani section is 809 kilometers. Since it goes across the Karakoram mountain with the average elevation over 5,500 meters, the geological

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<sup>1</sup><http://cpec.gov.pk>



Figure 4.14: Highways Network of CPEC

Source: CPEC Authority

situation is extremely complicated with many kinds of disasters often occur such as landslides, falling rocks, snow and ice. Therefore, it is very risky and expensive to construct and maintain. Actually, China helped the construction of the KKH since 1968 and it opened to use since 1986. Under the frame of CPEC, the new KKH phase II (Thakot—Havelian, 118km) is aimed to construct the six-lane access controlled class-II highway. As a priority project the Menshera—Havelian section already opened in September 2019, the remaining section is scheduled to complete in March 2020. KKH Thakot—Raikot section project has been approved by Pakistan in March 2017 still in progress. The other priority project is the Meltan—Sukkur section (392 km) within the Peshawar—Karachi motorway (PKM project), completed and inaugurated in November 2019. This section is a six-lane access controlled Intelligent Transportation System motorway funded by China's EXIM Bank. By the way, PKM project is

the largest project under the CPEC framework.

Figure 4.15 shows the main railway projects including construction of new lines and modernization of the existing lines. There are four rail-based mass transit projects planned: Karachi Circular Railway, Greater Peshawar Region Mass Transit, Quetta Mass Transit, Orange Line-Lahore. A flagship project is the up-gradation of Karachi—Lahore Peshawar (ML—1) line. It is planned to double the entire track with the freight train speed improved to 120km/h, passenger train speed 160km/h. Along this railway line, a critical important project is the construction of the Havelian dry port. According to the plan, Havelian is targeted as the future containerized freight railway station with high speed and capacity stock, with capability to handle bonded import/export containers. Located over 680 kilometers away from Chinese border Khunjerab, it is planned to be the transshipment hub for goods delivered through KKH from China.

### **Gwadar port**

Gwadar port is a warm-water, deep-sea port, occupying excellent conditions for maritime shipping. Situated on the shore of the Arabian Sea and the mouth of the Persian Gulf, Gwadar port has an advantageous geographical position with short distance to the main shipping routes across the Indian Ocean. The geographical map of Gwadar is as shown in Figure 4.16, the port area is on the hamper-shaped island stretching to the sea near to the East Bay, with enough space and coastal line for construction and capacity expansion. In Pakistan, it is one of the three major international ports, located in the southeast coast of Balochistan province, around 460 kilometers away from Pakistan's largest seaport Karachi port and about 120 kilometers away from the border shared with Iran (MFF Pakistan 2016). Port Qasim is the other major operational port with only 35 kilometers west distance from Karachi port. While, the two ports of Karachi and Qasim have significant physical limitations for further expansion. According to the official website, the port of Karachi is located within the city of Karachi itself, hence has limited space for massive expansion. Qasim port situated around 35 kilometers away from Karachi city center is an industrial base port but not advantageous to function as transshipment port, since its up-stream location determines it requires longer turnaround time for visiting ships. With this background, the construction plan of Gwadar port under the framework of CPEC is intended to fully realize its potential to emerge as a major international business hub in the region.

In February 2013, the government of Pakistan officially transferred the construction and operation right of Gwadar port to China Overseas Port Holding Company (COPHC). Three months later, Pakistan and China achieved agreements on jointly constructing CPEC to connect Gwadar port and China's Kashgar city in Xinjiang Autonomous Region. Actually the Pakistan side has the intention to construct the port far before this, and China Harbor Construction Company conducted the Phase-I

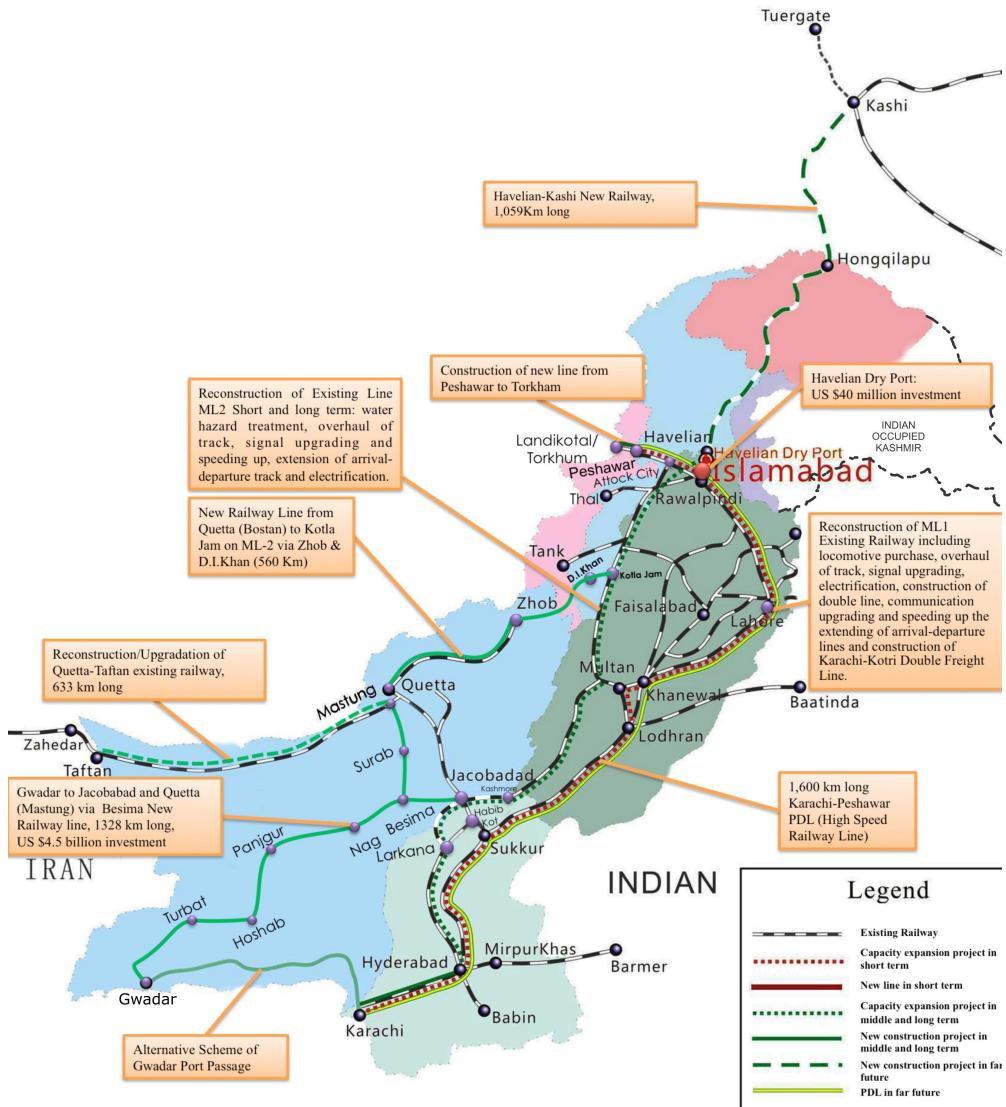


Figure 4.15: Railway Network of CPEC  
Source: CPEC Authority



Figure 4.16: Geographical map of Gwadar port  
Source: based on Google map

project of port construction since 2002 and completed in 2006. After the completion of the first phase project, Gwadar has three multi-purpose berths with a total length of 600 meters, one maintenance berth, and the associated infrastructure and equipment. The designed container throughput is 100,000 TEUs and the bulk grain of 720,000 tons per year. In 2007 Pakistan tendered for the port's development and operation right for a lease period of 40 years. Among six port operators, Port of Singapore Authority (PSA) obtained the contract. The signed agreement includes further investment to implement the Phase-II project of construction plan. While in the following years the construction of Gwadar port did not implement as agreed in the contract, and never achieved real commercial use (Ali 2020; Aparna 2017). Until 2010, Pakistan government reassess the project and decided to sign a contract with China's enterprise COPHC. In the following years, after negotiations China and Pakistan agreed on the planning of the construction of CPEC, and focus on Gwadar port, energy, infrastructure, and industrial cooperation to form the "1+4" cooperation plan. In 2015, the two sides agreed on the contract to transfer Gwadar port with the use right of around 2281 acres land for 43 years to construct the first Free Zone in Pakistan.

Moreover, the vision of Gwadar under CPEC is far beyond port development. According to the official website<sup>1</sup>, there are eight planned projects in Gwadar: Gwadar East-Bay Expressway, New Gwadar International Airport, Construction of Breakwaters, Dredging of berthing areas & channels, Development of Free Zone, Pak-China Friendship Hospital, Pak-China Technical and Vocational Institute at Gwadar, and Gwadar Smart Port City Master Plan. Besides, a new project of 300MW coal power

<sup>1</sup><http://cpec.gov.pk>

plant in Gwadar was approved by Pakistan in February 2017. This project will be invested and conducted by China Communications Construction Company Ltd. to conquer the power shortage issues in Gwadar. According to the Master Plan, Gwadar city will be developed to be the center of industries and business activities, as well as a critical international shipping hub. The corresponding construction task will be divided into three phases, separated by the year of 2025, 2035, and 2050. The first period of construction focuses on the provision of basic living infrastructure, covering electricity, water supply, sanitation, roads and security, expected to complete before 2025. Afterwards, the focus will shift to the construction of functional port infrastructure, including modern loading and unloading equipment, advanced storage and logistics equipment, infrastructure for the SEZ, roads to airport and other transportation infrastructure, etc.

Focusing on the development of the port, the construction of Gwadar East-Bay Expressway can connect the port to Pakistan's National Highways to improve hinterland access. Within the port, COPHC built a new liquefied petroleum gas (LPG) receiving station, installed five new container bridge cranes, constructed a 100,000 square meters storage yard, and set up the most advanced container scanning equipment. The original desalination plant expanded from a daily output of 100,000 to 220,000 gallons, and installed two sets of sewage treatment systems to better provide drinking water to local people and also the ships calling the port. Gwadar port turned to be a full functional port, with capabilities of handling bulk cargo, container, Ro-Ro cargo, and LPG. On 13th November 2016, Gwadar port officially put into operation through the route of CPEC for the first time. Cargoes from Kashgar transported across about 3000 kilometers spent around 15 days to Gwadar port, and then shipped to Middle East and Africa by "Wellington" vessel. On 7th March 2018, COSCO group starts a new container shipping line service named "Karachi Gwadar Gulf Express (KGS)", which calls at Gwadar port once a week.

Gwadar port is faced with very different situations compared to the port of Piraeus. As a newly established port open for business since the end of 2016, until now there is no significant sign of traffic growth. Located proximity to the complicated Middle East, its construction and future prosperity are up against many challenges. Meanwhile, since the development of Gwadar port and CPEC is still in progress, the port itself combined with the improved hinterland connectivity make it potential to be a regional hub. Considering the impacts on GLN, there are three directions to discuss. Firstly, with advantageous geographical conditions, the implementation of CPEC projects can further improves the port infrastructure, and enhance competitiveness in the Arabian Sea. Gwadar port has potential to serve as regional transshipment ports. Secondly, as described above, Gwadar port is designed as a strategic node embedded in CPEC, which connects the land-based "Belt" and the ocean-going "Road". The construction of CPEC can offer China an alternative sea-land intermodal transportation route to access the Indian Ocean. Besides, there are several landlocked countries such as Afghanistan capable to acquire ocean access through Gwadar port as well. Hence, it is possible for Gwadar port to develop to be a Gateway for Central Asian countries and

China's less-developed western cities. Thirdly, the vision of CPEC covers the development of Gwadar port, the construction of Free Zone, and even the city. This plan follows China's special "Port-Industry-City" development mode, may largely promote the process of industrial specialization in the hinterlands. Gwadar port can be the destination receiving part of industry transfer and further develop to be an export-oriented port.

#### **4.4.2 Prospect of Gwadar port for transshipment: port hierarchy**

A hub port's transshipment function refers to sea-sea connectivity to feeder ports, regardless of its capability of hinterland transportation. Mega ships(or mother vessels) need to dock at transshipment ports because there are demands to serve smaller feeder ports which are unable to accommodate large vessels due to infrastructure and space restrictions. In such cases, large vessels need to dock at transshipment hubs and unload some cargoes. These cargoes need to be stored at the hubs for some time (like a few days) waiting for the load into smaller vessels. Therefore, the capability to handle large vessels and enough yard space for storage are the basic requirements to be transshipment hubs. As the consignment of ever large mega vessels, ports and terminals are faced with severe capacity expansion pressure, the differentiation of hub ports and feeder ports will be further enlarged. Besides, the geographical features (such as position, depth, wind) and port efficiency are also important factors determining a port's significance as a transshipment hub. Due to these reasons, the position of a transshipment hub is vulnerable compared to gateway ports, and port infrastructure provision is one of the most crucial determinant. Infrastructure investments in some central-located ports without space limitation may largely improve port competitiveness as transshipment hubs, and further change the port hierarchy and regional shipping network.

Gwadar port is a natural warm deep-water port, situated around only 400 kilometers from the Hormuz Channel, one of the world's most critical choke-point for oil shipping. This distance is even shorter compared to the distance of 460 kilometers between Gwadar port and Karachi port. Some may argue the geographical proximity to oil-rich Persian Gulf countries however is not an advantage in this circumstance, since vessels from the Middle East ports do not need to tranship at ports with such short distances. While, this kind of idea is perceived based on the current pattern that Middle East ports are functioning as regional hubs, and consumed the growth potential of Gwadar port depends on how well it will serve ships from these Middle East ports. In fact, the current leading position of Middle East ports, such as the port of Dubai (Jebel Ali), is largely due to their large volume of transhipment cargoes instead of export/import demands. Gwadar port occupies excellent location and geographical features, situated near to the main shipping passages serving the Asia-Europe, Asia-Africa, East Asia-Middle East, and even Trans-Pacific trade. Its growth potential does not limited to offering feeder shipping services from/to Middle East ports, it also has potential to



Figure 4.17: Major ports in the Arabian sea range

attract certain amount of transshipment volumes as regional hubs. From this point of view, its future prosperity is determined by how competitive it is to accommodate mother vessels compared to the current major hubs.

Investigating the current pattern of port hierarchy in the surrounding sea range, it is found the largest ports are Dubai (Jebel Ali) port in United Arab Emirates (UAE), Colombo port in Sri Lanka, ports of Jawaharlal Nehru and Mundra in India, Jeddah port in Saudi Arabia, etc. Figure 4.17 illustrates the allocation of major ports that dispersed along the East Africa, in the Arabian Sea, and along the western India. The largest ports are also significant hubs in the regional shipping network, verified by port annual container throughput and country's port performance statistics. Figure 4.18 illustrates the number of arrivals of different types of cargo ships by country in 2018, also to some extent present the share of various cargoes in each country. Figure 4.19 shows the comparison of related countries in terms of the number of arrivals of container ships, the average and maximum container carrying capacities per ship in 2018. As shown, India and UAE recorded most total ship calls and container ship calls, while the ports can handle mega container ships with capacity of around 20,000 TEUs are the ports in UAE, Sri Lanka, Egypt, Saudi Arabia and Oman. There is little doubt that ports in these countries function as regional transshipment hubs, while even the largest ports in India i.e. Jawaharlal Nehru port and Mundra port are incapable to accommodate mega vessels. Considering the large population and market in India, the poor port infrastructure provision seems to be a major restriction. The

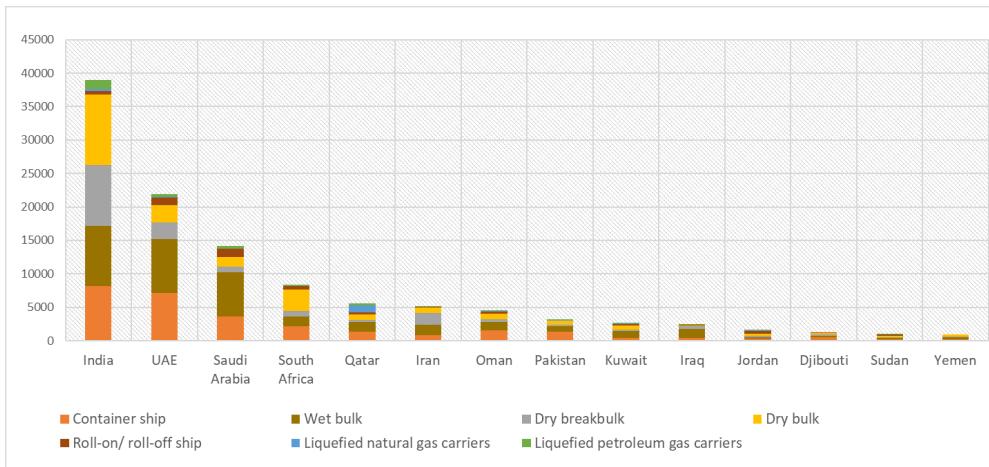


Figure 4.18: Number of arrivals of different cargo shipping vessels by country, 2018

