*Journal of Infrastructure, Policy and Development* (2020) Volume 4 Issue 2.
DOI: 10.24294/jipd.v4i2.1227

ORIGINAL ARTICLE

# Sustainable port-hinterland intermodal development: Opportunities and challenges for China and India

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## ABSTRACT

This paper reviews and compares the opportunities and challenges in terms of port and intermodal development in China and India—the two fast-growing economic giants in the world. The study analyzes the future direction of these two countries' port-hinterland intermodal development from the sustainability perspective. Both China and India face some major opportunities and challenges in port-hinterland intermodal development. The proposal of the Silk Road Economic Belt and the 21st-century Maritime Silk Road, also known as the Belt and Road Initiative (BRI), offers plentiful opportunities for China. A challenge for China is that its development of dry ports is still in the infancy stage and thus it is unable to catch up with the pace of rapid economic growth. As compared with China, India focuses more on the social aspect to protect the welfare of its residents, which in turn jeopardizes India's port-hinterland intermodal development in the economic sense. The biggest challenge for India is its social institution, which would take a long time to change. These in-depth comparative analyses not only give the future direction of port-hinterland intermodal development in China and India but also provide references for other countries with similar backgrounds.

***Keywords****: port; intermodal transport; sustainable development; dry port; Belt and Road Initiative*

## 1. Introduction

Efficient transport systems play a crucial role in globalization. Due to the importance of port connectivity, the role of ports has developed into one which is influential to affect the performance of supply chains (Loh and Thai, 2016). In order to provide a seamless, efficient and reliable delivery of cargos from original production sites (shipper nodes) to final customer sites, supply chain networks and transport systems rely increasingly more on intermodal transport networks (Robinson, 2002; Lam and Van De Voorde, 2011; Lam and Yap, 2011; Lam and Yap, 2011; Vieira *et al.*, 2014). There is also a close connection between port performance and intermodal connectivity. Many research articles

**ARTICLE INFO**
Received: June 17, 2020
Accepted: October 22, 2020
Available online: December 31, 2020

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**CITATION**
Gu Y, Loh HS and Yap WY (2020). Sustainable port-hinterland intermodal development: Opportunities and challenges for China and India. *Journal of Infrastructure, Policy and Development*, 4(2): 228–248. doi: 10.24294/jipd.v4i2.1227

have shown a positive relationship between these two elements (Marlow and Paixao, 2003; Paixao and Marlow, 2003; Bichou and Gray, 2004; Rodrigue and Notteboom, 2009; Lam and Notteboom, 2014). Ports are no longer seen as an individual setting; instead, competitive advantage can be achieved through integration with intermodal transport (Lam and Gu, 2013).

Currently, the issue of environmental friendliness has become a key concern in sustainable port development. This not only includes the environmental performance of cargo terminals but also the ports' intermodal network (Rahimi *et al.*, 2008; Liao *et al.*, 2009). Reducing total truck miles when utilizing intermodal transport networks, such as the modal shift from road to rail, can cut down carbon footprint for greener distribution solutions. Kim and van Wee conducted a European case study and their empirical results proved that intermodal systems generally emit less $CO_2$ than the truck-only system (Kim and Wee, 2014). Sustainable port and intermodal development requires a balance among economic prosperity, social welfare and environmental preservation (Lam and Gu, 2016).

In recent history, there has never been any economy like China and India, which has seen such large populations rising so rapidly. China and India are two fast-growing economic giants, with striking average GDP growth rates of 8.95% and 7.34%, respectively, in the last decade. These figures are more than three times the average world rate, which is 2.51% (World Bank, 2019). Both countries are experiencing urbanization processes, which imply huge potential demands of not only domestic trade but also international trade in terms of value and volume. Owing to their abundant natural resources, relatively low labor costs, sufficiently skilled worker supplies and increasingly open economic policies, many international manufacturers have their production sites relocated to China or India as their corporate strategies. At the same time, these two countries have a massive consumption potential in light of their huge population and the rising GDP per capita. In addition, the new Belt and Road Initiative (BRI) has infrastructure plans for both Chinese and Indian ports. All these drivers grant strong support for the development of their port and transport industries, including the intermodal development, due to their wide hinterland ranges (Chhibber, 2017).

A number of studies on China and India converged on comparing bases of economic growth, political structures, institutional reform processes and trade. Postigo conducted a comparative analysis of China and India's transport infrastructure development (Postigo, 2008). Pucher *et al.* made such comparison from the transport policy perspective (Pucher *et al.*, 2007). Two other research, by Kroeze *et al.* (2004) and Shalizi (2007), highlighted that the greenhouse gas emission problem will worsen with the rise of the two countries' rapid economic development and called for an array of protection action. Only Hanaoka and Regmi compared the intermodal issues in Asia, including China and India (Hanaoka and Regmi, 2011). However, to the best of the authors' knowledge, no study has focused on port and intermodal development in these two newly-industrialized economies, let alone the comparison between them in terms of the potentials and challenges in sustainable port intermodal development. Such comparison is beneficial and serves as lessons learned for other economies, as it gives insights into why two emerging economic powerhouses can perform vastly different in its port-hinterland intermodal development and achievement. This gap in the literature leads to the objective of conducting this comprehensive review study, which compares the state of port-hinterland intermodal development in China and India. The major approaches are data and content analyses of a wide range of credible sources, such as scientific literature, country/state websites, port websites, annual reports, market reports and

international and local organizations and associations.