Source: based on UNCTAD database

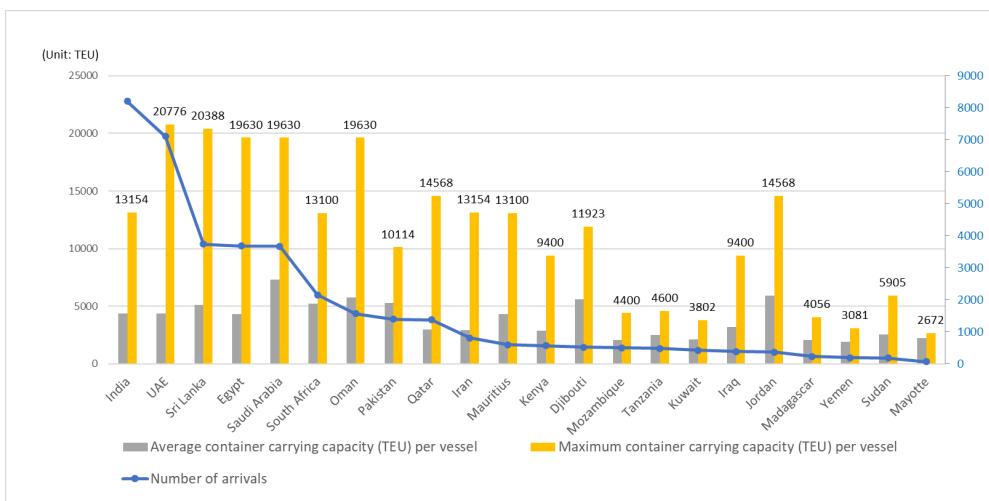


Figure 4.19: Port calls and container capacity statistics by country, 2018

Source: based on UNCTAD database

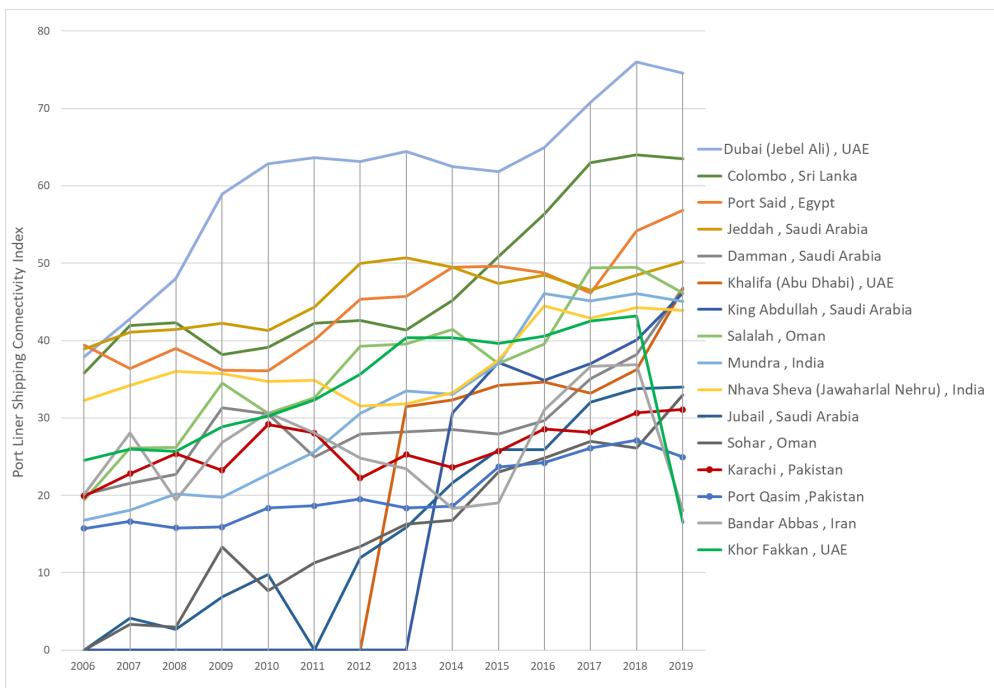


Figure 4.20: Port Liner Shipping Connectivity Index, 2006-2019

Source: based on UNCTAD database

other strong evidence is the Port Liner Shipping Connectivity Index by UNCTAD, which can be used as the indicator presenting how well the ports are connected to the global shipping network. As in Figure 4.20, in general ports in the area are more and more connected during the last several years. In the Middle East, Dubai port is the best connected port, followed by the ports of Jeddah, Damman, Khalifa, King Abdullah, etc. New ports include Khalifa (Abu Dhabi) in UAE and King Abdullah in Saudi Arabia dramatically gained market share in 2012 and 2013 respectively since operation and grow fast. Port of Karachi and Qasim however is not so well connected to the shipping network. The capacity of the largest container ship handled by Pakistani ports in 2018 is limited to 10,114 TEUs as shown in Figure 4.19, indicating these ports are more likely to serve feeder shipping services, in line with the smaller port connectivity index. It can be concluded Pakistani ports (i.e. Karachi, Qasim, Gwadar) are not regional transshipment hubs. The overall container throughput of the country accounted for 3.28 million TEUs, may largely be attributed to domestic import/export demands. According to Lloyd's List, the largest port in the area is the port of Dubai (Jebel Ali) handled 14.954 million TEUs. Though Dubai port experienced 2.7% decrease, the throughput is still almost four times that of Jeddah port, the second largest in the Middle East. Geographically, Jeddah port is located in the Red Sea, along the shipping passage across the Bab-el-Mandeb Strait and Suez Canal.

This is the only route for Asia-Mediterranean shipping. In terms of transshipment, it seems that the ports of Jeddah and King Abdullah instead of Dubai port occupy more critical locations. It turns out geographical position is not the most crucial determinant in this case. The reason why Dubai port is the largest hub port is mainly due to its capabilities to handle mega ships, to store cargoes, etc. By the way, the leading position of Dubai port is also related to the construction of its Free Zone, where over 7300 companies are situated. This fact however does not change the situation that infrastructure provision determines the port hierarchy, since Middle East ports rely heavily on transshipment services accounting for more than half (53%) of the total throughput Giovanni Moscatelli et al. (2018). Therefore, port infrastructure provision should be classified to the most critical influencing factor especially in this case, far more important than geographical factors. Only if the rival ports satisfy the requirements of mega vessels handling capabilities, there is space to compare other dimensional criteria.

Pakistan's dominant freight transportation mode is maritime shipping, over 90% trade by volume is through sea (Shah et al. 2019). At present, the port of Karachi and the Port Muhammad Bin Qasim handle the majority of all external merchandise trade. Gwadar port at its early stage is facing a lack of business issue after the official operation. There is only one weekly short-haul container shipping service that calls at the port offered by COSCO Shipping Line Co. Ltd., see Figure 4.21. The cargoes shipped to Gwadar port are limited to a few categories: construction equipment & materials from China and fertilizer; cargoes export are mainly containerized fishery products. This is in line with Pakistan's economic situation, the country relies on import and has a trade deficit, its domestic industrial structure is relatively simple and agriculture is the main industry. The lack of business may be attributed to the still poor infrastructure provision of Gwadar port. Gwadar port is with three multi-purpose berths (200 meters each), one RO-RO facility, one service berth (100 meter). The current maximum depth of Gwadar port is 12.5 meter<sup>1</sup>. The port can simultaneously accommodate two large vessels with carrying capacity of 50,000 DWT. By comparison, Table 4.2 lists some capacity characteristics of shipping vessels handled by Pakistani ports in 2018. It is obvious that the level of Gwadar port's infrastructure provision is relatively low. Fortunately, Gwadar port is still under construction as well as the CPEC. Information about Gwadar port's expansion plan is really limited, hence it is hard to know how large scale it will be. According to the initial Phase-II project which was expected to complete by 2010 but suspend after the took-over by PSA, the development plan includes four container berths, one bulk cargo terminal, one grain terminal, one RO-RO terminal, and two oil terminals. Some resources mention that Gwadar port will construct 100 berths by 2045, but there is no published official plan yet. From the latest available information on CPEC official website, dredging of berthing areas & channels of Gwadar port is in progress, preparing for the further construction of container terminals on the western and north western side of the existing multi-purpose terminal, and also the second phase terminals on the eastern side. It

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<sup>1</sup><http://www.gwadarport.gov.pk/portprofile.aspx>



Figure 4.21: Shipping route of "Karachi Gwadar Gulf Express" (KGX)  
Source: COSCO Shipping Lines

Table 4.2: Characteristics of Pakistani ports handling capacities of cargoes, 2018  
Source: data from UNTCAD

Cargo type	Average cargo capacity (DWT) of vessels	Maximum cargo capacity (DWT) of vessels
LNG carriers	91,573	122,079
Dry bulk	57,564	98,681
Wet bulk	47,349	116,104
Dry breakbulk	21,078	55,683
RORO	17,910	26,985
LPG carriers	8,639	18,844

will take years to get the port's capacity expanded even if the projects implemented smoothly. Before that, Gwadar port cannot handle mega vessels as transshipment port and can hardly gain market share.

Still, from the analysis of the current Pakistani shipping market and ports, growth potential for Gwadar port is suggested from the perspective of increasing domestic demands. Some evidences show the ports of Karachi and Qasim have severe congestion issues due to port constraints and increasing demands for both sea and hinterland transportation<sup>2</sup>, especially the oil terminals<sup>3</sup>. Pakistan is a growing economy with the world's sixth largest population, and the growth rate of merchandise exports in 2018 records 8.1% implying large market potential. To release the congestion pressure, the

<sup>2</sup><https://fp.brecorder.com/2016/07/2016071665792/>, accessed on 20 Dec. 2019

<sup>3</sup><https://www.dawn.com/news/1350078>, accessed on 20 Dec. 2019

Table 4.3: Container terminals of Pakistani ports  
 Source: various official websites

Container terminal	Depth (m)	Number of Berth	Berth length (m)	Capacity (TEU)	Storage area (hectares)
PICT	13.5	2	2*300	750,000	21
KICT	13.5	3	963		26.03
PDWCP					
Phase I (completed)	16.0	2	800	1,500,000	
Phase II (in progress)	16.0	2	1500	3,200,000	

two ports are in need to expand capacity and in recent years they indeed attracted investments. Karachi Port Trust (KPT) framed its "Ten Year Business Plan" in pursuit of privatization strategy based on landlord mode, and set up several infrastructure development projects, covering various terminals and port hinterland connectivity. The Pakistani largest port has 30 dry cargo handling berths and three liquid cargo berths. Among them, there are three privatized container terminals in Karachi port: Pakistan International Container Terminal (PICT), Karachi International Container Terminal (KICT), and the newly constructed Pakistan Deep Water Container Port (PDWCP), see Table 4.3. PICT is operated by Hutchsion Ports, a Chinese terminal operator, whose subsidiary— South Asia Pakistan Terminals (SAPT) Ltd., is the one invests, constructs and operates the new PDWCP on a BOT basis. Currently, it is Pakistan's first and only deep-water container terminal. With the depth of 16 meters and possible to be dredged to 18 meters in the future, the PDWCP is designed to accommodate Super Post-Panamax ships, the largest container ships with capacity of 250,000 TEUs. The construction of PDWCP planned four container terminals in two phases. After the completion of Phase I project, the terminal is with depth of 16.0 meter and two berths with 800 meter. The terminal was test operated since December 2016, and being inaugurated in May 2018. It is also the first semi-automated terminal in South Asia, installed with remote-controlled cranes to improve loading/unloading efficiency. With the capability of handling 15 meter draught vessels, PDWCP quickly exceeded the performance of the other two terminals, handled the same number of vessels but almost doubled the Gross Registered Tonnage comparing to PICT during July 2017-July 2018. The Phase II project is planned to invest \$240 million to add two more berths with length of 700 meter. The construction has been started in 2019, by the end of 2020 the container handling capacity will expand to 3.2 million TEUs from the current 1.5 million TEUs. Moreover, in the port there will be a four-lane railway track of around 4.5 kilometer constructed and power plant production capacity expanded. Besides, the development of multi-purpose cargo terminal, cargo village, wetland park, LNG Complex, and hinterland connectivity in Karachi port are planned as well. Qasim port is an industrial base port and also the energy hub of Pakistan. It has a higher level of privatization, port infrastructure include oil terminal, liquid terminal, LPG terminals, grain & fertilizer terminal, LNG terminal, etc. are all func-

tion by private operators to supply their production plants in the port. The port's industrial complex covers refinery, fertilizer, automobile, polymer, steel, power, etc.. The port is actively expanding its scale of industry and constructed the associated supportive terminal facilities, especially for its energy supplying industries. The latest activities of Qasim port includes the operation of a new LNG terminal in 2015, a new coal clinker & cement terminal in 2017, and a new LNG project in the same year. To satisfy the increasing power consumption level of production and households, in the port the  $2 \times 660\text{MW}$  coal-fired power plants were constructed under the frame of CPEC. Financed by Qatar's AL-Miraqab Capital and China's Power Construction Corporation, the plant has been operational since August 2017. The port's executed and future projects are mainly infrastructure construction projects of road, highway, water supply and sewerage. The 2nd integrated oil terminal is also planned with investment of \$164.5 million. As an important content of CPEC, the three ports will be connected through the construction of Gwadar East-Bay Expressway, which stretches to the Makran Coastal Highway. As the development of Gwadar port, the southern coastal line will become Pakistan's important growth engine.

To compete in the surrounding sea range, Gwadar port is faced with complex situations, partly due to the fierce competition, partly due to the complicated business environment. Both challenges and opportunities exit. Due to geographical proximity, Gwadar port directly compete with ports allocated in the Persian Gulf and the Gulf of Oman, such as the regional largest port— Dubai's Jebel Ali port, Abu Dhabi's Khalifa Port, Salalah port in Oman and the Indian invested Chabahar port in Iran, etc. One major challenge is including these competitors many Middle East ports have set up massive infrastructure upgrade plans as well, despite the fact of their overcapacity issues (Giovanni Moscatelli et al. 2018), adding more dynamics and further enhancing competition. Located at the crossroads between North and South, East and West, Middle East ports can easily acquire transshipment volumes if they are capable to handle mother vessels. The most typical example is Jebel Ali port in Dubai, handled 14.9 million TEUs in 2018 remaining its leading position. The achieved success prompt these economies to further develop ports and shipping industries. DP World—the operator of Jebel Ali port, planed to expand its annual capacity to 22 million TEUs through the construction of its fourth container terminal. Near to Dubai port, Khalifa port in Abu Dhabi has labeled itself as a global hub integrated into China's BRI represented by its 35-year concession agreement with COSCO. In fact, this port is experiencing several large scales of infrastructure upgrade programs and also in partnership with Noatum Maritime Group and Mediterranean Shipping Co. (MSC). According to the official website, the expansion plan includes the construction of a new channel with draft of 18.5 meters, the creation of a new island where general cargo and RORO operations will shift to, etc. The port container handling capacity is designed to reach 15 million TEUs by 2030. Besides, the port is promoting the construction of Khalifa Industrial Zone Abu Dhabi (KIZAD) to attract investments and accelerate industrialization. Until April 2018, there have been 19 Chinese companies invested to establish the China-UAE Industrial Capacity Cooperation Industrial Park. These activities are in line with UAE's economic diversification agenda—"Abu Dhabi Economic Vi-

sion 2030". As well-known, Gulf countries occupy oil-dependent economic structures. Ports and maritime shipping development has become a breakthrough point for Gulf countries to reduce reliance on oil production and transfer domestic economic structures. UAE is not the only one. Almost all the Persian Gulf countries have launched port infrastructure upgrade plans. Similar strategies include Saudi Arabia's "Vision 2030", "Oman Logistics Plan 2020", "Sultanate of Oman Logistics Strategy", etc. In addition, the circumstances of unstable political and business environment generate many uncertainties to the regional shipping pattern. For instance, Qatari crisis in 2017 caused the port of Doha's boycott by neighbors. Qatar quickly opened Hamad port in September 2017 to diminish the lost of ban on transshipping at Jebel Ali port.

In such a condition, improving the capability to handle mega vessels and expanding capacity are extremely important for Gwadar port to gain transshipment market share in the Persian Gulf. If Gwadar port can improve its infrastructure and capacity, with its advantageous geographical location and features, it is very possible to be the regional transshipment hub, since transshipping via it can avoid the voyage to the turbulent and narrow Hormuz Channel. This is especially true for the trade lanes between East Asia and the Mediterranean, Europe, Africa and even East coast of America. Still, through cooperation and forming partnerships with ports and carriers, Gwadar port can grow by offering feeder services at this early development stage, such as the operating "Karachi Gwadar Gulf Express (KGS)". Meanwhile, the transition of Gulf countries, especially the construction of free zones and industrial parks, can attract investments and accelerate domestic industrialization process. In the following years, it is expected to witness the growing export/import demands for production purposes. For instance, COSCO's investment in Khalifa port and the construction of China-UAE Industrial Capacity Cooperation Industrial Park may offer extra shipping demands and the opportunity for Gwadar port to function as a regional port to serve the convey of intermediaries.

Moreover, it is worth-noting that located only 72 kilometers away from Gwadar port (see Figure 4.17), Chabahar port in Iran received Indian capitals since 2016 and set up a five-phases infrastructure upgrade plan could be a strong rival. Due to political reasons, India intends to find solutions to access Central Asian countries bypassing Pakistan. The intention of developing Chabahar port to be a regional hub for connecting India to Central Asia can be originated to the year of 2003. Not until 2016 in May, the two countries India and Iran agreed on a five-phases Chabahar port infrastructure upgrade plan, this is the first time that Indian got involved in foreign ports. Chabahar port consists of two complexes, namely Shahid Kalantari and Shahid Beheshti. The upgrade plan mainly focuses on the port of Shahid Beheshti, with the cost of \$1 billion, the first phase project was already inaugurated in December 2017, finished the construction of two 640-meter-long container berths and three 540-meter-long multi-purpose berths. The port capacity has been expanded from 2.5 million tons to 8.5 million tons, and the port currently is capable to handle large vessels with capacity of 100,000 tons. According to the online news, the entire five phases of the program are expected to be completed in 2024, afterwards the capacity of Chabahar port will reach 85 million

tons. The competition pattern between Gwadar port and Chabahar port, however is quite different from other Gulf ports, since both ports have potential to serve as gateways to access inland Asian countries. The competitiveness depends on not only the transshipment capabilities, but also the ports' hinterland connectivity. Hence, the competition between Gwadar port and Chabahar port refers to the topic of the next section, related to the prospect of Gwadar port as a gateway port with the support of CPEC construction. In fact, Gwadar port as a major project embedded in CPEC, the main growth potential may arise from the improved inland connectivity to serve as a gateway port instead of the regional transshipment hub especially in the early development stages.

#### **4.4.3 Prospect as a gateway: hinterland connectivity**

Compared to transshipment ports, a gateway's position relies heavily on its hinterland connectivity. A gateway port needs to burden the function of export/import to support the production or marketing in hinterland economies. In other words, it is an inter-modal transit node for sea-land transportation. Therefore, a regional gateway port requires the operation of good quality hinterland transportation system, and usually connects to either industrial complexes or markets. The prosperity of a gateway port also refers to a certain level of integration into the global value chains. Designed as a strategic node embedded in the CPEC, Gwadar port is the south end reaching Kashgar city in China's Xinjiang Uygur Autonomous Region. The significance is CPEC can offer an alternative land-sea transportation route for Chinese western area to access the Indian Ocean as the first point. Second, the landlocked Central Asian countries can acquire a shipping possibility via Gwadar port to get more involved in the global economy. The improved connectivity for China's western area and Central Asian countries can play an stimulating role in promoting trade and economic development. Third, the planned parallel pipelines can provide an extra oil and gas transportation route for China to import energies from the Middle East countries. The following contents discuss the impacts on GLNs from the three perspectives.

##### **Land-sea intermodal transportation route to China**

The main idea of constructing CPEC is to connect the southern coastline of Pakistan to China's western area. Hence, the corridor needs to pass through the whole country from south to north. Pakistani domestic transportation infrastructure provision is relatively lagging. Compared to its neighbors, as shown in Figure4.22, logistics performance of Pakistan is just better than the landlocked and turbulent Afghanistan. The lack of sufficient and effective infrastructure is one major factor constraining its growth. The main freight transportation mode in Pakistan is via road. According to National Highway Authority (NHA) of Pakistan, the total na-

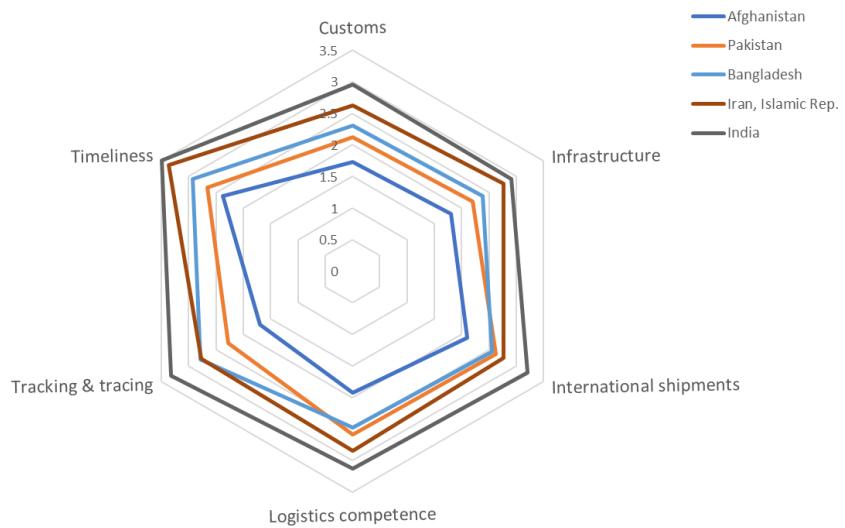


Figure 4.22: International Logistics Performance Index, 2018

Source: World Bank

tional road network is 263,775 kilometers. Among them, NHA manages 39 national highways/motorways/expressway стратегиче routes with a total length of 12,131 kilometers, see Figure 4.23.

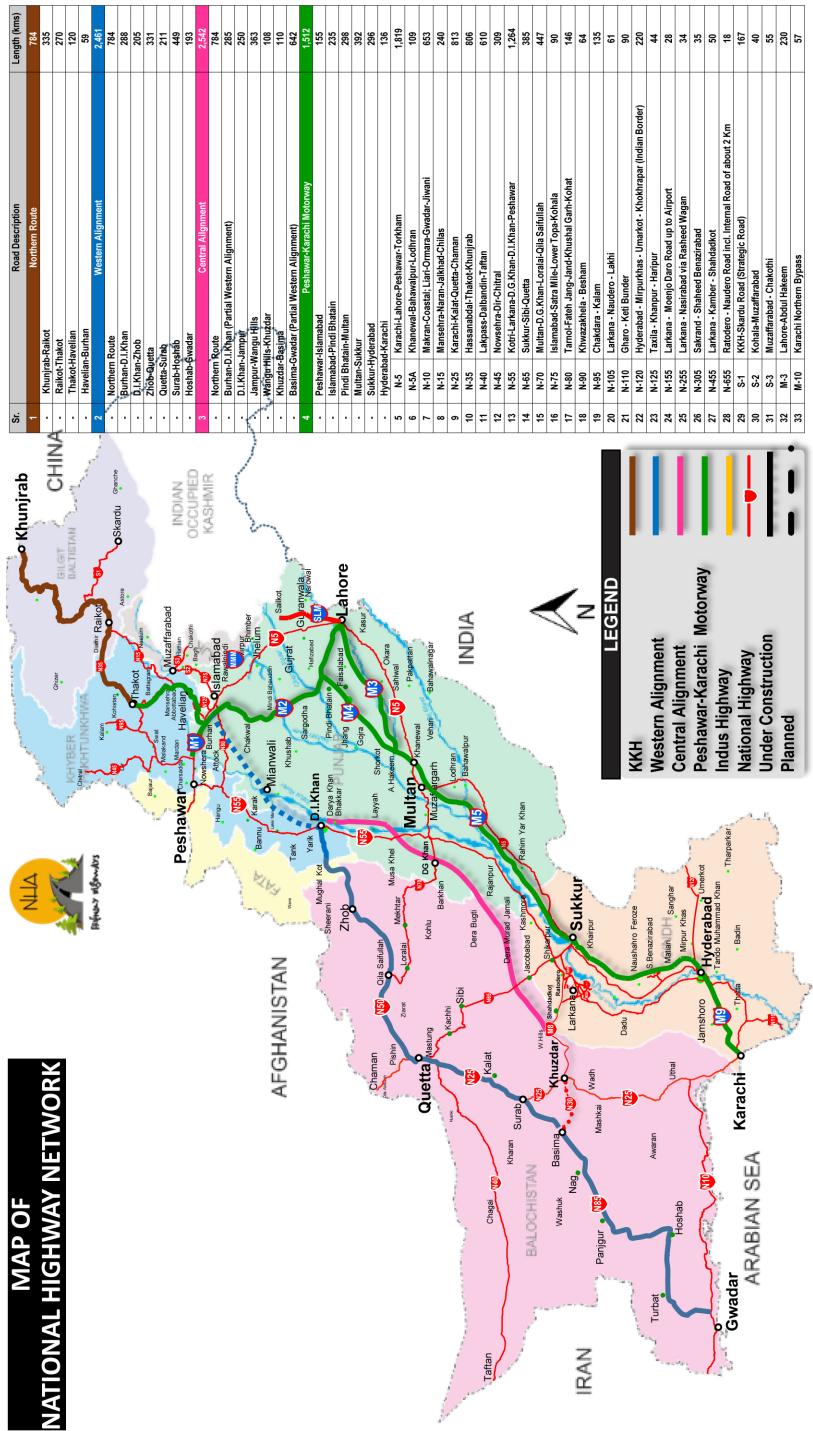


Figure 4.23: Pakistan road network  
Source: National Highway Authority of Pakistan

Source: National Highway Authority of Pakistan

These roads support the country's 80% commercial traffic. The national longest highway is N-5 connecting Karachi port to the border with Afghanistan—Torkham. With a length of 1756 kilometers, it is also the busiest road conveying 65% of the whole country's commercial cargoes. Railway infrastructure in Pakistan is unevenly constructed as well. Since 2000, the Pakistan Railway remains a total length of 7,791 kilometers with old facilities and locomotives and almost no electrification. The country's railway network mainly consists of the north-south ongoing Peshawar—Karachi line (Main Line 1), Kotri—Attock Line (Main Line 2), Quetta—Taftan Line (Main Line 4); and the east-west stretching Rohri—Chaman Line (Main Line 3). The longest and busiest is Karachi—Peshawar Line (ML-1), established in 1881 with a length of 1,687 kilometers. In general, the eastern part of Pakistan has higher density of roads and railways, the western part is far less developed.

In terms of land freight transportation, CPEC construction projects cover both road and railway. The main road infrastructure projects consist of four alignments, see Figure 4.24.

- Northern Alignment (790 km): as the Pakistani part of Karakoram Highway (KKH), the road project along the Northern route refers to the reconstruction and upgrade of Pakistan's National Highway 35 (N-35). The southeast end is Burhan, at where it can further access the motorway M1 and M2. Burhan is also the intersection node of the Eastern Alignment and the Western Alignment. The KKH extends to China's Kashgar as the north end through Khunjerab Pass, connecting to China National Highway 314 (G314). As mentioned, passing by the Karakoram mountain with average elevation over 5,500 meters, the KKH is 1032 kilometers and the highest paved road in the world. KKH is also a part of the Asian Highway AH4. The KKH Phase-II project is to upgrade the section between Burhan and Raikot. At present, the Thakot—Havelian section has been completed. The Thakot—Raikot remaining portion is under plan.
- Western Alignment (2,492 km): covers the lagging western provinces of Balochistan, Khyber Pakhtunkhwa, and western Punjab province. Starts from Barahma Bahtar Interchange on the M1 motorway near Burhan, the western route goes across Dera Ismail Khan (D.I.Khan), Zhob, Quetta, Surab, Hoshab, and finally reached Gwadar. There are several projects including new construction and reconstruction of the existing sections. The Western Alignment can largely promote local development. For instance, in Balochistan province 870 kilometers road project was planned to reconstruct. In Khyber Pakhtunkhwa, at least seven special economic zones (SEZs) are designed along the route.
- Central Alignment (2,423 km): connects Gwadar to the cities of Basima, Khuzdar, Sukkur, Rajapur, Layyah, Muzaffargarh, and terminated at D.I.Khan, then goes to connections to KKH via Braham Bahtar—Yarik Motorway, merge to the western route.

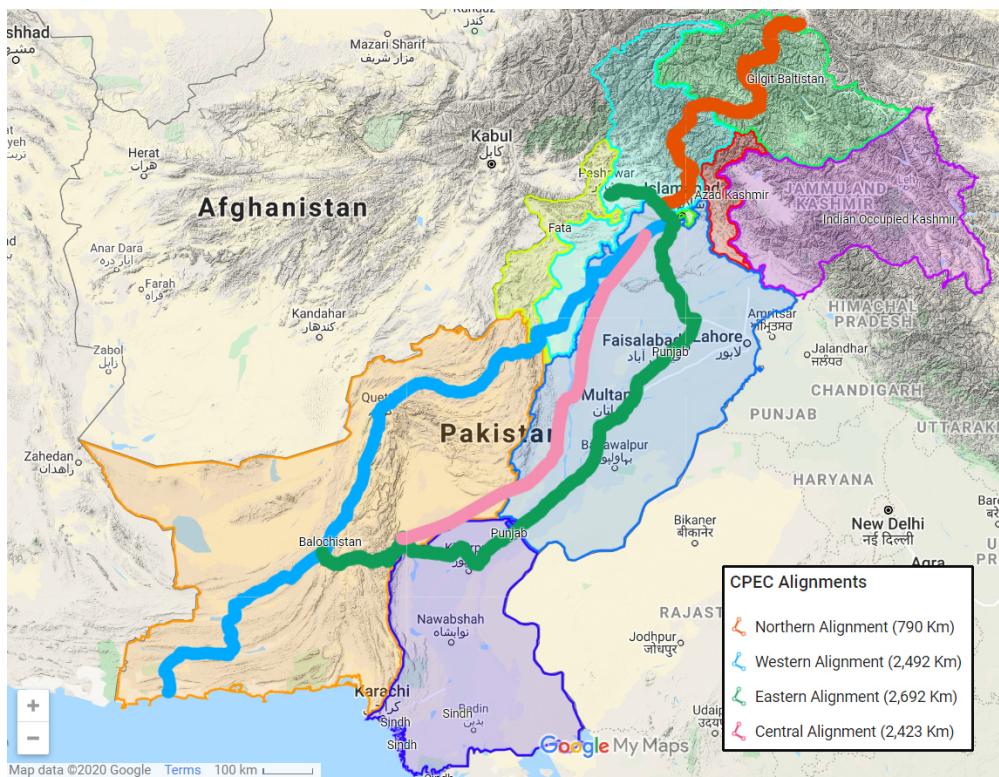


Figure 4.24: CPEC road projects—four alignments

Source: National Highway Authority of Pakistan

- Eastern Alignment (2,692 km): the entire Eastern Alignment motorway project consists of four sections, linking Karachi and Lahore as part of the Karachi—Peshawar Motorway. The upgrade of Karachi—Hyderabad section (136 km) is also the M9 Motorway to provide high speed road access. A six lane controlled-access motorway of Hyderabad—Sukkur section (296 km), including seven interchanges and 25 bridges on the Indus river and various canals. This route is parallel to the existing two-lane National Highway and one-lane Indus Highway. A six lane wide controlled-access highway of Sukkur—Multan section (387 km), including 11 interchanges, 10 rest facilities, 492 underpasses, and 54 bridges along it. The Multan—Lahore section (333 km) includes the first 102 km M4 Motorway between Khanewal and Abdual Hakkem, funded by the Asian Development Bank.

At present, the progress of road infrastructure projects surpasses the progress of railways. Major projects including KKH Phase-II and Multan—Sukkur section have completed. Western Alignment is designed as the highest priority, projects including Hakla

D.I.Khan Motorway, Surab—Hoshab (N-85), and Gwadar—Turbat—Hoshab (M-8) has been completed.

The railway infrastructure construction projects under CPEC is in line with Pakistan Railway Vision 2026, which is proposed in 2014 to increase the freight market share of railway. There are several reconstruction projects and new line construction. The planned projects along the North Alignment also cover the construction of Havelian—Kashi New Railway (1,059 km). Along the Western Alignment, the projects include the reconstruction of Kotri—Attock Line (ML-2), Quetta—Taftan Line (ML-3), New Railway Line from Quetta to Kolta (560 km), New Railway from Gwadar to Jacobabad and Quetta (1328 km). Along the Eastern Alignment, the projects cover the expansion and reconstruction of the existing Karachi—Lahore—Peshawar (ML-1) railway and the Havelian Dry port for containers. These two at present are the main projects in progress as the short-term plan by 2020. The ML-1 is intended to build the High Speed Railway Line with a length of 1,600 km. Besides, there is an alternative scheme of Gwadar Port Passage planned. The whole projects are planned to complete in short term by 2020, middle term by 2025 and long term by 2030.

Currently, China's Indian Ocean access via Gwadar port can only achieve by road. From Kashgar goes through KKH, at the end of the North Alignment, the other three alignments are all possible. Through the Makran Coastal Highway (N-10), Gwadar port is also connected to Karachi, hence Gwadar port can access China through the Eastern Alignment as well. Through the CPEC, China can access the Indian Ocean to avoid the long-haul through Malacca Strait, as shown in Figure 4.25. The figure presents the two routes from Dubai, UAE to Shanghai, China as an example.

For comparison purpose, the research applied the Time/Cost-Distance approach by UNESCAP, which is a suitable method for transit corridor performance evaluation. The time-distance graphs are shown as Figure 4.26. For the sea shipping route, according to the online statistics<sup>1</sup>, it is 6,627 nautical miles from Jebel Ali port (Dubai) to Shanghai. According to COSCO SHIPPING Lines website, the time for this eastern bound service—the CMS1 takes 22 days<sup>2</sup>. In terms of the land-sea intermodal route, it is 474 nautical miles from Jebel Ali port to Gwadar port; the Western Alignment of CPEC is 2,492 km; from Kashgar to Shanghai it is 5,188 km through China's G7 Expressway. COSCO's KGS is the only line that calls Gwadar port, and the western bound service from Gwadar to Jebel Ali takes two days. The land transportation time is calculated by the speed of trucks—40 km/h in this case. Normally the highest speed is up to 80 km/h on the smooth way and dropped to 30 km/h or below in mountainous area (Alam et al. 2019). Besides, considering factors like traffic jam, rest of drivers, it is reasonable to diminish eight working hours per day for road transport.

As shown, the CPEC route can decrease around 30% of distances and over 40% time.

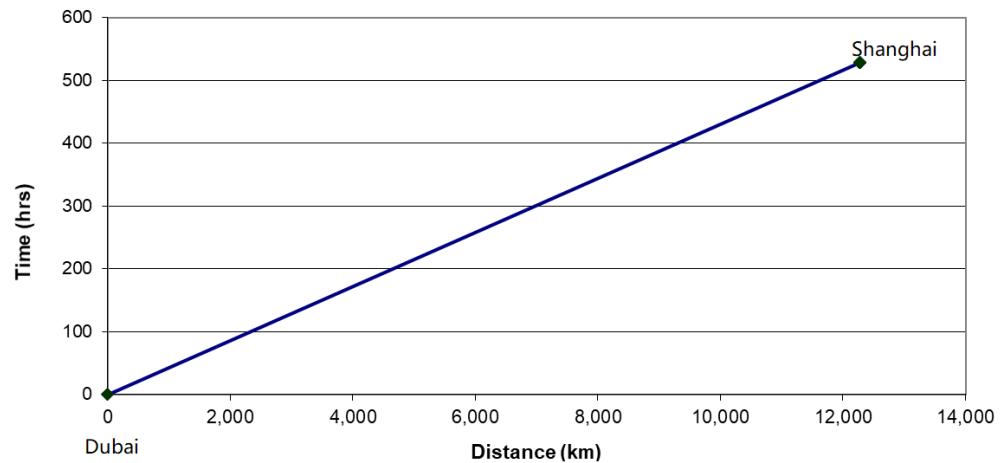
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<sup>1</sup>ports.com

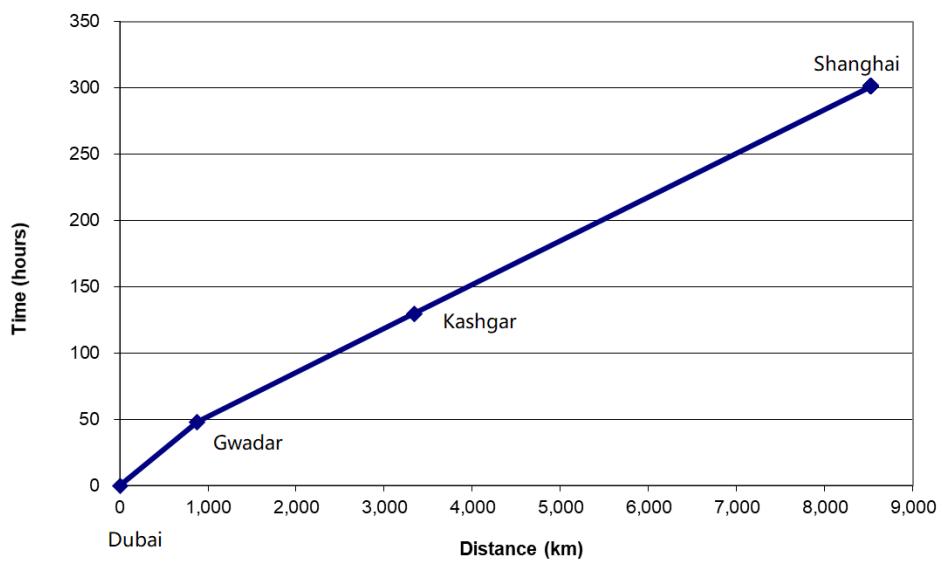
<sup>2</sup><http://lines.coscoshipping.com/home/Services/route/11>



Figure 4.25: CPEC land-sea intermodal transportation routes



(a) Time-distance graph of sea shipping route



(b) Time-distance graph of CPEC route

Figure 4.26: Comparison of CPEC route to sea shipping route

Compared to road transportation, a large advantage of sea shipping is the capability of transporting large volume of cargoes. This shortage of road compared to sea can be largely fulfilled if railway services are available. The designed routes of Pakistani railway lines are generally in parallel with the alignments. Once these railway lines are into practice, the land-sea intermodal route will be more efficient. Besides, the comparison route is destined in Shanghai, as the representation of China's supply/demand nodes. This is because China's eastern coastal area is one of the busiest economic center. While, as western regional development is one of China's objectives to establish BRI, the potential of western area such as Khorgos is rising and could be new supply/demand node by participating in economic activities (refers to section 4.6). With the development of both Gwadar and China's western area, the CPEC can further realize its potential and advantages compared to the sea shipping route.

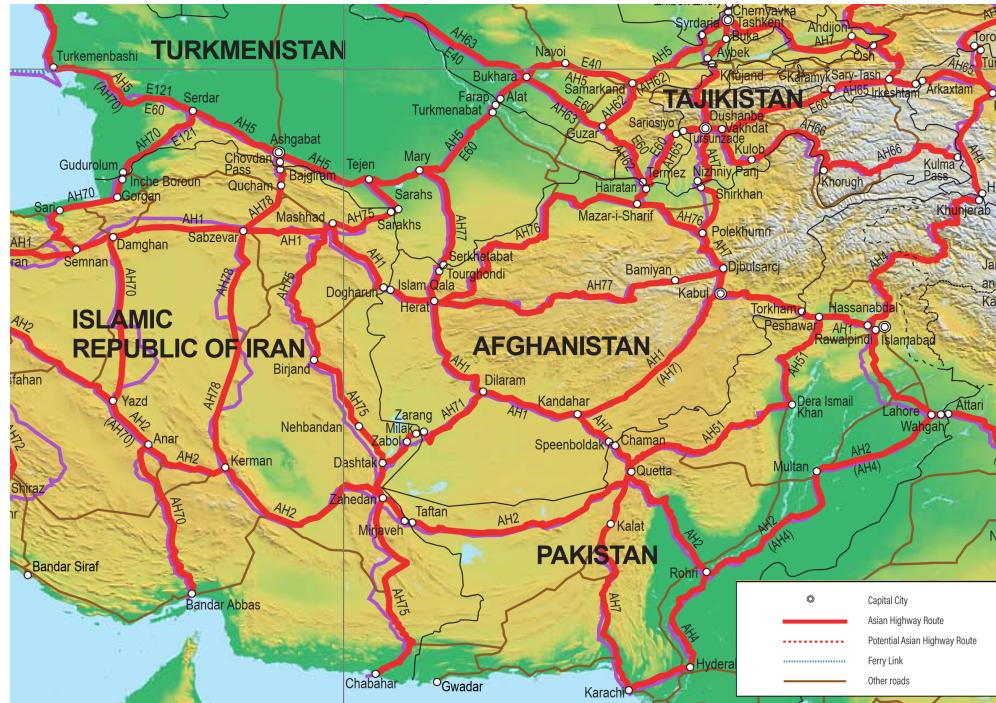
### **Gateway for Central and South Asian countries**

Central and South Asian landlocked countries can access the Indian Ocean via Gwadar port as well. The hinterland connectivity of Gwadar port to these countries hence is the most critical factor, determining the potential of Gwadar port as the gateway to inland areas. CPEC mainly focuses on the connections between Gwadar port and Chinese western area, the land access to Pakistani landlocked neighbors are not emphasized. Still, over the development, there are several related infrastructure programs or agreements improving connectivity, including the construction of Asian Highway Network, Trans-Asia Railway network, and Central Asia Regional Economic Cooperation (CAREC) planned corridors. Pakistan can access the Central and South Asian landlocked countries through these corridors, offering Gwadar port opportunities to serve as gateway.