The paper is organized as follows: Sections 2 and 3 address the opportunities and challenges, respectively, for China and India. Section 4 offers comparisons between China and India on their current status of port and intermodal transport and future development implications. The conclusion is then drawn in Section 5.

## 2. China's opportunities and challenges in sustainable port and intermodal development

The global economy is influenced greatly by the "China effect", and the development of Chinese ports is remarkable. In 2018, seven of the ten busiest ports in the world were Chinese ports. These Chinese ports, ranked in terms of container throughput, were Shanghai (1st), Shenzhen (3rd), Ningbo-Zhoushan (4th), Guangzhou (5th), Hong Kong (7th), Qingdao (8th) and Tianjin (9th). Hence, conducting an in-depth study on Chinese ports is valuable when one considers such a phenomenal trend. Chinese ports face plenty of opportunities and challenges in sustainable port-intermodal development.

### 2.1. Opportunities and challenges co-existing in Chinese port development

There are two major opportunities in Chinese port development. First, China's government at various levels recognizes the importance of Chinese seaport development. As early as 2006, China's Ministry of Transport (MOT) released the "Coastal Port Layout of China" to formally divide China's coastal ports into five port clusters to form a hub-and-spoke container transport system in China. It also strategically designed China's specialized seaport development, such as coal, oil, iron ore, grain and Ro-Ro seaports (MOT, 2018). As driven by the central government of China, the new BRI highlights the promotion of policy coordination including multi-level intergovernmental macro policy exchange (NDRC, 2018). The national effort greatly facilities port development. The key ports in the new BRI are mainly located in South China.

The second opportunity is the phenomenon of deregulation and privatization in China, which began from the start of "reform and opening up" 40 years ago. After the 1970s, the tide of deregulation and privatization appeared worldwide, especially in the transport industry. Under such domestic and international background, private capital has increasingly participated in China's seaport industry. Domestic private capital mostly chooses small-sized or middle-sized seaports and inland barge ports as targets for investment. In spite of this successive growth of the privatization process, the amount of private capital invested in China's seaport industry is still limited due to China's institutional setting. There is still potential for its seaports to undergo deregulation and privatization.

Challenges and opportunities usually come together. There are four major challenges that accompany opportunities in Chinese port development. The first and greatest challenge may be the cut-throat competition among Chinese ports, especially so for those located in the same region. Competition may also exist between any Chinese ports or sometimes between Chinese ports and the ports in neighboring countries. The competitiveness experienced by the Chinese shipping industry is a result of the over-building of Chinese ports in the last two decades, coupled with the shipping market slump due to recent years' economic recession as well as the rapid maritime industry

development in the neighboring countries (Cullinane *et al.*, 2004; Cullinane *et al.*, 2005; Lee and Rodrigue, 2006; Yap and Lam, 2006; Yap *et al.*, 2006). With more and more Chinese coastal ports shifting their competition from sea-bound to hinterland, intermodal connectivity and hinterland economic development have become the main concerns in a port's hinterland development strategy (Zhang *et al.*, 2009; Zondag *et al.*, 2010).

The second challenge in the development of Chinese ports is institutional in nature. There is an absence of a unified top-level institutional coordination body in China. Many ministries within China work independently and with insufficient communication and coordination. The lack of a uniform set of policy guidelines in China may cause legal challenges as well. In most cases, the central government modifies relevant institutional settings based on the existing regulatory framework, but local governments may interpret the intention of the central government according to local needs (Beresford *et al.*, 2012).

The third challenge is China's underdeveloped information management level. The seaport transportation system cannot be enhanced by merely improving hardware such as infrastructure construction. The development of information technology and its management is also crucial. The Chinese government has realized this issue and injected a large amount of funding to develop the Intelligent Transportation System (ITS) at the national level. The effectiveness of information management is widely seen as an aspect of port performance and China's information management level is considered lagging behind that of developed countries (Li and Miao, 2003; Bichou and Gray, 2004). Specifically, the overall logistics performance index (1=low to 5=high) indicates that China is ranked 27th with a score of 3.66 in 2016 (see Table 1) (World Bank, 2019). Hence, this aspect needs improvement for the benefits of the BRI to be realized (Lin and Wang, 2017).

The fourth challenge is the absence of a national green and sustainable port development strategy in China. The notion of "Green Port" has gained popularity in recent years and is associated with a sustainable supply chain strategy (Notteboom, 2010). The greening of ports is not only a challenge for China but also a challenge for seaports worldwide. While the good practice of "Green Port" in China is on the rise, the development of the BRI is expected to generate more pollution as traffic at Chinese ports increases. Hence, how to achieve sustainable development in the Chinese port industry is a big challenge under the BRI background.

### 2.2. China's intermodality

Intermodal development in China can be reviewed from the perspective of three major opportunities and two major challenges. As mentioned in Section 2.1, the Chinese seaport competition is cut-throat nowadays. This challenge in Chinese port development is a good opportunity in Chinese intermodal development. Many researchers have observed that seaport competition has shifted to a hinterland capture campaign (Starr and Slack, 1995; Carbone and Martino, 2003; Yap *et al.*, 2006; Zondag *et al.*, 2010). Hence, many shipping lines aim to provide an intermodal service to the shippers, and various forms of inland ports are emerging, such as barge ports or dry ports, some of which have customs clearance functions just like seaports. On the other hand, local governments develop dry ports on their own and such dry ports generally are far away from seaports and function more like logistics parks (Beresford *et al.*, 2012). The emergence and development of these inland ports may be seen as a milestone in significantly promoting China's intermodal development to facilitate the BRI.

The second opportunity comes in China's great potential to improve the containerized cargo ratio. In 2017, only less than 20% of cargos (16.7% in 2009) are containerized in China (Ding, 2018). There is a great deal of potential to improve the containerized cargo ratio of China. As containerization plays an essential role in intermodal transportation, if the ratio of the containerized cargo of China catches up with other developed countries (60%~80%), the intermodal development in China will be enhanced.

The third opportunity can be found in China's Western Development strategy (national level) and the BRI proposal (international level). The Western Development strategy was proposed in 1999 by former president Jiang Zemin, aiming to reorient the vigorous growth towards the western region. All levels of government have invested massive manpower, physical resources and financial resources on this great project. It offers a good opportunity to develop China's intermodality, which can in turn boost the western region's economy through domestic and international trade (Lu and Neilson, 2004). The presently unbalanced regional development will be gradually improved after the Western Development strategy is promoted by the Chinese central government. The Western Development strategy therefore opens up a great opportunity for China's intermodal development. China needs to integrate shipping, railway, roadway, inland waterway and air to pursue a multi-modal strategy. The new BRI proposal can integrate with China's Western Development strategy to develop an efficient intermodal logistics network across regions and cities. China will develop infrastructure linkages and transport connections and cooperation with other relevant countries through policy coordination. This new BRI proposal could promote China's industry partnership on various levels (Hahm and Raihan, 2018).

Although the above opportunities are attractive, the following challenges cannot be ignored. For the first challenge, insufficient rail links in China, which are the bases of freight intermodal transportation, would affect China's intermodal development substantially (Rimmer and Comtois, 2005). Unlike other developed countries, the railway system in China is owned by the state and has little involvement from private investors. The majority of railway capacity is deployed for passenger transport due to the huge population. There is limited railway capacity for freight transport. The Chinese government has never stopped the expansion of the railway network since China's independence in 1949. However, the growth of rail freight capacity cannot meet the requirements of its fast economic development (National Bureau of Statistics of China, 2018). Over the years, the Chinese government invested to build its High-Speed Rail system to relieve the pressure of passenger transport and release more rail capacity to its freight transport, according to the Chinese Ministry of Railways (after 2013, called the China Railway Corporation) (Guo, 2010). From China's actual situation and referring to the foreign experience, China's railway network needs a multi-layer hub-and-spoke pattern and double-stack capability. The railway infrastructure in China needs more time and resources to construct and modify because China has a vast geographical area with complex terrains. To tackle the issue of railway capacity, the Chinese government may consider partial privatization of its railway system in order to speed up the pace of its railway development, just like the privatization in its seaport system. For example, the Chinese government should allow more private capital to enter into the construction of shuttle railways with a dedicated link that connects the inland dry ports with seaports.

The second challenge is that a systematic policy framework to ensure intermodal development is missing. The institutional problems in China have been elaborated in Section 2.1 above. The

same challenge will also exist in relation to the intermodal development in China. For example, some researchers have realized that there is no standard and clear definition of "dry port" in China, with related problems in management and operation (Beresford *et al.*, 2012). How to improve the existing institutional and regulatory framework in order to get closer and proactive cooperation among different government departments is a critical question. The Chinese government could learn from the successful experience of other developed countries and provide more detailed policy support for inland intermodal infrastructure development (Wang, 2009; Yang, 2009).

## 3. India's opportunities and challenges in sustainable port and intermodal development

As compared with China's port development, India is still far behind. There were only two Indian ports ranked in the top 50 in terms of container throughput in 2018 (World Shipping Council, 2018). The two ports were Jawaharlal Nehru Port (JPNT) and Mundra Port, ranked 29th and 34th, respectively.

However, India's achievement in economic development should not be disregarded. India was the sixth-largest economy in terms of GDP in 2018 (World Bank, 2019). Although the transport sector in India has great potential due to its rising trade volume, its disadvantages should be studied seriously. There are also more social problems in India due to its regulatory framework and this would impede its economic development.

### 3.1. Opportunities and challenges in Indian port development

This section discusses the opportunities and challenges in Indian port development. The first opportunity in Indian port development is its remarkable economic development. In line with India's fast economic development, its trade growth is also significant. India's foreign trade (import and export) accounted for 39.9% share of GDP in 2016 from only 17.2% in 1990. During the past three decades, this share reached its peak in 2012 (55.6%) and then went down slightly after that (World Bank, 2019). A good port system would facilitate a growing trade volume, which in turn would lead to better economic development. In a good economic situation, there will be more capital resources to develop and expand India's port system (Wu and Lin, 2008).

The second opportunity is that India inherits geographical advantages. India is endowed with a 7,000km coastline, along which are 12 major seaports out of 180 minor ports. Moreover, India has a big hinterland with coasts on three sides, which implicates great geographical advantages in its maritime industry and port development. These two major opportunities can be strengthened with the new development of the BRI, along which Indian ports are being called.