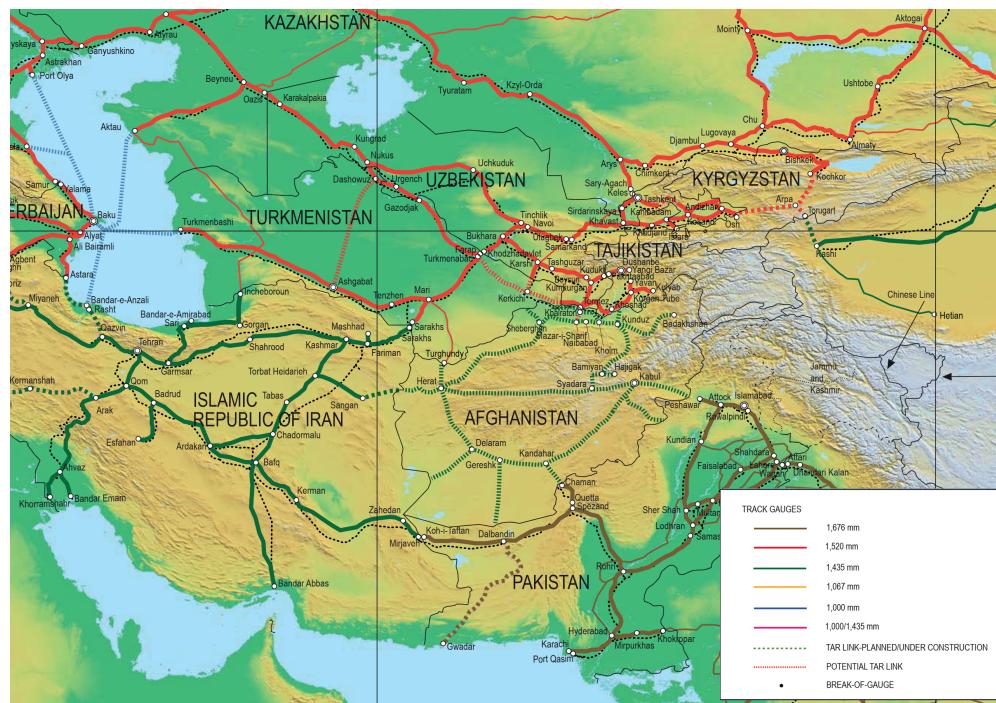
UN Economic and Social Commission for Asia and the Pacific (UNESCAP) developed the concept of Asian Highway Network (AH) and Trans-Asian Railway Network since 1950s. The aim is to enhance the efficiency and development of road and rail infrastructure in Asia, to support Eurasian transport linkages and improve connectivity for landlocked countries. A total length of 141,000 km of roads comprising the AH network linking 32 member countries<sup>1</sup>. The Trans-Asian Railway (TAR) network is 117,500 km long connecting 28 member countries. Screenshot the Pakistan section, the newest AH network and Trans-Railway network are shown in Figure 4.27. As shown in sub-figure (a), Pakistan can access Afghanistan from Torkham or Chaman through CPEC planned Western and Eastern Alignments. Passing through Afghanistan, these roads further extend to stan countries in the north. Gwadar port is not directly connected to the AH network, and Karachi port is linked to the AH stretching to Northern part of Pakistan. Instead, Chabahar port in Iran is connected to Zahedan and then goes to Afghanistan, offers a possibility to serve Afghanistan as a gateway. To gain market

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<sup>1</sup><https://www.unescap.org>



(a) Pakistan section of Asian Highway Networks



(b) Pakistan section of Trans-Asian Railway Network

Figure 4.27: Pakistan section of AH and TAR networks  
Source: UNESCAP

share, it is in urgent need for Gwadar port to further increase the connectivity and quality of road infrastructure. In sub-figure (b), it is shown that the track gauges in the area is quite different from country to country. Pakistani applied track gauges are 1,676 mm; Iranian applied gauges are 1,435 mm. In Afghanistan, there is almost no available railway lines. The lack of railway infrastructure in Afghanistan indicates that road is the only mode to deliver Pakistani transported goods to reach Afghanistan and Central Asian countries. Trains from Pakistan to Iran needs to transfer at different sizes of tracks, which increases inconvenience and decreases efficiency. In terms of Gwadar port, there is a planned line connecting to the Quetta—Koh-i-Taftan line, the same route planned under CPEC. After the completion, Gwadar port can connects to Zahedan in Iran by railway with break-of-gauge.

CAREC has 11 member countries, including the five stan countries in Central Asia, and Afghanistan, Azerbaijan, Georgia, Mongolia, Pakistan, as well as China. Pakistan joined the CAREC Program in 2010, seeking ways to improve regional connectivity and overcome barriers to growth. The CAREC six corridors are designed in the Transport and Trade Facilitation Strategy (TTFS) in 2007 to enhance the regional connectivity as well, see Figure 4.28. The main idea is to promote development through infrastructure investments and trade facilitation initiatives. The program is initially planned to be applied in 2008-2017. After TTFS, CAREC published the CAREC 2020, CAREC 2030 to report the progress and update the further implementation measures. Among the six corridors, corridor 5 connects East Asia to Middle East & South Asia. After Pakistan joined the Program, a significant change to the plans is to extend the initial corridor 5 to the Arabian Sea. It connects ports of Gwadar and Karachi to Central Asia mainly by road transit, can facilitate trade flows among East Asia, Central Asia, and South Asia. According to CAREC, the road from Karachi to the border at Torkham (Afghanistan)—Peshawar is about 1,750 km long, which is the shortest route for Central Asia countries to a seaport. Besides, there are two directions from Gwadar port and Karachi port to Kashgar (Kashi in the Figure). The eastern route starts from Karachi port, is in parallel with the Eastern Alignment of CPEC. It is the realignment of KKH at Hunza due to Attabad Lake overflow. The western route starts from Gwadar port, goes across the border Chaman, and connects to Kabul (Afghanistan), Dushanbe (Tajikistan), and Irkeshtam, the border crossing between Kyrgyzstan and Xinjiang, China. The western route of corridor 5 therefore offers an alternative choice for Gwadar port—Kashgar connection, can be a substitute for KKH to enter China. Corridor 6 connects Europe and Middle East & South Asia, a north-south corridor offers access to Pakistan and Iranian seaports in the south. Through this corridor, Gwadar port is linked to Turkmenbashi port in the Caspian Sea, offers the possibility of sea-land-water intermodal transportation.

In a summary, with existing road network, Gwadar port as the gateway for Central and South Asian countries is possible. The largest advantage is via Gwadar port is the shortest distance for those landlocked countries to access sea. The possible competitors are the port of Bandar Abbas and Chabahar in Iran. Bandar Abbas port is located at the Strait of Hormuz, far away from those landlocked countries with little

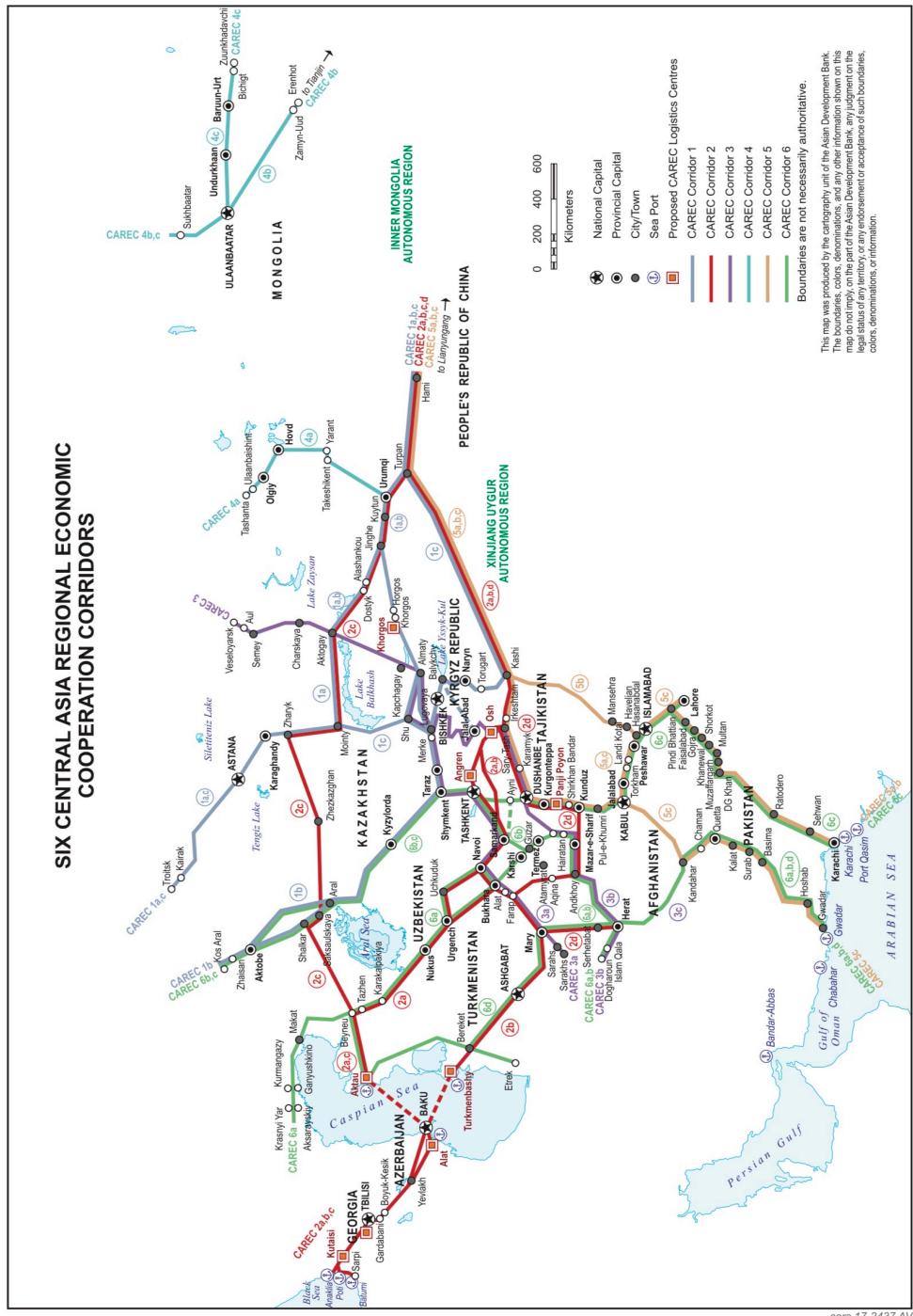


Figure 4.28: CAREC six corridors  
Source: CAREC

advantage. Chabahar port as the first foreign invested port project by India, can be a strong competitor to Gwadar port. For instance, to support the transit between India and Afghanistan via Chabahar port, Iranian railway route Chabahar-Zahedan is under construction. At the same time, a trilateral agreement was signed between India, Iran and Afghanistan for the transit route linking Indian ports to Chabahar port for freight goods destined to Afghanistan. Special Economic Zone in Chabahar port is invested by India as well. Hence, to enhance the competitiveness of Gwadar port, it is necessary to further invest port infrastructure and improve its connectivity to both China and the countries of Central and South Asia.

#### **4.4.4 Potential of regional industrialization**

The construction of expressway, new airport, and Gwadar port in the city can significantly improve its connectivity to the global transportation system. This enables the mobility of physical materials and people, lays fundamental basis for regional industrialization. Pakistan government has the "Gwadar Smart Port City Master Plan" agreed with China in 2015. According to the "Integrated Gwadar Smart Port City Master Plan (2017-2050)", the population of Gwadar will reach 2 million from around 300,000 in the next 30 years. The size of the city's economy will achieve \$30 billion annually. Three directions is the city heading. First, it is designed as a new national gateway with innovative policies, convenient transportation and smooth trade. Second, it is a new engine to drive the development of southwestern Pakistan. Third, it is a smart port city referring to the construction of the city itself and the operation with information technology. The city will consist of Industry Service Center and the Trade Service Center. With seven north-south orientation corridors planned in the entire urban area, the city will be divided into 11 zones. The eastern large five zones will be production area, the western five zones will be life area, and the last one zone is the southern port area. To achieve these goals, the first step is to create a sounding investment environment to attract investment through establishing Special Economic District. To enhance the investors' confidence and increase the local's living environment, the government intends to build the city as a "weapon-free" zone. The second step is to develop leading industries and consolidate the economic foundation. The guide industries mainly are petroleum refining, marine fishery, and trade logistics to form industrial chains. The third step is to coordinate port and city with diversified development, construct diversified and sustainable industrial structures such as chemical, automobile building materials, marine fisheries, environment protection and IT to create more jobs.

As the transitional form of FTZ, the Free Zone within the port area is an important measure to support the future sustainable growth of port throughput and local economy. The Free Zone project is managed by Gwadar Free Zone Company Ltd (GFZL), a subsidiary of COPHC. The other two subsidiaries are Gwadar International Terminals Ltd. and Gwadar Marine Service Ltd. The GFZL designed the entire zone to two

areas: the South Area (Phase-I project) and the North Area. The South Area project started in September 2016 has been completed, it is around 62 acres and will function as the commercial logistics zone with commodity exhibition, transit trade, etc. The North Area covers 2219 acres designed for introducing manufacturing companies in the future, and the area will be developed in three phases. Currently, the South Area of Gwadar Free Zone has completed the process of investment and business introduction. More than 40 Chinese and Pakistan corporations arrived, specialized in hotel, banks, insurance, logistics, warehousing, grain and oil processing, fishery processing, etc. Besides, in parallel with the Free Zone, 3000 acres of land is remarked as industrial zone implemented by Gwadar Industrial Estates Development Authority, and 1000 acres of land is designed as processing zone managed by Export Processing Zones Authority. In order to attract FDI, Pakistan government offers tax exemptions of 23 years for the corporations in the Free Zone. The 1st & 2nd International Exhibition in Gwadar i.e. GWADAR EXPO 2018/2019 have been successfully conducted by COPHC. The 3rd exhibition GWADAR EXPO 2020 is planned on June 18-19th, 2020.

Though Gwadar port is still at its early stage of development, these measures have drawn a lot of attention from countries and companies. They perceived the opportunity of industrialization of Pakistan, especially in the resource-based sectors such as oil refinery. For instance, Saudi Arabia decided to invest with \$10 billion to construct a petroleum refinery near the port in the beginning of 2019. Considering the large shortage of resources in Pakistan, the new refinery will fuel the domestic living and production needs. And Gwadar port can supply its export shipping demands. In addition, it is discovered in August 2018 that in Pakistan near to the Iranian border, there are large amount of oil reserves. And this is not a single case. The Oil and Gas Development Corporation of Pakistan (OGDCL) announced the discovery of a new oil and gas condensate in the country's southern Sindh province in May 2019. It is very reasonable to predicate oil drilling, refinery and petrochemicals can one of the leading industry in Pakistan. Considering the geographical proximity to the Middle East, Gwadar port has the potential to develop to a new energy transit node.

## **4.5 New Eurasia Land Bridge and CR Express**

The implementation of BRI, especially the efforts on improving overland connectivity in Eurasian, is very likely to change the pattern of world economy supported by maritime shipping, and further change the spatial structure of GLNs. Land connectivity improvements offer alternative transportation services and routes for the mobility of goods and people. Not only the two ends of the transport corridors but also the economies along it will benefit from trade promotion and economic growth. Due to spillover effects, these benefits may even extend to neighboring areas, and cause a sequences of dynamic effects. Critical dry ports can function as transit nodes. Just like seaports' integration into global supply chains, dry ports also have the potential

to attract investments and become strong engines to drive logistics and industrial specialization. These dry ports can function as part of hinterland transportation system corresponding to a specific sea port, constitute a land-sea intermodal transportation system. Or they can function as pure land transit nodes. In the Eurasian continent, maritime shipping have maintained its leading position for goods exchange over time. While, the improvements of regional land connectivity in Eurasian can alter the situation, leading to a new era of long-haul land transportation. Besides, under the frame of BRI, corridors are both transport corridors and economic corridors. Apart from transportation infrastructure projects, many other economic, industrial and technical cooperation projects, such as trade agreements, cooperation parks, electronic custom clearance etc. are implemented as well. These measures can help to realize the potential of infrastructure investments and enhance regional economic integration. For the landlocked countries in the Eurasia, BRI offers opportunities for them to get more involved in world economy, and improve their industrialization level to be integrated into global value chains.

Among the six economic corridors, the construction of the New Eurasian Land Bridge Economic Corridor (NELBEC) refers to the idea of promoting physical connectivity and economic cooperation along the New Eurasian Land Bridge (NELB). This is a new trans-continental railway channel, starts from China and reaches several destinations in Europe. It is also called the "Second Eurasian Land Bridge", as a comparison to the "First Eurasian Land Bridge", which is the Siberian Land Bridge (SLB), or Trans-Siberian Railway (TSR). The SLB with a total length of 9,258 km linking Russian Far East seaport Vladivostok to Moscow<sup>1</sup> was completed in 1916 (Rodrigue 2016). As its development, it further access to some European countries such as Finland, Latvia and Poland (Schramm and Zhang 2018). Nowadays the SLB section has been integrated as one section under the framework of the NELB (see Figure 4.29). Chinese part of it consists of two sections: Lianyungang-Lanzhou Railway and Lanzhou-Xinjiang Railway. It goes across 7 provinces of China until the port of entry Khorgos/Alashankou (border between China and Kazakhstan). Then it spans to 3 directions and at last extends to Rotterdam (Netherlands). From a historical view, the NELB actually first launched the block train from Chongqing to Duisburg (Germany) in 2011. In the following years, this line has been integrated into a regular express line named "Yu Xin Ou", which operates block trains from Chongqing to European countries via Xinjiang. Meanwhile, other railway lines are also developing. The eastern terminal Lianyungang port, for instance, opened several entry and exit channels through Alashankou, Kashgar, Khorgos, Almaty (Kazakhstan) for container shipping. Therefore, the NELB is more like a reintegrated and updated plan reallocating the existing resources to better connect China and Europe.