There are four challenges in Indian port development. The first challenge for India shows up in its social institution problem. Many researchers have noticed the disadvantages caused by the infrastructure of the Indian ports and national transportation network (e.g., Kim and Nangia, (2008); Postigo, (2008)). However, after comprehensively reviewing the literature, it is found that the underlying challenge comes from India's social institution (Muller, 2006). India's development strategy started with a rational approach to maintaining a balance between economic growth and distribution. However, in mid-course, it puts great emphasis on the redistribution of wealth rather than economic growth, which is led by its social institution (Kim and Nangia, 2008). The Indian

government has pursued economic liberalization since the late 1970s. Under this background, various economic sectors, such as transportation, have opened their doors to private investors, whether they are domestic or foreign. The port of JNPT represents an initial trial of privatization in India's seaport system, established by the Indian government in 1993 (Bennett, 1995; Monie, 1995). Despite India's economic liberalization reform, not many private investors would like to invest a large amount of money in Indian seaports due to India's huge social safety net concern. It would be unwise to postpone the privatization process in Indian ports, but cautious steps are required. It might be possible to negotiate with the labor sector in India and introduce some new commercial orientations. Moreover, the Major Ports Trust Act (MPTA) has been criticized as the main stumbling block to the introduction of successful privatization in India (Haralambides and Behrens, 2000). Legislation and institutional change should be more important than physical infrastructural improvement in the Indian context and will take considerable time to achieve. As a matter of fact, various international organizations and foreign countries have provided vast technical assistance to Indian ports, but the results are disappointing because of the deep-rooted social institution of India (Monie, 1995; De and Ghosh, 2003; Ng and Gujar, 2009).

For the second challenge, the undesirable current status of India's port development is a disadvantage as well. Ghosh and De have found that inequality among major ports has hindered India's port development (Ghosh and De, 2001). Geographically, the ports on the east coast have stagnated, while the ports on the west coast and south coast have done better. De and Ghosh have attempted to find out the causal relationship between port performance and port traffic by using Indian statistical data (De and Ghosh, 2003). They discovered that better port performance (i.e., higher efficiency with better facilities) will lead to higher traffic in Indian ports. However, most Indian ports have poor performance. Generally, the capacities of both major and minor ports in India need to be increased to cater to increasing trade volume, and also there is a strong need to form a global hub port or at least a regional hub port for the whole country, like what Singapore or Shanghai had done (Gujar, 2006).

For the third challenge, India's import trade still holds a dominant position relative to its export trade, and the gaps are even wider in the last decade (World Bank, 2019). An export-oriented economy would bring more income to a country and a positive impact on its economic development (Kim and Nangia, 2008). India's import-oriented economy will inhibit its port development due to lesser trade volume than an export-oriented economy (Ghosh and De, 2001).

For the fourth challenge, India's biggest infrastructural deficiency shows up in its shortage of power, which would not only influence port development but also the economic development of the whole country (Gujar, 2006). The Indian government set an ambitious goal to provide enough electric energy for the whole country before March 2012. Although India has a surplus power generation capacity by 2018, it lacks adequate distribution infrastructure and more than 300 million Indian citizens lack access to electricity. The power shortage of India is hampering India's manufacturing.

### 3.2. Intermodality in India

Similar to the analysis of China, India's intermodal development was also investigated from the perspective of opportunities and challenges. Intermodal development strategy is essential for India as well. Till now, there are two opportunities in Indian intermodal development, as follows: Firstly,

a number of dry ports have been built in India's large hinterland. Dry port development could accelerate India's intermodal development. There are two kinds of inland dry ports in India: ICD (inland container depot) and CFS (container freight station). ICDs are normally located near port areas, while CFSs are usually near inland customers and may have more functions than ICDs. A port will become a hub only when its spokes are connected with ICDs or CFSs (Gujar, 2006). India's dry port development is relatively mature as compared with other inland infrastructure development. By 2016, a total of 61 large-scale inland dry ports had already been established (see Table 1) (CONCOR, 2017).

Secondly, there is a large demand for intermodal transport services because many manufacturing sites in India are far away from seaports. Major manufacturing activities take place in the north-western states, notably Delhi, Punjab and Uttar Pradesh, where textiles are produced and automotive components are both produced and assembled. In contrast, international trade is conducted through gateway ports far away along the southern and western coasts, such as JNPT, Mumbai and Mundra ports, which are visited by the mainline vessels. JNPT, Mumbai and Mundra ports handle almost 80% of Indian containerized cargos, which mostly originated from north-western states (Lall *et al.*, 2004; Indian Port Association, 2018). Hence, many ICDs and CFSs are built near to such manufacturing plants which are linked to gateway ports by rail.

Although Indian dry ports have good performance, the performance of its other intermodal infrastructure is barely satisfactory. The first challenge refers to insufficient inland intermodal infrastructure in India. About 40% of containers are transported by railway in India (Carbon Tax Centre, 2017). The rail haulage is conducted by Indian Railways, which monopolizes the industry. There are two kinds of gauges of the railway route, 1.00 meter and 1.67 meters, which may cause some discontinuities to impede the Indian railway connectivity. Another shortcoming of the Indian railway system is that the length of the electrified railway routes is insufficient (Gujar, 2006). Although the Indian roadway system carries over 57% of the total container traffic in India, its road infrastructure is unsatisfactory with many unpaved roads. Regarding inland waterways, only very few restricted rivers can be utilized. The capacity of India's inland waterway transport can almost be ignored (IWAI, 2018). Wu and Lin (2008) and Chandrasekaran and Kumar (2004) found that most Indian ports and its inland transportation network are inefficient and proposed that the Indian government should upgrade the infrastructure and facilities of its ports, rails, roads and waterways and make this a national intermodal development strategy. The necessary construction of intermodal infrastructure in India is lagging severely.

For the second challenge, effective government policy guidance is missing. The Indian government calls for foreign private investors to participate in its inland dry port development, but as mentioned earlier, under the Indian rooted social institution tradition, the government has to protect its local operators' interests. Hence, in order to resolve this contradictory issue, the Indian government tries for dualistic policies on "land pricing and distribution" and "dry port operation" between foreign investors and the state-owned corporations (Ng and Gujar, 2009). Moreover, excessive investments have been thrown into the roadway system at the expense of the railway system, and this trend needs to be changed (Sriraman, 2009). The Indian government should guide such investment to the railway system in order to integrate its now available dry ports to achieve efficient and sustainable intermodal development. Intermodal services in India should target high-value and finished goods, which need high-frequency, reliability and fast services. Railway is the

unique choice in the Indian context (Shinghal and Fowkes, 2002). The Indian government needs to provide more guidelines and support for this strategic target's realization.

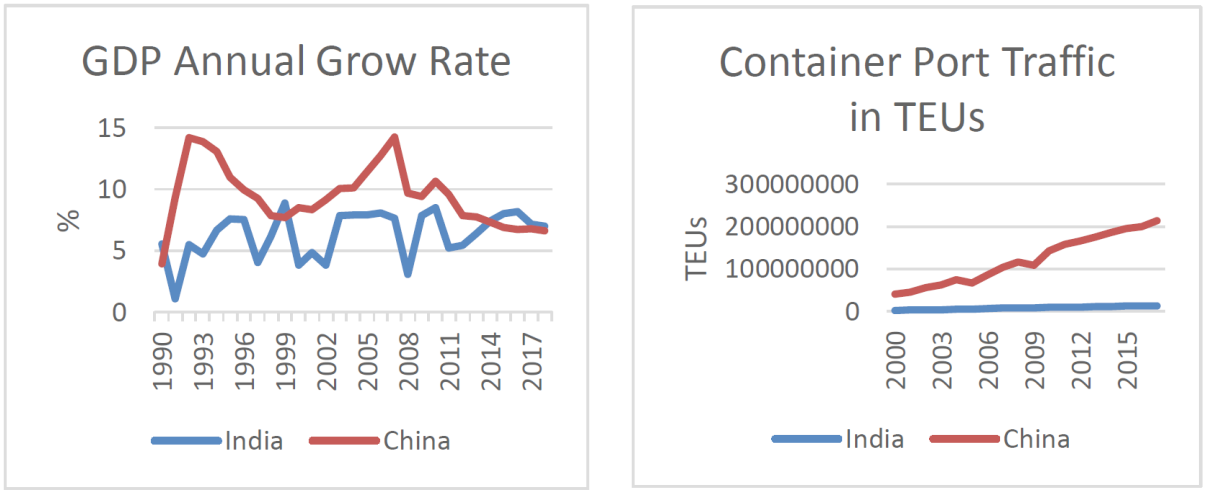
## 4. Comparison between China and India in terms of sustainable port and intermodal development

In this section, a comparative analysis is conducted with regard to these two countries. It is expected that this comparison would not only give direction to future development in these two countries but also set an example for other countries with similar backgrounds. All the detailed information in Sections 2, 3 and 4 is concluded and listed in **Table 1**, **Table 2** and **Table 3**, respectively, for reference. Table 1 presents a quantitative characterization comparison between China and India in terms of port and intermodal development. The focus of Table 2 is the policy and regulatory regime comparison between China and India. Table 3 lists the comparison of the opportunities and challenges between China and India.

From Table 1, it can be deduced that both China and India have great potential for their port and intermodal development. Both China and India have large populations covering huge geographical areas and have the most extreme rapid-growth economies in the world. Both China and India are experiencing urbanization and globalization processes, which would imply huge potential demand for international trade. This phenomenon can be verified from **Figure 1**, which shows that China's container port traffic experienced dramatic and continuous growth since China entered the WTO in 2001. In 2011 (ten years after entering WTO), the port of Shanghai was ranked first in the world, based on its container port traffic. Both China and India have gradually become the world's largest manufacturing centers for the world. Owing to their abundant natural resources, relatively low labor costs, sufficiently skilled worker supplies, increasing open economic policies and so forth, many international manufacturers have relocated their production sites to China or India. The new BRI proposal would increase the pressure of global distribution, especially for China and India's transport systems. Both China and India are in urgent need of their port and intermodal development.

Along with China and India's rapid economic growth, environmental issues such as $CO_2$ emission and water pollution have become more severe than before. Intermodal transport and various inland terminals are all included in the "Green Port" strategy of Europe's successful experiences (Notteboom, 2010). However, few studies focused on intermodal development in Asia. Hanaoka and Regmi analyzed five dry port projects in five developing inland-locked Asian countries, including China and India. They reached the conclusion that railway connection to dry ports can greatly reduce carbon footprint (Hanaoka and Regmi, 2011). Hence intermodal transport can be suggested as a national development strategy from both economic and environmental perspectives.

Both the Chinese and the Indian governments have paid attention to environmental protection issues. In China's 11th Five-Year Plan (2006–2010), intermodal development was proposed as a national strategy. In addition, China's central government proposed the new BRI proposal in 2015. China's intermodal development can be expected to be further promoted in the near future. Similarly, the Indian government has also realized the significance of environmental protection in the transport sector, but a national sustainable intermodal strategy is lacking.