The most significant achievement of NELBEC is the operation of CHINA RAILWAY (CR) Express, which offers railway container freight services with fixed lines and sched-

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<sup>1</sup><https://www.thetranssiberiantravelcompany.com/tours/planning-route-options/>, accessed on Oct.31th, 2018

ules. It provides alternative transportation services linking China and Europe. This improves the regional land connectivity facilitating China-EU trade, and the large amounts of inland countries can seek opportunities to benefit from this corridor. As the development, the scale of CR Express and its services keep expanding, nowadays CR Express is not restricted to serve China-Europe trade any more. The block trains go to Southeast Asia, Central Asia, and Middle East as well. The last several years witnessed its rapid market expansion surpassed its initial plan implying large growth potential in the future.

#### **4.5.1 CHINA RAILWAY Express planning**

The construction of NELB is mainly represented by the operation and expansion of CR Express. The detailed route map of the NELB is shown as Figure 4.29, released as the planning map of CHINA RAILWAY (CR) Express in the official document "Development Plan of China-Europe Freight Train Construction (16-20)". Described in this document, CR Express is organized by the state-owned enterprise China Railway Corporation, offers scheduled international railway container freight transportation services between China and Europe. In this plan, authors analyze the background and the demand for railway freight between China and European countries and present the spatial structure design of the railway transit corridors, hub nodes, and routes. As illustrated there are three railway passages initially shaped on the basis of SLB and NELB.

- Western route: comprises three main branches. One exits through Alashankou/Khorgos Pass (border between Kazakhstan and Xinjiang Autonomous Region, China) into Kazakhstan to access to the Trans-Siberian Railway, spanning Belarus, Poland, Germany and other European countries. One crosses the border at Khorgos/Alashankou Pass, extending through Kazakhstan, Turkmenistan, Iran,

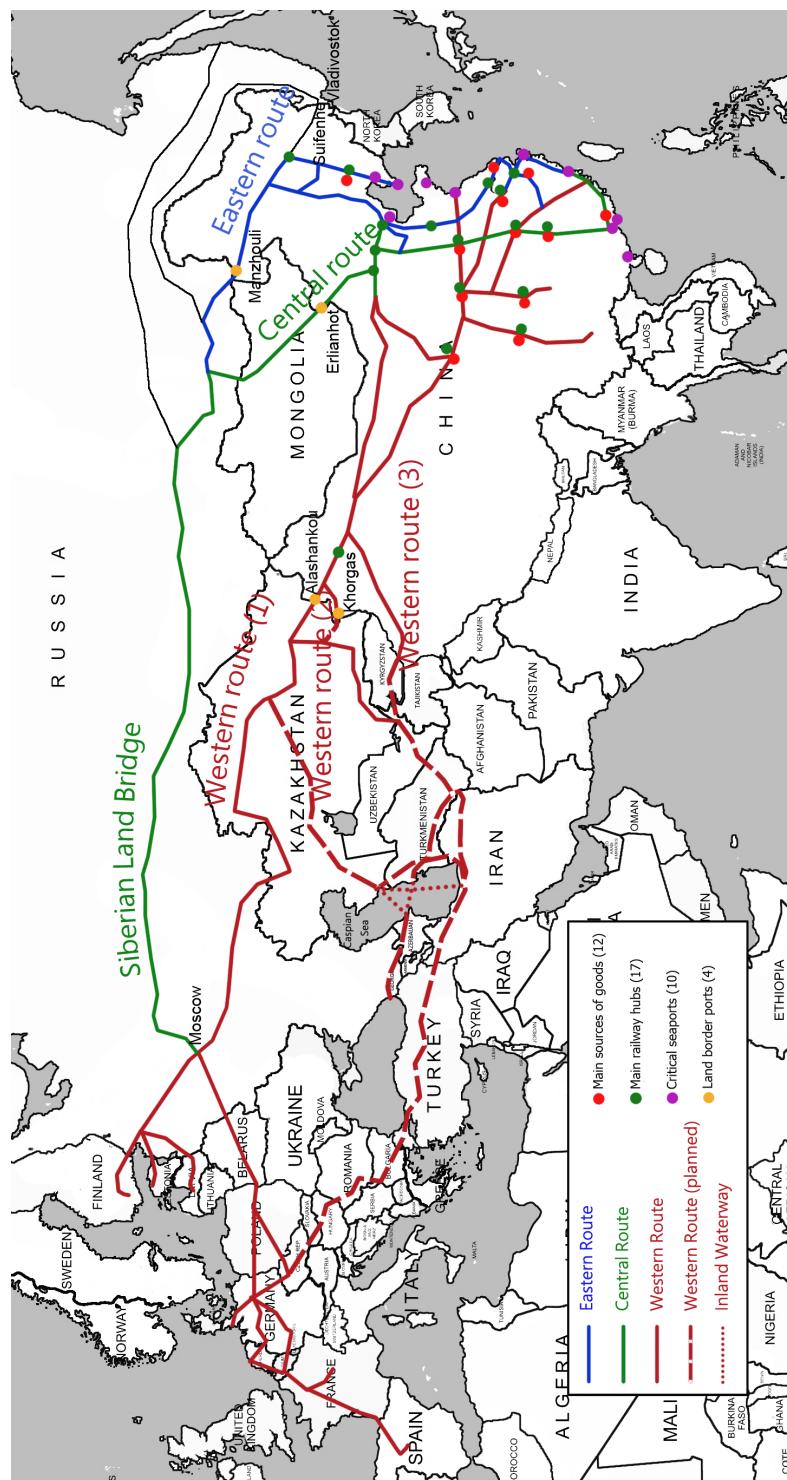


Figure 4.29: CR Express plan  
Source: adapted from the "Development Plan of China-Europe Freight Train Construction (16-20)"

Turkey and other European countries; or crosses the Caspian Sea via Kazakhstan, entering Azerbaijan, Georgia, Bulgaria, etc. and finally European countries. The last branch spans across Torugart/Irkeshtam Pass (border between Kyrgyzstan and Xinjiang Autonomous Region, China) and connects to the planned China-Kyrgyzstan-Uzbekistan Railway. It leads to countries in the Middle East such as Turkmenistan, Iran, and ends in European destinations.

- Central route: runs across Erlianhot land port (Inner Mongolia Autonomous Region) and through Mongolia linking to the Trans-Siberian Railway. .
- Eastern route: starts from Manzhouli land port (Inner Mongolia Autonomous Region) or Suifenhe port (Heilongjiang province) linking to Trans-Siberian Railway.

Based on the planned three directions of transportation routes, they divided the whole country into three freight attraction areas: China's western area, central area and eastern area, as shown in Figure 4.30. The organization of CR Express is designed as main lines combined with branch lines and 43 hubs are set up which respectively located at inland main sources of goods (12), main railway hubs (17), main seaports (10), land border ports (4). The detailed hubs' location and their function are listed in the Table 4.4.

Table 4.4: CR Express critical nodes

Source: Based on "Development Plan of China-Europe Freight Train Construction (16-20)"

Type	Function	Location
Sources of goods (12)	Goods collection and distribution, more than 2 direct trains per week	Chongqing, Chengdu, Zhengzhou, Wuhan, Suzhou, Yiwu, Changsha, Hefei, Shenyang, Dongguan, Xi'an, Lanzhou
Railway hubs (17)	Transit and distribution hubs, train marshaling plan	Beijing, Tianjin, Shenyang, Harbin, Jinan, Nanjing, Hangzhou, Zhengzhou, Hefei, Wuhan, Changsha, Chongqing, Chengdu, Xi'an, Lanzhou, Urumqi, Ulanqabu
Seaports (10)	Sea-rail intermodal transportation hubs, more than 3 direct trains per week	Dalian, Yingkou, Tianjin, Qingdao, Lianyungang, Ningbo, Xiamen, Guangzhou, Shenzhen, Qinzhou
Land border ports (4)	Entry-exit inspection and quarantine, facilitated customs clearance, transshipment of goods	Alashankou, Khorgos, Erlianhot, Manzhouli

In line with the allocation of hubs, CR Express operates direct lines from either these

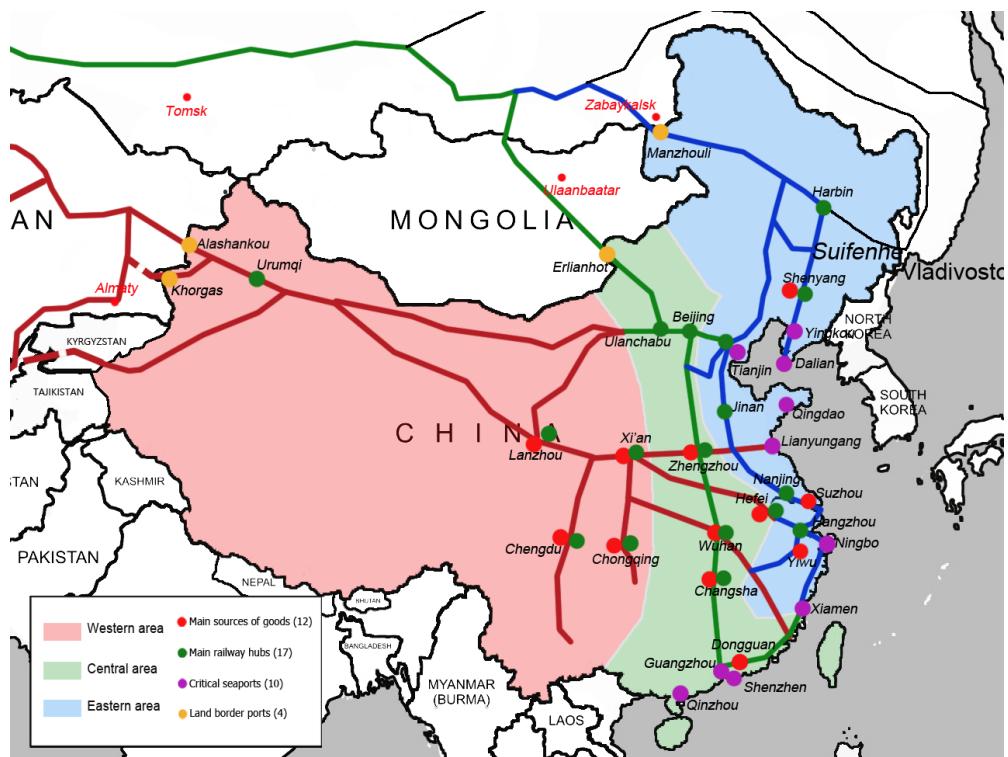


Figure 4.30: Freight attraction areas of the three CR Express routes

Source: adapted from the "Development Plan of China-Europe Freight Train Construction (16-20)"

12 sources of goods or 10 seaports to European destinations, as well as transfer lines transiting or distributing at the 17 railway hubs or from other scattered lines. The document also reveals there are 23 direct train lines operating and 23 lines under planning.

#### 4.5.2 Relocation motivated the first CR Express— "Yu Xin Ou"

The first launched block train is "Yu Xin Ou" from Chongqing to Duisburg in 2011. The story behind represent well the close relationship between transportation, investment, relocation & industry transfer, regional specialization and economic growth. The common idea is the promotion of connectivity and transportation infrastructure/services can help foreign direct investments (FDI) attraction as well as regional growth. While, in this case of Chongqing we can notice that the FDI also push forward the promotion of connectivity and the updating of transportation infrastruc-

ture/services, as long as the local governments offered enough attention and support. More importantly, these positive effects lead to further improvements of FDI attraction, regional specialization, and industrial clusters agglomeration. It turns out a strong feedback loop that reinforces the whole dynamic process. The rise of Chongqing, especially its core role as a laptops production base, accompanies with relocation of many firms causing a small scale of industry transfer.

Chongqing as a inland municipality is located at the southwestern area of China and the upper reaches of the Yangtze River. Compared to the eastern coastal cities, it has no significant geographical advantages for maritime shipping. Since China's rapid growth heavily relies on exports, the most important economic growth poles in a long time are the Yangtze River Delta and the Pearl River Delta. To respond to the "Western Development Policy", Chongqing authorities were actively improving infrastructure and seeking foreign investments. The turning point is 2008, when Chongqing government successfully introduced investments from Hewlett-Packard (HP). In the year of economic crisis, different from other industries, laptop computer sales continue to grow. HP hence was considering to set up a new factory in Asian countries. To seize this opportunity, Chongqing authorities offered beneficial incentives and more importantly, they guaranteed to localize 80% of parts (Ishikawa 2018) in the next three years, and if not they would compensate the caused logistics costs. The conventional pattern is to import parts and export assembled laptops, thus localized production of parts can largely reduce inventory and transportation costs. This is obviously a irresistible deal. HP decided to configure a production site for 40 million PCs in Chongqing to pursue comparative advantages to lower production costs and this factory opened in 2010. Yet, this is only a start. To further attract parts suppliers, Chongqing operated railway block trains to Shanghai and Shenzhen, and reduced the delivery time to Shenzhen to 2 days. Following those measures, Chongqing negotiated a sequence of investments and finally formed the "3+6+300" laptop industry cluster in 2011. This cluster includes 3 laptop export manufacturers: HP, Acer, Asus; 6 Taiwanese original design manufacturers (ODMs) including Foxconn; and over 300 parts suppliers. Accompanying with this process, many suppliers relocated from coastal cities like Guangzhou to Chongqing. A relatively small scale of industry transfer rapidly took place. This is partly due to the competition relationship between the PC brand companies, and partly due to the close collaboration between PC brand companies and parts suppliers (Ishikawa 2018; Li and Taube 2019). In summary, HP's investments in Chongqing caused a sequence of positive results: more investments attracted, agglomeration effects happened, regional specialization achieved and industrial clusters formed.

The formulation of industry cluster created mass pressure on transportation, especially in terms of exporting to Europe. The available freight channel from China to Europe at that time is either transport to Shanghai on inland waterway of the Yangtze River or Shenzhen by railway and then ship to Europe by sea (accounting for 60%-70%) or air(Ishikawa 2018; Li and Taube 2019). However, maritime shipping is the most time-consuming mode, and the value of electronic products are highly time-sensitive.

Air transportation is fast enough, but the cost is too high. Though the costs induced by long delivery time can be covered by the savings from relatively low production costs, all these producers are eager to seek more efficient logistics solutions. HP set up a special group analyzing the Eurasian Land Bridge, and even tried to convey products to Europe by rail but failed due to many complex reasons. To conquer this issue, in 2010 Chongqing authorities went to Beijing and applied the prototype of China-Xinjiang-Europe transportation channels to China's General Administration of Customs and China Railway Corporation, with companions include the current corporate senior vice president of HP. This proposal was then put on the agenda. After many negotiations with several stakeholders, China has signed an agreement with Russia and Kazakhstan to ease the procedures of customs clearance. The block train from China only requires one inspection at the exit border, and with the one loading bill it can smoothly reach European destinations. Besides, the multilateral negotiation also cleared the responsibility of each side. After several sectional trials, the first direct block train from Chongqing to Europe finally operated in 2011. Electronic products on the train were delivered to Duisburg spending 16 days. Following this, the memorandum of "jointly promoting regular operation of "Yu Xin Ou" international railways" is signed on the second meeting. A joint venture platform company named "Yu Xin Ou (Chongqing) Logistics Co.,LTD" is officially formed with the involvement of China Railway, Russian Railway, Deutsche Bahn (DB, Germany railway company), Harbin Railway, as well as Chongqing Transportation Group. Since 2013, "Yu Xin Ou" regularly organizes either 1 or 3 block trains per week. Nowadays, this route operates 1 block train (?) The initial goal of "Yu Xin Ou" railway route is to facilitate laptops export from the production base Chongqing to Europe. While, 2 years later the idea of jointly building the BRI is proposed, and naturally "Yu Xin Ou" railway route is included under the framework. Then this market driven bottom-up strategy integrated into a top-down national initiative. The construction of the NELBEC stimulates diversified opportunities. In this context, "Yu Xin Ou" meet new chances and the success can expand to many aspects rather than just exporting laptops. The first sign is this route starts to deliver European goods to China on the return trips. The inbound regular trains were operated since 2014. The first one started from Duisburg following the same route arrived Chongqing, loading with vehicle parts from Chang'an Ford Automobile Co., Ltd. with a total value of more than 5 million euros. the construction of Land-sea freight route This is in line with the feedback loop modeled in section ??.

Since the railway in Russia/Mongolia/Kazakhstan is mainly broad-gauge (1520mm), while the

railway in China and most European countries are normally standard tracks (1435mm), the entire block train needs to transfer twice along the route. The NELB access more than 40 countries/regions, connecting the two critical economic centers- the Pacific Ocean in the east and the Atlantic Ocean in the west.

### 4.5.3 Operation of CR Express

Since 2011 before the official announcement of CR Express, driven by market demands, block train service "Yu Xin Ou" started operation. Over the last several years, as the implementation of BRI, it is witnessed that CR Express experienced rapid growth, see Figure 4.31. Many cities in China have opened CR Express lines. Until the end of

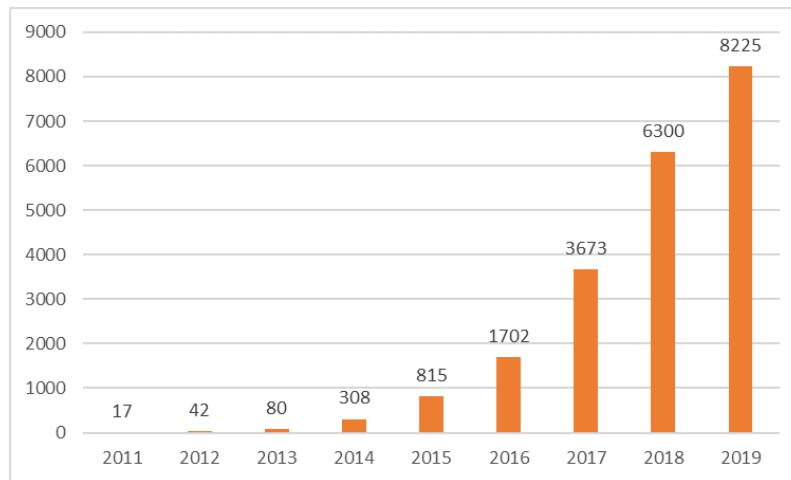


Figure 4.31: Number of CR Express by year

Source: online news

2019, there are about 65 Chinese cities offering regular block trains to over 50 cities in 15 foreign countries, leading to a complex railway services network. This network has surpassed the initial designed scale and is still expanding. The east end of CR Express is China's domestic railway network connecting all the important nodes. Starts from these nodes, trains go through three railway transport routes and across four land border ports: Alashakou & Khorgos at the western route, Erlianhot at the central route, and Manzhouli at the eastern route. After passing the border, trains go to cities in Russia, Asian, and Europe, linking to Trans-Siberian Railway, Trans-Asian Railway network and European railway network.