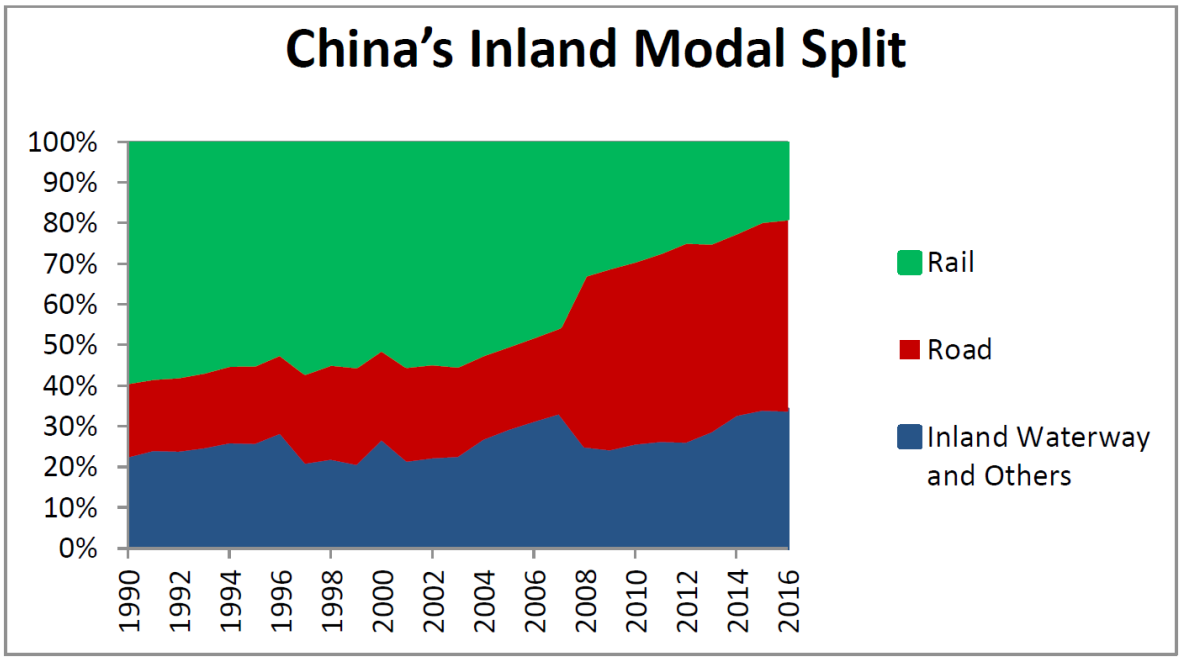

*Source: Drawn by authors based on data from (World Bank, 2019)*

**Figure 1.** Annual grow rate of GDP in China and India (left) and container port traffic in China and India (right).

Due to the export-oriented economy of China, it has more potential than India in economic development in terms of GDP growth rate and seaport traffic (see Figure 1). The sharp increase in container cargos exported from China to North America and Europe bears witness to China's economic success. China has performed well in its export-led economy. It is suggested that India should transform its current import-oriented development strategy to an export-oriented economy, the same as China. India should make more effort with regard to this transition.

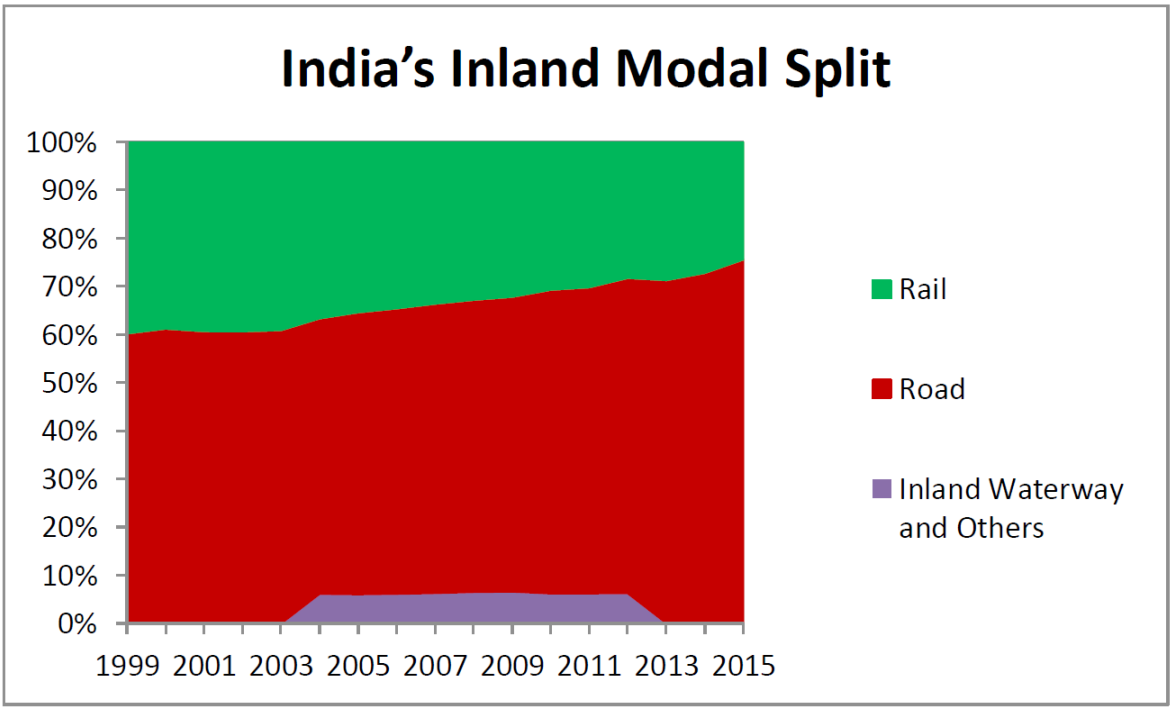
In terms of transport modes, India mainly uses the roadway to carry containers (see **Figure 3**). For China, although the railway mode occupies a large share of container traffic based on the historical statistics of China, the proportion of its road traffic for containers is increasing every year. Since 2008, China's biggest share of container traffic has been the roadway mode (see **Figure 2**). A modal shift from road to rail is needed both in India and China. These two countries have huge hinterland ranges and their industrial sites are far away from their seaports. Hence, dry ports with long-distance intermodal rail corridors are proposed. Geographically, China's central and western parts are land-locked, while India has more favorable maritime access than China. Hence, the Chinese government has made great efforts in rail line construction, a 137.7% growth in 2017 as compared with 1991. In terms of rail line length, India has seen almost no improvement, stagnating at its initial stage of colonial times (8.86% growth in the same comparison) (see Table 1). Although China has built up many new rail lines, its railway capacity remains insufficient. The capacity shortage of Indian railway transport is a bigger problem. In order to solve the railway capacity shortage problem, the Chinese government is developing its high-speed railway network, which can increase passenger and freight traffic capacity. However, India does not have such plans in the pipeline.

The number of large-scale dry ports in India was greater than in China in 2010 (61 vs. 18), but India's inadequate railway infrastructure holds back its overall intermodal development. At the same time, the rapid development of Chinese dry ports is illustrated by the presence of various forms of dry ports. As of 2017, China has built more than 100 large-scale inland dry ports. As for the double-stack development in the railway system, India has done well enough, ranked third in the world,




*Source: Compiled by authors based on Organisation for Economic Co-operation and Development ((OECD, 2018)*

**Figure 2.** Freight modal split of China (million ton-km).




*Source: Compiled by authors based on (OECD, 2018)*

**Figure 3.** Freight modal split of India (million ton-km).

after the USA and Canada. In comparison, China has only just begun this double-stack journey. In 2007, Chinese Railways operated 680 double-stack trains that carried 53,161 twenty-foot equivalent unit (TEU), compared with 2005 when it operated 454 trains that carried 39,437 TEU (UNESCAP, 2009; Hanaoka and Regmi, 2011). Overall, the development in China and India in terms of intermodal rail mode can be improved greatly, such as developing dry ports and railway links. Good

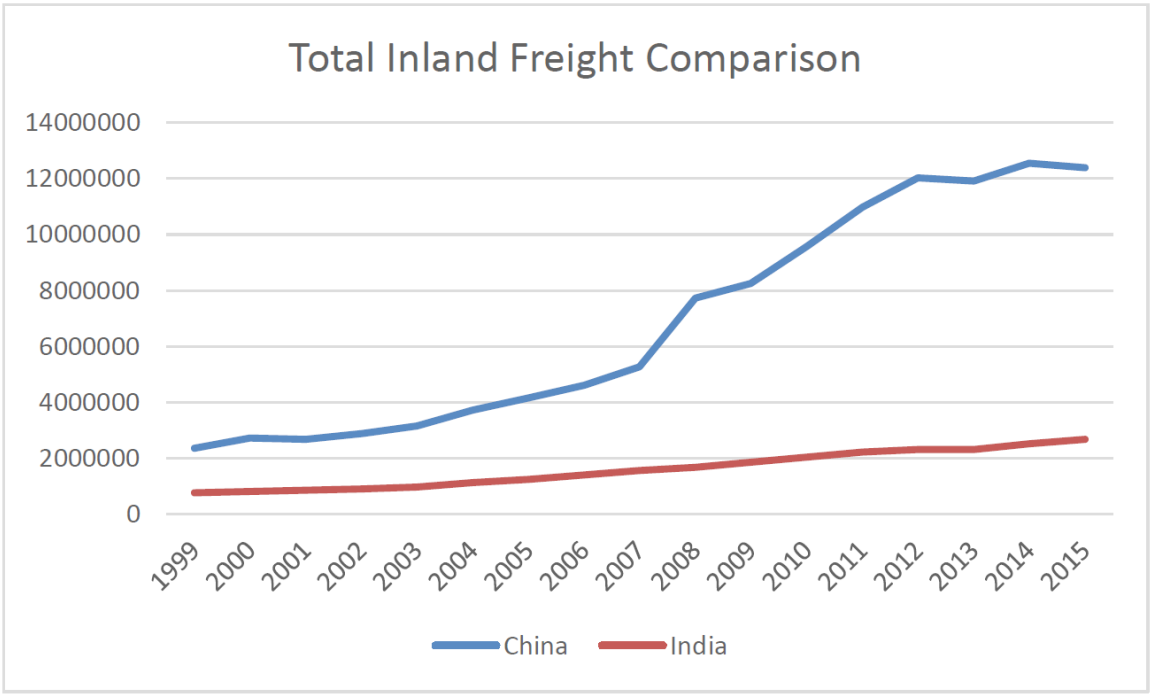
performances of both dry ports and railway links are essential for better environmental performance of intermodal transport.

From Figure 2, it can be seen that inland waterway accounts for a large proportion of the inland transport mode in China. With the strong development of the Yangtze River Strategy by the central government of China, driven by the Shanghai international shipping center, the barge intermodal along the Yangtze River from upstream Chongqing to downstream Shanghai has attracted a lot of attention. Many satellite barge terminals have been established along the Yangtze River. However, more maintenance works, such as dredging, widening and deepening the waterway channels, need to be done. Nevertheless, inland waterway is almost unavailable in India, as aforementioned. This phenomenon is also shown in Figure 3. The great potential of inland barge transport in China can give China more confidence in its sustainable intermodal development, as compared with India.