As the development, CR Express services cover not only the European destinations, but also Central Asian and Southeast Asian countries. Through these services, China can trade by rail with western Europe economies such as Germany, England, Spain; central and east Europe such as Latvia, Austria, Czech; central Asian countries including the five stan countries; Middle East countries such as Afghanistan, Iran; southeast Asian countries such as Vietnam. Table 4.5 lists some operating CR Express lines linking China and European countries. Table 4.6 presents the railway services connecting to Asian economies. Keep in mind that currently there are over 65 lines operating, but it is

flexible to arrange (add or cut down) railway service lines based on good infrastructure and coordination. Hence, the tables can reflect the general operation status but not all of them. As shown, to access Vietnam the routes Guangzhou/Nanning—Hanoi and Kaiyuan—Haiphong have to pass through the border ports Pingxiang and Shanyao respectively. The expansion of CR Express is not restricted to Chinese domestic nodes and European nodes. The extension to Southeast Asia seems like a natural result of the process of market maturity, promoted by China's late plan on establishing the New Western Land-Sea Corridor. This corridor is centered on Chongqing, targets at linking western Chinese provinces to Southeast Asian countries such as Singapore, Vietnam, Laos, Myanmar, etc.

Table 4.5: CR Express: China—Europe railway services

<b>Origin—Destination</b>	<b>Border port</b>	<b>Distance(km)</b>	<b>Duration</b>	<b>Frequency</b>
<b>Westbound</b>				
Zhengzhou-Hamburg/Munich	Alashankou/Khorgos	10245	15d	6/week
Zhengzhou/Wuhan-Hamburg	Erenhot		15d	2/week
Chengdu-Lodz	Alashankou/Khorgos	9826	12d	3-4/week
Chengdu-Nuremberg	Alashankou/Khorgos	10546	14d	1/week
Chengdu-Tilburg	Alashankou/Khorgos	10858	14d	2-3/week
Chengdu-Moscow	Erenhot	9572	12d	4/month
Wuhan-Minsk /Kunsevo/Hamburg	Manchuria	10700	12-15d	2/week
Wuhan-Pardubice /Lodz/Hamburg/Duisburg	Alashankou/Khorgos		15d	4/week
Chongqing-Duisburg	Alashankou/Khorgos /Erenhot	11179	15d	15/week
Chongqing-Cherkessk	Manchuria		10d	2/week
Yiwu-Madrid	Alashankou	13052	18d	1/week
Yiwu-Minsk	Manchuria		12d	1/week
Yiwu-Istanbul	Khorgos		18d	1/week
Yiwu-Chelyabinsk		11000	8d	
Yiwu-Riga	Manchuria		16d	
Yiwu-London	Alashankou	12451	18d	1 /week
Yiwu-Prague	Alashankou		16d	
Xi'an-Hamburg	Alashankou	9547	16-18d	3/week
Xi'an-Kouvola	Khorgos	9110	13-15d	1/week
Xi'an-Budapest	Alashankou	8767	13-15d	2/week
Suzhou-Warsaw	Manchuria/Erenhot	11200	12d	1/week
Yingkou-Hamburg	Manchuria		13d	3/week
Shenyang-Hamburg	Manchuria	9326	13d	7/week
Shenyang-Moscow	Erenhot		12d	1/week

Harbin-Moscow	/Warsaw/Hamburg	Manchuria	6578-9820	10-15d	3/week
Hefei-Hamburg		Alashankou	10600	15d	1/week
Changchun-Schwarzheide		Manchuria	9800	13d	2/week
Tianjin-Moscow		Manchuria/Erenhot	7800	10-11d	3/week
Chifeng-Chelyabinsk	/Sarepta/Kleschikha	Manchuria	9000	10d	1/week
Lianyungang-Duisburg				18d	
Lianyungang-Istanbul		Alashankou	10000	18d	1/week
Ulanqab-Moscow		Erenhot		5d	1/week
Changsha-Hamburg		Alashankou/Erenhot	12000	15d	4/month
Guangzhou-Moscow		Manchuria		14d	3/week
Xiamen-Hamburg		Alashankou	11866	16d	1/week
Xiamen-Moscow		Erenhot	10920	13d	1/week
Xiamen-Moscow		Manchuria		16d	2/week
Moscow	/Warsaw/Minsk/Duisburg				
<b>Eastbound</b>					
Hamburg/Munich-Zhengzhou		Alashankou	10245	18d	4/week
Hamburg/Munich-Zhengzhou/Wuhan		Erenhot		18d	1/week
Lodz-Chengdu		Alashankou/Khorgos	9826	15d	2-3/week
Nuremberg-Chengdu		Alashankou/Khorgos	10546	17d	1/week
Tilburg-Chengdu		Alashankou/Khorgos	10858	17d	2-3/week
Moscow-Chengdu		Erenhot	9572	12d	4/month
Hamburg-Wuhan		Alashankou	10000	18d	2/week
Tomsk-Wuhan		Manchuria		15d	2/week
Duisburg-Chongqing	/Chengdu	Alashankou/Khorgos	11179	18d	14/week
	/Erenhot				
Tomsk-Chongqing		Manchuria		16d	2/week
Madrid-Yiwu		Alashankou		20d	1 /week
Prague-Yiwu		Alashankou		16d	1/week
London-Yiwu		Alashankou	12451	18d	1 /week
Brest-Suzhou		Manchuria	11200	15d	1 /week
Brest-Shenyang		Manchuria		15d	1/week
Schwarzheide-Changchun	(Tomsk-Harbin)	Manchuria	9800	15-18d	2/week
Vorsino-Ji'ning		Erenhot		10d	1/week
Irkutsk-Xiamen		Erenhot		14d	1/week

Table 4.6: CR Express: China—Asia railway services

<b>Origin—Destination</b>	<b>Border port</b>	<b>Distance(km)</b>	<b>Duration</b>	<b>Frequency</b>
<b>West/southeast-bound</b>				
Yiwu-Hairatan	Alashankou	7500	12d	1/week
Yiwu-Tehran	Alashankou	10399	14d	
Xi'an-Almaty/Tashkent	Khorgos		2-7d	3/week
Nantong—Mazar-e-Sharif	Khorgos	7000	5d	1/week
Jiaozhou-Yên Viên	Pingxiang		5d	1/week
Luoyang-Central Asia	Alashankou			
Xinxiang-Central Asia	Alashankou	3600	3-5d	
Zhengzhou-Tashkent		5000	3-5d	
Chengdu-Almaty/Tashkent	Khorgos			2/month
Chongqing-Central Asia	Almaty		9-11d	2/month
Lianyungang-Almaty/Tashkent	Alashankou/Khorgos		6-10d	
Lianyungang-Istanbul			15d	
Qingdao-Almaty	Alashankou/Khorgos		10d	3-4/week
Ji'nan-Andijan	Khorgos	7300	13d	
Hefei-Almaty	Alashankou			1/week
Nanjing-Central Asia	Alashankou			
Xiamen-Central Asia	Alashankou		5d	
Ganzhou-Hairatan	Khorgos		17d	
Ganzhou-Alamedin	Khorgos		11d	
Urumqi-Almaty/Tashkent	Alashankou/Khorgos			3/day
Lanzhou-Central Asia	Alashankou/Khorgos			1/day
Guangzhou-Hanoi	Pingxiang			
Nanning-Hanoi	Pingxiang	400	20h	1/week
Kaiyuan-Haiphong	Shanyao		68h	2/day
<b>Eastbound</b>				
Tashkent-Wuhan	Khorgos			
Almaty-Xi'an			2-7d	
Almaty-Qingdao				

The line Yiwu—Alashankou—Madrid is the longest railway freight transportation service route in the world, first operated on 18th November, 2014. It took 21 days and requires over 60 train drivers to surpasses eight countries: Kazakhstan, Russia, Belarus, Poland, Germany, France, and Spain. Due to the different sizes of track gauges used in countries, it needs three times of break-of-gauge at Dostyk (Kazakhstan), Brest (Belarus), and Irún (Spain). Compared to maritime shipping which requires around 40 days, the time reduction advantage is obvious. After the improvements of speed and custom clearance facilitation measures, nowadays it takes around 18 days to deliver Yiwu produced commodities to Europe.

### **Custom clearance: improve efficiency**

Custom clearance facilitation as measures to improve transport efficiency, is a typical example representing the logistics pattern transition in the CR Express. In the Eurasian continent, there are two main regional railway cooperation organizations: OSJD (Organization for Co-operation Between Railways) and OTIF (Intergovernmental Organization for International Carriage by Rail). Both organizations have a specific consignment note using within the scope of their member states. OSJD members covering economies in Eastern Europe, Russia, China and other parts of Asia, applies SMGS<sup>1</sup> consignment note. OTIF members cover Western and Central European economies use CIM<sup>2</sup> consignment note. Therefore, at the early stage of CR Express, the block trains from China (OSJD member) destined to Germany (OTIF member) needs to use SMGS consignment note first and then exchange to CIM consignment note in Poland. The existence of two different legal regimes is an invisible border leading to interruption of smooth movement, administrative burdens, delays and extra costs, etc. To improve efficiency, OSJD and OTIF cooperate to set up the uniform CIM/SMGS consignment note and speed up the application of electronic uniform CIM/SMGS consignment note. The measures of transport document unification move towards a uniform body of law for freight traffic by rail in the Eurasia.

The facilitation measures is also applied to land-sea intermodal transportation, leading to more efficient and smooth CR Express services. On 1st November 2019, for the first time Xi'an starts a rail-sea-rail intermodal container service applying a single consignment note destined Mannheim. The train carried 42 forty-foot containers (equivalent to 84 TEUs) went through Khorgos exit and across Kazakhstan, Russia, Belarus, and finally arrived the port of Baltiysk spending 8.5 days. The port of Baltiysk is located in the Russian enclave between Poland and Lithuania on the Baltic Sea. At there, containers were transshipped from 1,520 mm gauge track platforms to vessels, and then being delivered to the Mukran/Sassnitz railway port terminal in Germany. From there, containers were uploaded onto wagons which are suitable for European narrow

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<sup>1</sup>Transliteration of the Russian abbreviation for the Agreement on International Goods Transport by Rail.

<sup>2</sup>Uniform Rules Concerning the Contract for International Carriage of Goods by Rail

gauge track of 1,435 mm. The total delivery time took 14 days, saved a lot of time by reducing the cumbersome operation problem of changing the consignment note.

### **Expansion of service network**

A certain pattern of cooperation between national railway corporations, logistics service providers, and customers has been formed. Chinese freight consignors sign contracts with China's domestic railway carriers, who need to cooperates with several foreign carriers spanning national boundaries. At the destinations, goods are delivered to foreign receivers. Hence, the operation of CR Express relies on the participation of local administration, railway corporations, freight consignors, logistics service providers, and customers. The main operator of CR Express—China Railway Corporation needs to cooperate with local corporations along the railway lines, such as Russian Railways (RZD), Germany's Trans-EurasiaLogistics, Switzerland's InterRail, etc. The joint stock company "United Transport and Logistics Company—Eurasian Rail Alliance" (UTLC ERA) was founded in 2018 by restructuring JSC UTLC initially founded in 2014. UTLC ERA is a joint railway container transportation service provider based on three countries' railway infrastructure: Kazakhstan, Russia and Belarus. National railway corporations of three countries hold 33% share respectively. On the basis of large scale regional railway infrastructure network, UTLC ERA nowadays dispatches around 450 trains monthly and has a large group of customers.

The cooperation between national railway corporations helps expanding the network of CR Express, which is not restricted within China. From the Southeast Asian countries such as Vietnam, the Far East countries including Japan, Korea, and to the Northern European country such as Finland are all actively seeking ways to cooperate with each other. For instance, several countries have perceived the large potential of Southeast Asian countries. Belarus and Russia have both signed agreements with Vietnam. Ratraco—a logistics company under Vietnam Railway Corporation has agreed with Belarus's Belintertrans to launch new railway freight service to link the two countries, and use Kolyadichi city as the multimodal transportation terminal for cargoes distribution. Obviously, Vietnam seized the opportunity of CR Express to develop its logistics industry and promote growth. Japan and Korea as the Far East end of Eurasia, actively integrated into the CR Express network as well. Korean's Pantos Logistics, for instance, cooperates with Russia's railway freight operator—TransContainer, to pave the way for multimodal transportation network spanning Korea, China, Uzbekistan, Kazakhstan, Russia and Europe. Transport via Northern Europe countries is an alternative gate for CR Express to reach European markets. The route through Finland, for example, has large advantages since it uses the same wide gauge track as Russia. Therefore, the trains starts from China to Finland only needs to break of gauge at the border with Kazakhstan leading to shorter total delivery time. The largest multimodal transportation terminal at Helsinki is Kouvolta, which is under expansion project, has large potential to grow to be a new regional intermodal transit node due to its rail

and sea connectivity.

The long-haul transportation distances promotes the development of multimodal logistics services. Large shipping companies also perceived the opportunities of rail-sea intermodal transportation. The shipping giant Maersk is getting more aggressive in expanding its Intercontinental Rail (ICR) service network. Maersk cooperates with Korean's freight forwarder Pantos Logistics, Russia Railway and Russia's Modul LCC, opened a shipping route from Korea to Northern Europe. Cargoes first delivered from Busan port to Russia's Vostochny port by sea, then delivered to St.Petersburg by rail. At first, the service is dispatched once a month and only westbound route is offered. Nowadays, the frequency increased to twice a week, and the eastbound service is offered too. In May 2020, after three years success of ICR service, Maersk launched its first intercontinental railway service route linking Xi'an and Izmit, Turkey. This new route further shortens the transit time by applying the Baku (Azerbaijan)—Tibilisi (Georgia)—Kars (Turkey) railway line.

#### **Growing market: various customers**

Comparing to maritime shipping, CR Express offers an alternative solution for transcontinental logistics service with shortened delivery time. Currently, one block train can organize maximum 41 wagons, opt for carrying one forty-foot container, equivalent to 2 TEUs. Hence, one block train can carry maximum 82 TEUs, relatively small compared to shipping vessels. As the development, this volume can hardly satisfy the growing market demands. According to official news, to tackle the issues, there are block trains equipped with four locomotives to improve the capacity to carry 200 containers. It is planned to carry 300 containers in the future. Still, the time efficiency of CR Express is the predominant advantage. The capacity shortage issue can also be tackled by improving the frequency. With other advantages including flexibility, security, trace & tracking, one third the price of air freight, CR Express has attracted a large group of customers, especially the companies producing high value and time-sensitive products. This is in line with the expansion of its service network. There are several categories of rail freight services offered by CR Express as follows.

- Customized block trains for large companies, including electronic producers such as HP, Asus; automotive producers such as BMW, Audi, Porsche, Mercedes-Benz, Volvos, etc.
- Full container load (FCL) service—normalized regular trains for diverse customers with fixed route and schedule. Customers pay to delivery a certain number of containers.
- Less than container load (LCL) service for small companies. E-commerce logistics market is growing with the application of LCL service.

The transported cargoes are diverse, covering electronic products, vehicles, automotive parts, communication equipment, machinery, small household appliance, food, medicine, clothing & shoes, consumer commodities, agriculture products, wood, etc.

Automotive manufacturers are main customers of CR Express on the eastbound lines, through which convey both automotive parts delivery and finished vehicles deliveries. In the first several years of CR Express operation, there are no eastbound rail freight demands at all. Westbound dispatched trains had to carry empty containers return China, which led to high delivery costs and waste of transportation resources. To fill up the gap, China Railway Corporation started to offer finished vehicles delivery services. Meanwhile, due to many reasons China lowered the import tax on finished vehicles for several times, from 220% in the beginning till current 25%. As one of the largest market in the world, this measure largely promoted the enthusiastic of foreign automotive producers. China's cities, on the other side perceived the opportunity of growth, actively applied to establish ports that qualified to handle finished vehicle import business. By the end of 2018, there were 31 sea and dry ports with qualification and 15 of them are accessible by rail. To further improve the capacity, CR Express applied a special kind of wagon for carry finished vehicle. The special dedicated wagon can contain 8–10 finished vehicles and easy to load/unload. The first test train arrived Chongqing on 19th November 2018 carried 112 Mercedes-Benz finished vehicles. Nowadays, including BMW, Audi, Porsche, Mercedes-Benz, etc. have become customers of CR Express to import finished vehicles to China. As shown in Table 4.5, the busiest eastbound lines are Hamburg/Duisburg—Chongqing/Chengdu, linking the automotive industry giant Germany to China's emerging automotive production bases. Besides, China's domestic automobile factories such as Dongfeng Motor in Chongqing, Volvos Cars in Chengdu utilized CR Express route to export as well.

## 4.6 Case study: Khorgos Gateway

Coastline cities have enormous advantages over inland ones due to their maritime connectivity to the GLN. Without sea shipping accessibility, the fundamental backbone role of transportation infrastructure becomes more obvious in landlocked areas. SREB's transportation infrastructure construction and logistics service provision target at the physical connectivity improvements in the vast inland territories spanning the Eurasia. This can largely offset the disadvantages of being landlocked. As the regional connectivity in Eurasian continent improved, land ports are playing significant roles and have large potential to develop to be new growth engines. Located at the border between China and Kazakhstan, Khorgos is a typical example within the construction of NELBEB under the frame of BRI. Situated at the utmost point far from ocean, the two countries cooperated with each other to exploit growth opportunities of Khorgos. The redesigned logistics network in the continent is gradually altering the pattern of GLN.

#### **4.6.1 Introduction of Khorgos: China–Kazakhstan cooperation**

Khorgos River is the boundary between China and Kazakhstan. On its east side, China's Khorgas city named after the river is a whole new city established in 2014 as a flagship project of BRI with a total area of 1908.55 square kilometers. It is 90 kilometers away from the nearest major city of Ili Kazakh Autonomous Prefecture—Yining, and 670 kilometers away from the Urumqi, the administrative capital of Xinjiang Uyghur Autonomous Region. On the west side of Khorgos River, Kazakhstan's Khorgos city is located in Panfilov district of Almaty region. The two names are slightly different in spelling, hence are equivalent in most cases. Both China and Kazakhstan target at constructing Khorgos as an international hub integrated with logistics, commercial and industrial function. From the perspective of China, the establishment of the Khorgas city is in line with China's Western Development Strategy. China's strategic position for this city is a comprehensive one integrating border region, port city, commercial center and internationalization. To promote growth, China focuses on not only its function as strategic transit node, but also its pushing effects to drive the western regional economic development. Four main construction focuses include Khorgos Port, International Center for Boundary Cooperation (ICBC), Khorgos Economic Development Zone, and the city itself.

Kazakhstan is an important partner joining the construction of BRI. Kazakhstan's Nazarbayev University is the place where Chinese President Xi Jinping first proposed the idea of jointly establishing the SREB in 2013. Corresponds to the SREB, Kazakh President Nursultan Nazarbayev announced the new national economic policy "Nurly Zhol" (Bright Path) in November 2014, emphasized the goal to turn Kazakhstan into a key Eurasian transport and logistics hub by transportation infrastructure construction. The president also addressed to allocate 81 billion tenge in 2015 to complete the construction of the "dry port" complex, the infrastructure of SEZs including Khorgos-Eastern Gate. To enhance the transport and transit capabilities, the country received \$14.86 billion during 2015—2019 to develop the transport industry, built and reconstructed roads, railways, airports, and the sea ports on the Caspian Sea in the west. Both the Kazakhstan—Turkmenistan—Iran—Persian Gulf Railway and the highway section of Western China—Western Europe can improve the regional land connectivity and being an integrated part of the SREB. In 2016, Kazakhstan and China signed the cooperation plan to synergize the Bright Path policy and SREB. Kazakhstan and China share common goals to improve land connectivity, and cooperate within many aspects in terms of borders, oil and gas pipelines, railways, agricultural, industrial and economic projects, etc. The new agenda of Nurly Zhol 2020—2025 plans to further develop transportation infrastructure to stimulate trade flows and economic development. According to the plan, fixed assets of the transport industry will triple to \$8.71 billion by 2025, Kazakhstan is designed to be a key hub connecting the North, South, West and East.

The consensus of constructing Khorgos between the two countries in fact is even earlier

before the announcement of SREB and Nurly Zhol. In 2010 the two countries signed an agreement on establishing the Khorgos special economic zone (SEZ). The President of Kazakhstan released the decree on "Establishment of Khorgos-East Gate" SEZ in 2011, consists of three components: dry port, industrial zone and logistics zone. Khorgos Gateway has put into operation since 29th July 2015. In total, Khorgos Gateway dry port occupies 129.8 hectares of land with a capacity to hold 18,000 containers. The logistics zone and industrial zone each has 225 hectares. The main objective is to promote export, realize the transit potential of Kazakhstan, attract investments and developing its logistics and industry fields. In addition, International Center for Boundary Cooperation (ICBC) Khorgos was established on the territory on both sides of the border under the agreement of the two countries. Within the total 560 hectares land, China's side is 343 hectares and the left 217 hectares belong to Kazakhstan.

#### **4.6.2 Khorgos Gateway Dry Port**

The advantageous location of Khorgos refers to its central position in the Eurasian continent. It is with the shortest distance to Central Asian countries compared to other Chinese border ports, situated with 378 kilometers from Almaty, the former capital of Kazakhstan. The area within the outer converge radius of 1000 km is allocated with economic center and densely populated area in Central Asia. It is also the utmost place far from ocean. The prosperity of Khorgos as a transit hub depends heavily on the regional land connectivity. Infrastructure construction and improvements can largely realized the potential of its geographical advantages. The promoted connectivity enables the international dry port hub function of Khorgos.

As the border between China and Kazakhstan, Khorgos is the first batch of Chinese land ports opened in 1981, and started to open for third countries since 1992. With the promotion of China's Western Development strategy proposed in 1999, Xinjiang due to its long borderline with massive neighbors received favorable policies and resources. As the development of railway infrastructure, Khorgos opened for railway traffic services in 2012. Since then, it became a road and rail integrated border port. Nowadays, designed as flagship project of SREB, Khorgos is China's first-class commercial border port and the largest dry port. It is the only Chinese western international transit hub integrated with highways, railways, aviation, pipelines and fiber. The goal for the dry port is to achieve 500,000 containers annually by the year of 2020.

#### **Railway connectivity**

In fact, Khorgos is not the first border port equipped with railway infrastructure. Between China and Kazakhstan, there are five land borders functioning and two borders under planning. In terms of railway borders, there are only two of them. The first

railway border port is Alashankou, situated 278 kilometers away via national highway from Khorgos. Both borders are located in Xinjiang's northern part, the current more economic active area compared to the southern part. Alashankou is the railway entrance of the Second Eurasian Land Bridge into Central Asian countries, but due to the location its distance to Almaty is 200 kilometers longer compared to Khorgos. To take the advantage of Khorgos' good location, the local administration applied the qualification of Khorgos as a railway border in 2014. After two years construction and test, the railway border of Khorgos was officially inaugurated on 7th June 2016. The operation of CR Express quickly makes Khorgos an important node for long-haul container rail freight services.

The railway connectivity of Khorgos is based on the existing Jinghe-Yining-Khorgos Railway (Jingyihuo railway) with a length of 286 kilometers, which started operation since 2009. It is the first electrified railway in Xinjiang, connecting Khorgos to China's domestic railway network. In December 2011, the line connected to the Kazakhstan side 293 kilometers long railway, stretching from Khorgos to Zhetygen terminal (near Almaty). The biggest issue affecting logistics efficiency is the different gauges applied along the line. China and west Europe applies the standard width gauge with 1,435 mm. While the former members of the Soviet bloc including Kazakhstan uses Russia's wider gauge of 1,534 mm. Hence, at the border it is required to transfer cargoes from one train to the other. As shown in Figure 4.32, railway exchange stations are allocated in both countries: Altynkol Station in Kazakhstan and Khorgos Station in China. Though the countries use different standards of track gauges, rail connection at the border was finally achieved. Based on this connection, in the long-term plan of CR Express, Khorgos is designed as the entry and exit node of the Western Route, as shown in Figure 4.29 in Section 4.5.1. Due to the central alignment of the railway line, it is the shortest distance for China to reach Central Asia and Europe by rail.

### Rail-sea intermodal connectivity

Following the Western Route of CR Express, there are two options for rail-sea intermodal transportation to reach European countries. One is the Urumqi—Khorgos—Aktau—Makhachkala (Republic of Dagestan, Russia)—Tbilisi (Georgia)—Novorossiysk (Russia) route. Khorgos dry port is connected to Kazakhstan's Aktau port on the Caspian Sea through the east–west direction national railway line. Cargoes can be transferred to vessels at there to across the Caspian Sea, and then unload at Makhachkala port in the Republic of Dagestan, Russia. Through the railway line linking to Novorossiysk port on the Black Sea, cargoes then transported by rail. After that, cargoes can either be transported by railway or through Black Sea to reach Eastern Europe or Turkey. By choosing different seaports or railway stations, there are several alternatives. For instance, from Aktau port across the Caspian Sea, it is also possible to dock at the port of Baku in Azerbaijan, and then transferred to rail line stretching to Poti port (Georgia) on the Black Sea.

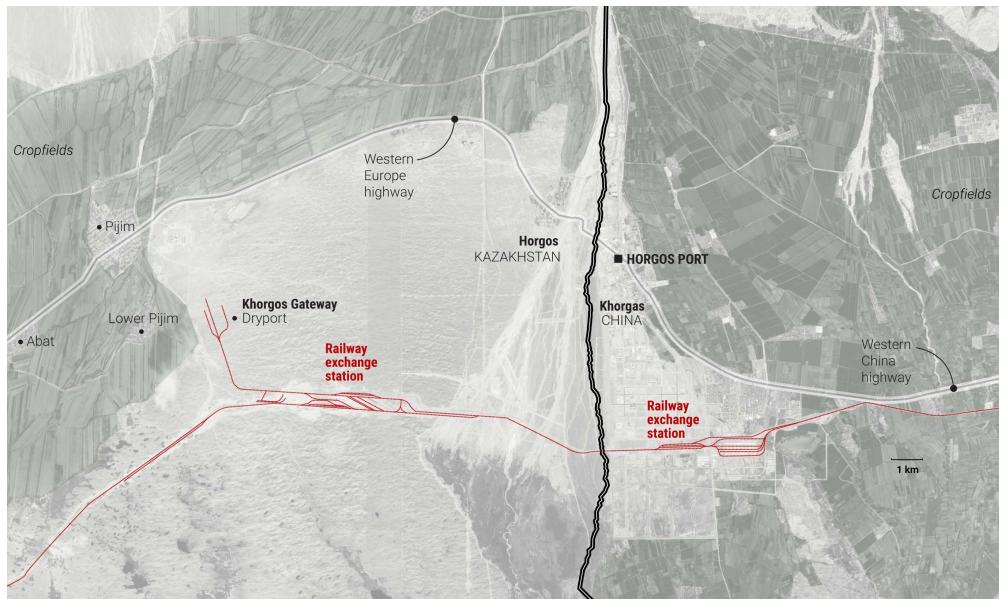


Figure 4.32: Allocation of Khorgos border  
Data source: Duhalde et al. (2018)

Besides, Khorgos dry port is also connected to China's Lianyungang port as the east end. From there, cargoes can be transferred to shipping vessels to reach Eastern Asian countries or farther destinations. In May 2017, the marine giant COSCO Shipping signed a three-party contact with Lianyungang Port Holdings Group Co. (LPH) and Kazakhstan Temir Zholy (KTZ). It is a share transfer agreement on Khorgos Gateway Dry Port. COSCO Shipping and LPH jointly acquired 49% stake of the dry port, each holds 24.5% of the share. KTZ as the national railway operator remains the largest stakeholder keeping 51%. Through share acquisition, COSCO group intends to utilize the dry port as a logistics hub for multi-modal transportation.

### Road connectivity

Within China, Khorgos is linked to Shanghai via China National Highway G312 with a total length of 4,967 kilometers, and connecting to Kazakhstan's highway A353 after cross the Khorgos border. The newly constructed G30 Lianyungang—Khorgas Expressway (also refers to Lianhuo Expressway) is 4,395 kilometers long, linking Khorgos to the starting point of MSR. The Expressway was inaugurated on 31th December 2014, is a critical traffic route of BRI and the longest expressway in China. Exit the border, Khorgos as the end of the Lianhuo Highway, in fact is part of "Western Europe - Russia - Kazakhstan - Western China" highway (also refers to "Shuangxi Road"). The

Western Europe—Western China (WE-WC) highway passes through more than ten cities of China, Kazakhstan and Russia (Lianyungang, Zhengzhou, Lanzhou, Urumqi, Horgos, Almaty, Kyzylorda, Aktobe, Orenburg, Kazan, Nizhny Novgorod, Moscow and Saint Petersburg) with access to EU ports. It is with a total length of 8445 kilometers, and also part of the CAREC corridor and Transport Corridor Europe—Caucasus—Asia (TRACECA). The planning of Shuangxi Road was initially proposed by China and Kazakhstan in November 2006, and Russia joined in the project lately. Chinese section is 3,425 kilometers, Kazakhstan section is 2,787 kilometers, and Russian section is 2,233 kilometers. The two countries have started the construction projects since 2008, the main content is to utilize the existing road networks and upgrade the substandard sections to highway standards. After around ten years construction, on 19th November 2017 the last section within China's boundary—G218 inaugurated, finally connected Chinese road section to Kazakhstan through Khorgos. The G218 is a critical project linking the new southern Khorgos border gate to the newly established Khorgos Interchange of Lianhuo Expressway (G30). This road section with 10 kilometers long forms an express passage for exit, can reduce the total transportation time through avoiding traffic jams via the old border gate.

Due to domestic poor road conditions of Kazakhstan, among the total 2,787 kilometers there were 2,452 kilometers requiring reconstruction. These large scale of projects due to their overlap with CAREC and TRACECA, were financed by five international financial institutions including Asian Development Bank (ADB), World Bank, European Bank for Reconstruction and Development (EBRD), etc. Regards as the "construction of the century" project by the government, Kazakhstan's section of Shuangxi Road has almost completed. The reconstruction has largely improved the transportation efficiency. For instance, the Khorgos—Almaty section (301 kilometers) used to take up to eight hours to cross, after its completion in 2016 it takes less than three hours. Until June 2019, Russia announced the plan of the Meridian Highway project, the first Russian section project of the Shuangxi Road. The Meridian Highway is 2,000 kilometers long, stretching from the Russia-Kazakh border to Minsk in Belarus. Hence, it is a critical road link as the end section of the Shuangxi Road for China to reach Europe. Later in November, Russia approved the plan of constructing the new toll highway between Moscow and Kazan (794 kilometers) in 2020, and estimated the entire project will be completed by 2027. The two projects cost around \$8 billion and \$9.4 billion respectively. Lately on April 29, 2020, Russian government stated that the construction of Russian section of Shuangxi Road will be accelerated. And projects have received many investors including Russian legal entities, banks and funds. After its operation, Shuangxi Road with around 8,500 kilometers will be the shortest distance linking China to Europe, reducing the delivery time to around 10 days. As a comparison, the 11,500 kilometers long Trans-Siberian Railway takes about 14 days. For maritime shipping it needs about 45 days to transit 36,300 kilometers<sup>1</sup>.

Apart from railway and road construction, Khorgos is also connected to the global

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<sup>1</sup><https://europe-china.kz/en>

transportation system by air and pipelines. For instance, according to the official document "Ili Kazakh Autonomous Prefecture General Aviation Airport Construction and General Aviation Industry Development Plan" released in 2017, Ili Prefecture will construct up to 11 airports including Khorgos General Airport by 2010. This airport is planned to improve air logistics services, and utilizing the tax-free policies of the ICBC to make Khorgos an international bounded air logistics port. As the cross-ends of Jingyihuo Railway, national highway G312, Western Europe—Western China Highway, and China—Central Asia Natural Gas Pipeline, with the operation of CR Express, Khorgos dry port occupies excellent conditions to be an international logistics hub.

#### **4.6.3 Development potential of Khorgos**

Based on desert, Khorgos now becomes an integrated city with dry port, logistics park, industrial park, International Center for Boundary Cooperation (ICBC), and SEZ. Trade volume of Khorgos keeps increasing, see Table 4.7. With the implementation in the following years, such as the completion of Russian section Shuangxi Road, Khorgos General Airport, the prosperity of the city as an international transit hub can be expected. The strategic orientation of Khorgos is far beyond its logistics hub function. The establishment of ICBC and the Khorgos SEZ show clearly that the development of Khorgos aiming at driving growth of China's lagging western area on its path to being an international trade and industrial center.

Table 4.7: Customs clearance volume of Khorgos, 2019

Source: Khorgos Customs

Border	2019	2018	
Railway	135.31	69.53	94.60%
Road	293.26	279.56	4.90%

Unit: 100 million yuan

ICBC is the world's first border free trade area constructed on both countries' land. Chinese part is 343 hectares and Kazakhstan part accounts 185 hectares. The agreement achieved by China and Kazakhstan to establish the ICBC together traced back to September 2004. On 18th April 2012 the Khorgos ICBC was inaugurated after the completion of the first phase construction. Khorgos ICBC opened bus and train services to delivery passengers since September 2012. The second phase of construction starts at the end of 2013, objects for passing cargo flow such as the customs control line of traffic. Function zones of ICBC includes International Tourist Center, Ethnographic Park Hotel and tourism complex, hotel area, cultural and exhibition area, transportation and lading terminals area, trade and exhibition area, etc. The citizens can freely go into the ICBC without visa to trade and communicate. With

this platform, flows of physical materials and people keep increasing. In 2016, ICBC exported 26 million tons of cargo, the total foreign trade volume achieve \$800 million increased by 10% compared to the previous year, transit population reached 5 million increased by 36%.

In terms of SEZ, both countries have positioned Khorgos as a SEZ. China's Khorgos SEZ was designed in 2010 with an area of 73 square kilometers, consists of three zones in Khorgos, Yining, and Qingshuihe. This is in line with the planning to develop Khorgos and Kashgar SEZs to formulate agglomeration economies to drive the development of the entire region. With various tax exemption policies, it has attracted numerous investments from enterprises, see Figure 4.33. The main industries include

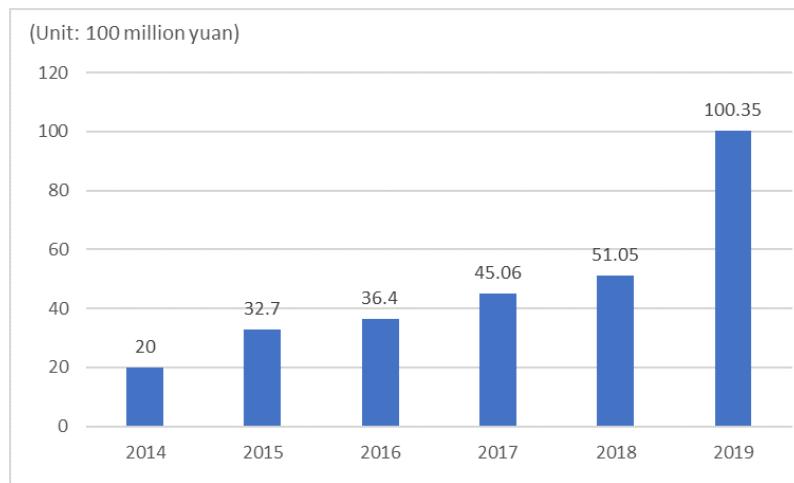


Figure 4.33: Capital investments of Khorgos, 2014-2019

Data source: Khorgos Government

energy industry, high-tech industry, processing, agricultural industry, etc. Companies with large investments include the nonwoven cloth industry project with 968 million yuan (Chinese currency), an automobile parts & components company with 2 billion yuan. High-tech industries are also motivated to take advantages of friendly investment and business environment. In 2017, Boshihao Electronics—a robot manufacturer moved its production site from Shenzhen to Hogros. The other example is the project of Sanyou Fuxin Semiconductor Seiko Co., Ltd. in September 2019. With a total investment of 10 billion yuan, the project will establish an industrial chain integrating R&D, production, and marketing of semiconductor electronic components. After completion planned in 2020, it is estimated to provide 2,000 to 5,000 job opportunities. At present, it has formed five industrial bases consist of wood processing, textiles, bio-pharmaceuticals, agricultural, and equipment manufacturing. Six industrial parks emerged through countries' cooperation such as China-Kazakh, China-Russia, China-Germany industrial parks.

Kazakhstan also regards Khorgos as an important node for industrial development. Khorgos SEZ Eastern Gate is one of the 10 SEZs planned in Kazakhstan set up in November 2011. After several years construction, the Khorgos SEZ Eastern Gate was inaugurated on 25th December 2014. The entire SEZ consists of three territories: dry port, industrial zone and logistics zone. The main goal of industrial development targets at food, leather, textiles, mineral, chemical, metal, etc. To attract investment, the SEZ applies generous concession for FDI: zero-rate property tax, exemption of land rent in the medium term, zero-rate land tax, 100% corporate income tax exemption for priority industries and activities, etc. The construction of the SEZ promotes the development of the city itself. To attract population and provide residence for staffs in the SEZ, Kazakhstan town named Nurkent was established in 2016. It is located just a few kilometers to the land port. According to online news, the population in 2019 is around 3000, increased from the figure of 1200 people in 2017. The Nurkent town is expected to host 100,000 inhabitants by 2035. China faces the same situation. The establishment of the brand new Khorgos city itself was in 2014.

## 4.7 Summary of interim results

In this chapter, a general analysis of BRI's impacts on the GLN is conducted at the first place. The author argues that transportation demands can be induced by new transportation infrastructure. The role of transportation infrastructure should not be underestimated. Three aspects of impacts on the GLN are analyzed. First, the significance of logistics nodes especially sea ports or dry ports are changing due to new or upgraded infrastructure. Second, the significance of logistics routes are altering, due to the shifts in port hierarchy, the availability of alternative transportation routes including new shipping route, new railway services, intermodal transportation possibilities, etc. Third, the geography of production and distribution sites will change in a long-term view. The alteration of transportation infrastructure and service networks will change the location advantages of some countries/regions/areas, promotes the re-location behaviors of MNEs. The law of agglomeration economies may even cause industry transfer phenomenon. Critical logistics nodes especially sea/dry ports will be the preferable candidates to receive FDI.

BRI's plan for improving maritime shipping connectivity represents by its vast investments in sea ports. Section 4.2 investigates China's overseas ports investment projects and introduces China's special "Port-industry-city" mode for port and regional growth. Following this, section 4.3 and section 4.4 conduct cases studies of Piraeus port and Gwadar port to validate the theories. The construction of Piraeus port has witnessed significant success, and changed the port hierarchy in the Mediterranean Sea. It also has large potential to be a southern European gateway with the implementation of the China-Europe Land-Sea Express Line. With the rising of Central and Eastern European countries as emerging automotive and electronic industry bases, Piraeus port

also occupies large potential to function as an international export/import hub. The city itself faces good opportunities to revive its maritime shipping specialization and economic development. To promote the positive shifts, Greek government should improve its domestic transportation systems to acquire better connectivity to hinterland emerging economies.

The advantage of Gwadar port is its good geographical characteristics including location and natural deep-sea feature. However, the construction of Gwadar port embedded in the project of CPEC has not seen large progress yet. The main reason is on the one side Gwadar port is still at its early stage of construction, its capacity and shipping capabilities are still insufficient to function as a hub. CPEC's implementation at present mainly focuses on improving domestic basic infrastructure such as energy supply, water supply, etc. as the basis for further development. On the other side, there is severe competition within the Middle East ports. While the port still has large potential as a gateway for landlocked Central Asia countries and Afghanistan, though there are many obstacles as well. Currently, road transportation is the only mode for hinterland transportation since Afghanistan has no railway networks. The construction of the SEZ in Gwadar port could be a driving force for port growth. Many enterprises have invested in the industrial parks in the SEZ. With the further construction of Gwadar port, it is expected to experience population and economic growth.

A significant pattern shift of the GLN could come from BRI's implementation of land connectivity improvement. Section 4.5 investigates the construction of New Eurasian Land Bridge and pays special attention to the CR Express. The first CR Express—"Yu Xin Ou" was motivated by the relocation of electronic manufacturer HP, and afterwards motivated the relocation of other electronic manufacturers as well as automotive industries. This caused industry transfer from China's coastal areas to western inland area. The story reveals that good connectivity combined with local policy incentives indeed can largely affect MENs' re-/location decisions. Besides, it also indicates that the overwhelming advantages of coast cities is diminishing due to the improvements of land connectivity.

Section 4.6 analyzes the potential of the world's largest dry port—Khorgos. Located at the border between China and Kazakhstan, the node has the longest distance far from sea. While as planned as a critical node serving the CR Express, combined with the construction of SEZs, the economic cooperation between the two countries, Khorgos is with large potential to become the next growth engine in China's western region. The rapid growth of CR Express crossing the node, as well as the increasing capital investments in these years show a clear sign of it. With its development, Kazakhstan's government is actively seeking ways to improve its domestic transportation networks and its intermodal transportation capabilities across the Caspian Sea. Landlocked areas along the CR Express are expected to benefit from the improved connectivity and spillover effects in the following decades.

## 5 Conclusion

The world keeps changing, and so is the spatial pattern of the GLN. Closely related to transportation infrastructure network and transportation service network, the structure of the GLN is determined by many factors, including geographical features, macroeconomic environment, economies of agglomeration, technology and innovations, etc. As the development, the GLN has formed certain trends in line with the pattern of global maritime shipping network, the allocation of trade partners, the participation levels of countries/regions in GVCs. Due to the predominant role of maritime shipping in supporting physical circulation, global shipping network represents the majority of the GLN. Driven by economies of scale, shipping companies tend to use large vessels leading to intensified port competition. As a result, some ports concentrate larger traffic flows and function as hubs, while the left function as feeder ports. The global shipping network is consist of several regional hub-and-spoke networks. Sea ports as critical nodes play significant roles in these networks. Meanwhile, ports get more and more integrated into GSCs, become preferable candidates to receive MNEs' new or re-located facilities. Agglomeration effects can even magnify the relocation behaviors and cause the phenomenon of industry transfer of different scales. This dynamic process of forming new pattern of the GLN takes place over time, and transportation infrastructure is an important driving force of the dynamics. Ports infrastructure construction hence not only benefits the development of the shipping industry. They are also impetus for attracting FDI to promote local economic growth. Especially for those ports where there are supplementary economic zones, tax-free zones, industrial parks, etc.

Along with the evolution of the GLN is the expansion of MNEs. They allocate their facilities all over the world to pursue competitive advantages that are unattainable in their home countries. Such advantages include low-cost labor and land, tax subsidies, large markets, existence of suppliers, etc. Therefore, MNEs are very sensitive to the external business environment related to the characteristics of specific countries/regions. To respond to the dynamic world, they need to review and reconfigure their production and distribution sites from time to time to maximize profits. The re-/design of GLNs has become a strategic-level SCM issue for MNEs to enhance corporate competitiveness.

At the same time, countries/regions are actively seeking measures to attract investments from MNEs. The more FDI they received, the more chances of countries/regions to improve their involvements in the GVCs. At present, due to many reasons, the world is not evenly developed. Countries occupy different levels of connectivity to the global

transportation network. In general, countries with long coastlines and large hubs are more active in the global economy; while landlocked countries are less participating in global value-added activities. Maritime powers have overwhelming advantages over the landlocked ones in terms of trade facilitation and economic development. On a regional scale, Asia maintains its high growth rate over the last several decades, followed by North America and Europe. The three regions have the highest levels of participation in GVCs, constituting three largest industrial clusters: "Factory Asia", "Factory America", and "Factory Europe". Globalization has intensified the interdependent between the three clusters, represented by the close relations between upstream suppliers and downstream manufacturers. Meanwhile, the intra-regional trade accounts for a large share of the world trade, in line with the increasing trend of economic integration at the regional level. "Factory Asia" is expanding its scale, along with the increasing materials circulation flows supporting production in the region. However, the rapid growth is mainly attributed to the fast development of East Asian countries, especially China. South Asia, West Asia, and South-east Asia are at the similar level. Central Asia is left far behind.

The BRI was proposed by China in 2013. The main idea is to improve maritime shipping connectivity by establishing the MSR, and promote regional land connectivity through the construction of the SREB. After several years of implementation, the regional transportation infrastructure and connectivity have been improved significantly. Chinese companies including COSCO group, China Merchants Ports, Shanghai Port, etc. invested in a large number of overseas ports. Four shipping passages are planned, including the exiting China—Indian Ocean—Africa—Mediterranean Sea passage, China—Latin America passage, China—Oceania—South Pacific passage, and the new China—Arctic Ocean—Europe passage (i.e. Polar Silk Road). These measures improve the ports infrastructure and offer new shipping routes stretching to all almost all the directions. As a result, the new/expanded ports become emerging competitors to the exiting regional hubs, altering the initial port hierarchy. Such competition took place between Piraeus port vs. nearby ports in the East Mediterranean Sea such as Gioia Tauro, Marsaxlokk; and it is very likely to happen between China's invested Melaka Gateway (Malaysia) vs. Singapore port in the Malacca Strait; Tangier Med port (Morocco) vs. Algeciras (Spain) in the Strait of Gibraltar, etc.

Case studies of Piraeus port and Gwadar port validate the impacts of ports infrastructure on the GLN. An important characteristic of these two cases is the combination of ports infrastructure promotion with land-sea transit passages construction. This further enhances the competitiveness of ports as gateways through improving hinterland connectivity. Piraeus port experienced rapid growth after the takeover by COSCO, reminds people that the role of transportation infrastructure in many cases are underestimated. The capacity expansion of Piraeus port turn it to be a major transshipment port, revived its prosperity in the Mediterranean Sea. Port hierarchy in the surrounding sea range has changed. Through analysis, it is known that Piraeus port enhanced its competition and absorbed some traffic flows from its nearby competitors especially the Gioia Tauro port. However, hinterland connectivity is the main shortage restrict-

ing it to develop to be a gateway. The planned Land-Sea Express route is designed to connect Piraeus port to Central and Eastern Europe. While due to many reasons, the construction of the high-speed railway sections Budapest—Belgrade is still at its initial stage. With its complete, Piraeus port can further grow through enhanced competitiveness of the Asia—Mediterranean route vs. the Asia—North Europe route. Apart for the development of the port itself, infrastructure improvements of Piraeus port also induced a sequence of positive changes to the local economy, including offering jobs, higher tax revenues, driving the development of shipping industries such as ship repair. The rise of Central and Eastern Europe as the receiver of factories relocation in automotive and electronic industries also brings bright future prospect of Piraeus port to support production and export. To function as a gateway to Europe, the container handling capacity should exceed at least 10 million TEUs, while currently Piraeus port is just around half of it. According to online news, COSCO has planned to expand its capacity to the figure, and designed it as an international transit hub. Considering its achieved success, the future prospect of Piraeus port hence is quite reliable.

Different from the case of Piraeus port, the construction of Gwadar port is still at an early stage and there is no significant growth sign. In the surrounding sea range, the growth of Gwadar port as transshipment hub faces difficulties. On the one side, ports in the Middle East achieved great success and with plenty of future capacity expansion investments, though they are facing an overcapacity issue. On the other side, Gwadar port though completed two phases construction projects, its handling capacity is still very low. This somehow is also a proof for infrastructure's significance. In terms of hinterland connectivity, the construction of CPEC offers the linkages between China's Kashgar to Gwadar port by land. Railway construction is still under plan. Considering the formidable natural conditions, it faces many difficulties to construct a railway link, as well as the pipeline projects. Still, it is possible to function as a gateway for Central Asia countries and Afghanistan, since via Gwadar port it is the shortest distance for them to access sea. Hence, the connection between Gwadar port and those landlocked countries is critical for the future prosperity. Another breakthrough is the construction of SEZ in Gwadar port. Applying China's "Port-industry-City" mode, with the implementation of the "Gwadar Smart Port City Master Plan", Gwadar is expected to accelerate its industrialization process leading by sectors such as petroleum refinery, fisheries, etc.

In terms of the land connectivity, China planned six economic corridors spanning the vast Eurasian continent in the northern, central, southern directions; and connecting China's southwestern areas to the Arabian Sea, the Bay of Bengal, and the Gulf of Thailand. These corridors starts from China's inland areas and link these areas to Central Asia, South Asia, Southeast Asia, Middle East, and Europe. The improvements of land connectivity can bring significant changes to the regional logistics service networks and freight transportation market. The most representative program is the expanding CR Express network and growing traffic volumes since it officially operated in 2016. Landlocked countries in the Eurasian continent such as Central Asian countries, can benefit from the improved access to the global transportation systems.

The advantages of traditional maritime powers are diminishing. Land dry ports are very likely to function as hubs, and become preferable locations to receive FDI from MNEs.

The case study of the China-Kazakh border city Khorgos is investigated to analyze the rise of Khorgos as a dry port through its regional connectivity improvements. Thanks to its central location between Asia and Europe, Khorgos is the remotest location from sea, but via it it is the shortest distance for China to reach Central Asia and Europe. With Jingyihuo Railway and Khorgos/Almaty border, Khorgos is well connected to both countries' national railway network. The share acquisition of COSCO and Lianyungang Port promotes the sea-rail intermodal transportation. Khorgos dry port also links to Aktau port on the Caspian Sea, hence Aktau port—Khorgos dry port—Lianyungang port route can constitute a long-haul multimodal logistics solution. Based on the transit hub function, Khorgos is strategic positioned as an international trade and industrial center for both countries. The rapid growth of capital investments and trade volumes show a clear sign.

Facing the continued tension between U.S.A. and China, it seems that the world is just at the eve of the second cold war. Due to the so-called Thucydides trap, the economic untie between the two world's largest economies is very likely to continue in the following years. Anti-globalization trend is also gradually rising. The pattern of world economy keeps changing and reordering itself. The relations between Europe and Asia, Africa will play a major role determining the future picture of macroeconomic environment. The good thing is there is no doubt that BRI is an initiative reinforcing economic integration at the regional level. Hence, it can be concluded that globalization will continue but at a regional level instead of at the global level. Countries within the same economic unions/organizations such as ASEAN, EAEU, China-CEEC (17+1) will become more integrated to compensate the market losing due to the untie between China and U.S.A. In such context, there are several implications to conclude in terms of BRI's impacts on the GLN in a system-thinking long-term view.

### **Implication for logistics industry**

Maritime shipping became the predominant mode of world trade since the Age of Discovery. Maritime connectivity and seaports are the most critical elements—links and nodes in the GLN. With the capabilities of shipping large quantities of cargoes with cheap price, maritime shipping will remain its leading position in global trade. But the relative importance of ports is changing due to BRI's overseas ports investments. Some BRI invested ports can be new hubs along the MSR, along with route allocations by shipping companies. For instance, if the capacity of Piraeus port could achieve 10 million TEUs, and the China-Europe Land-Sea Express Line was completed as the planning in the following years; Piraeus port will definitely grow to be the largest transshipment hub in the Mediterranean Sea. And the Asia—Mediterranean shipping

route will abstract a lot of market share from the Asia—North Europe route, since COSCO and its allies will chose the port it invested to call. Unless the Polar Silk Road was operated regularly, Northern Europe ports such as Hamburg, Antwerp will face large challenges. For such cases, port operators should carefully review its status and its neighboring ports and even shipping routes, and seeking ways to enhance its competitiveness. One reliable way is to build business connections with other ports, shipping companies, shipping alliances, etc, since maritime shipping market is more and more concentrated.

The second is to open new markets through cooperating with land logistics service providers. Shipping companies are also enhancing vertical integration with other transportation services providers such as rail, truck, barge, etc. With the operation of CR Express and long-haul road freight services in the Eurasian continent, multi-modal transportation services will account for some market share. Through consolidating cooperation with railway freight stations or dry ports, sea ports can acquire short-sea shipping markets and function as a multi-modal transit hub. In this case, it is also required for the port to occupy good hinterland connectivity. The third is to develop hinterland economy, and transfer the port as an export-oriented logistics node. However, without good infrastructure and connectivity the industrialization of the port itself is not realistic.

A very significant achievement of BRI's implementation is the improvements of regional land connectivity, especially by rail. Though currently the market of CR Express is unstable due to the subsidies offered by local administration, in the following years as the standardization the CR Express market will eventually adjust to be in accordance with demands. The land logistics service providers are facing enormous marketing opportunities, so as the operators of critical dry ports. Multi-modal logistics services will be more common, the capabilities of inter-modal transition will be an important factor determining the competitiveness of both sea ports and dry ports.

### **Implication for MNEs/manufacturers**

In the current turbulent macroeconomic environment, MNEs especially international manufacturers are facing many uncertainties and challenges. The implementation of BRI is reinforcing economic integration at the regional level. Investment environment is gradually changing, hence MNEs need to carefully investigate the relevant polices and regulations. The main goal of network reconfiguration of MNEs is to pursue maximum profit. Therefore, MNEs tend to relocate labor-intensive sectors to countries with cheap labors, and keep capital-intensive & high-tech commodities production sectors in home countries. Under the frame of BRI, continents including Asia, Africa, and Europe are getting more accessible, facilitating the mobility of physical materials and people. Countries with low-cost and skilled labors are very likely to receive low value-added production stages of different scales. In recent years, it is observed that

clothes selling in European market are commonly made in Thailand, India, Cambodia, Vietnam, etc. A few years ago, labels were normally written with "Made in China". This reflects the textile industry transfer from China to less expensive economies.

Relocation of electronic manufacturing is happening as well, but within Chinese boundary between different regions. Electronic factories used to be allocated in China's coast cities such as Guangzhou, Shanghai, gradually moved to the emerging western cities such as Chongqing, Chengdu. So are the automobile production factories. This may because both electronic and automobile production rely heavily on upstream suppliers. And they both require fast and in time delivery of part & components to support assembly. With close interrelationship between suppliers and manufacturers, the entire supply chain relocated to the same locations due to agglomeration economies. There is a similar trend shown in the relocation of the two industries from western European countries to Central and East European countries.

As the improvements of regional land connectivity, the advantages of coast cities are decreasing. Sea access can hardly counterbalance with the competitive advantages of low-cost labors, since the saved transportation costs can not cover the increased production costs. The development of land logistics service providers hence will further promote MNEs' motivation to pursue competitive advantages. Since the vast majority of landlocked countries get connected, the places with beneficial characteristics will become the candidates to receive FDI. In general, as the economic integration in the Eurasia continent, the improvements of land connectivity will help MNEs to exploit competitive advantages. Factors affecting production costs will be the main determinants for location decisions of labor-intensive or resource-intensive industries. For manufacturers with complex supply chains, it seems that the length of the supply chain is decreasing as the suppliers tend to locate close to its downstream manufacturers. Value chains become more regional instead of global, different production stages prefer to locate close to pursue agglomeration economies. Especially for high value, time-sensitive, short life-cycle commodities, improve the efficiency of production and distribution to markets is more beneficial even at the expense of higher transportation costs. This is also why automotive and electronic producers are the first customers of CR Express.

### **Implication for countries/regions**

Generally, areas along with coastlines have overwhelming advantages over landlocked areas in terms of the participation level in the global economy. Therefore, improving land connectivity of landlocked areas is the basis of further development. As the jointly establishment of SERB, which stretches China's inland areas to all the directions by six economic corridors, the regional land connectivity is improving significantly. Countries/regions along the SREB should seize the opportunities to develop local supporting logistics services to promote the development of logistics industry as the

first step. Based on mature logistics services providing, the administration needs to take facilitation measures to promote trade and investments. In a long-term view, it is critical to accelerate the process of industrialization. Railway container stations or dry ports occupying strategic locations are the breakthrough points to pursue cooperation with neighboring countries and develop domestic industries.

On a global scale, the rapid rise of inland areas illustrates that the global economic center is gradually shifting from coastlines to inland areas. Industry transfer took place by automotive and electronic industries from coast areas to inland areas. For instance, from Guangzhou to China's western inland Chongqing and Chengdu; from Western European countries like Germany, France to Central and Eastern European countries like Hungry, Czech. This trend will further be enhanced as the improvements of land connectivity. In fact, the case of HP's relocation to Chongqing is the motivation of the first CR Express. Therefore, the improvements of transportation infrastructure largely decreased the disadvantages of landlocked locations, can help to realize its growth potential. The leading position of coastlines is diminishing, and the vast potential of undeveloped inland areas is just emerging. To attract FDI, countries/regions need to increase the level of education as well. Low-cost labors are major motivation of relocation in basic industries such as textiles, energy, chemicals, etc, the starting sectors of industrialization. Based on the development of these basic industries, especially the energy industry, the industrial process can keep moving forward. Landlocked countries such as Central Asian ones are facing development opportunities with the implementation of BRI. Ny the way, with the improved connectivity, it is also possible for them to develop tourist industry.

### **Limitation**

Infrastructure construction and connectivity improvement are the top priority of BRI. Therefore, this research focuses on the investigation of BRI's impacts on the GLN through analyzing the role of transportation infrastructure. And the study mainly concerns maritime shipping and land freight transportation, ignores other transportation modes like air and pipelines. The research is also restricted to the lack of information. BRI was released in 2013, but it may take a long time to show the effects of transportation infrastructure. Due to the large scale and broad scope, it is impossible to cover all the important infrastructure projects in one study. Online news keep updating with the latest data, and available information from different sources sometimes is inconsistent. Hence, information shortage is one critical reason restricting the comprehensive understanding. Besides, BRI also intends to promote policy cooperation, and China signed numerous trade and investment agreements with the involved countries. Since network configuration issues are closely related with FDI location selections, MNEs' decisions are largely affected by the facilitation measures or agreements between country pairs. This aspect can be investigated further, opt for specific sectors, companies, and economies, etc.

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