India's port industry is lagging behind that of China. It is essential to promote India's port industry in order to capture the opportunities given by the BRI. China has achieved its tremendous progress owing to its fast transport infrastructure development. Construction of port facilities should be put in first place because ports can help link the domestic economy with the global economy. Compared with other developed countries, the proportion of transport infrastructure investment in the GDP of China was 5.64% in 2009, which was still very low, while the same proportion in the USA in the same year was 9.90% (Yu *et al.*, 2012). Such investments result in increasing calls from shipping lines (Lam and Yap, 2011). China's liner shipping connectivity index has been ranked 1st all over the world from 2004–2016 (World Bank, 2019). On the other hand, India has a poor performance in terms of the ranking of liner shipping connectivity index. Hence, it is suggested that India should allocate more resources into its transport infrastructure, especially in its port industry, in order to promote steady and fast economic growth in India.

In addition to the differences between China and India in terms of port and intermodal infrastructure stated above, their different social institutional settings will result in a developmental gap as well. **Figure 4** shows that there exists a huge gap in terms of total inland freight volume between China and India. China and India began their economic liberalization in the late 1970s and early 1980s, and at that time, India's transportation structure was better than that of China in terms of railway and roadway. However, after more than 40 years of development, India's original advantage has gradually disappeared due to its deep-rooted social institution. Under India's specific social institution, the Indian government focuses more on redistributing its wealth and welfare rather than economic growth, though at the beginning of its economic liberalization, the Indian government applied a rational approach to keep the balance between its economic growth and distribution (Kim and Nangia, 2008). India's social institution discourages many foreign investors who would otherwise be interested. In China, the picture of the social institution is different. China's social institution is a centralized and autocratic political system (see Table 2). Unlike India, the Chinese government intends to reduce its poverty by its rapid economic growth. The Chinese central government can easily concentrate all the national resources to focus on its big national projects, such as the BRI. However, like India, China should attach more importance to its wealth distribution to maintain social equity and justice.

Both China and India have made great efforts to create favorable policies and mechanisms to attract investments in their port and intermodal development, including domestic and foreign




*Source: Compiled by authors based on (OECD, 2018)*

**Figure 4.** Total inland freight volume gap between China and India (million ton-km).

investments. There had been US$7,136 million in private investment in the transport sector of China versus US$2,623 million for India in 2016. The statistical numbers were US$173 million for China versus US$1.9 million for India in 1990 (Table 1). Although the difference between China and India in terms of private investment in the transportation domain cannot reflect the whole situation, it can mirror that China is more proactive than India to private investors from the early stage. The Chinese government has explored and adopted many efficient, flexible and sustainable mechanisms and policy frameworks to encourage various investments involving the transport sector of China, achieving the right balance both between international and domestic capital and between private and public financing (Kim and Nangia, 2008; Postigo, 2008). India's privatization process is not as fast and in-depth as that of China, which may be caused by India's social institution problem as well. Nonetheless, the Indian government has realized the importance and benefits of attracting investments in its transport sector. Hence, India has sped up its privatization process. However, both countries still have much to do in making and modifying more policies and regulations to facilitate the involvement of private investors.

From Table 3, it can be concluded that both China and India have the following challenges in sustainable port and intermodal development: (1) their regional economic development is unbalanced, (2) the systematic regulation and policy framework is imperfect, (3) their overall logistics management levels are low and (4) the degree of containerization is low. India faces two more challenges: (1) unbalanced seaport development and (2) insufficient electricity resource. On these last two points, China has a better situation. The Chinese central government has set its long-term strategic layout for its port development. Hence, Chinese port cluster development is relatively balanced. While India is troubled with its power shortage, China has relatively abundant power resources.

In summary, the Chinese government has made great efforts with regard to its port and intermodal infrastructure development, but Chinese dry port development is still in its infancy stage and this is a key challenge in the BRI implementation. India's social distribution institution is the largest challenge which hinders its transport sector as a whole and would take a long time to change.

**Table 1.** Quantitative characterization comparison between China and India in terms of port and intermodal development

| **Comparison Factors** | **China** | **India** |
|---|---|---|
| Total area (millions of square kilometers) | 9.6 (ranked 3rd) | 3.3 (ranked 7th) |
| Population in 2018 (billions) | 1.39 (ranked 1st) | 1.35 (ranked 2nd) |
| GDP in 2018 (US$ millions) | 13,608,151 (ranked 2nd) | 2,726,322 (ranked 7th) |
| GDP per capita in 2018 (US$) | 9770 (ranked 68th) | 2015 (ranked 142nd) |
| GDP annual growth rate in 2018 | 6.6% | 6.99% |
| Economic liberalization dates from | Late 1970s and early 1980s | Late 1970s and early 1980s |
| Entering WTO dates from | Year 2001 | Year 1995 |
| Private investment in transport in 2016 (million US$) | 7136 (173 in 1990) | 2623 (1.9 in 1990) |
| Container port traffic in 2017 (millions of TEUs) | 213.7 (ranked 1st) | 13.3 (ranked 12th) |
| Container port traffic growth rate compared to Year 2000 | 421% (41 million in 2000) | 443% (2.45 million in 2000) |
| Coastline length (km) | 14500 | 7000 |
| Railway network length in 2017 (1000 km) | 127 (53.42 in 1991) | 68 (62.46 in 1991) |
| Road network length in 2017 (1000 km) | 4697 | 5472 |
| Inland waterway length in 2017 (1000 km) | 126.3 | 14.5 (not available) |
| Number of large-scale inland dry ports in 2017 | 100+ in 2017 (18 in 2010) | 61 in 2010 |
| Liner shipping connectivity index (LSCI)[1] in 2016 by UNCTAD | 167.5 (ranked 1st) | 46.2 (ranked 32nd) |
| Logistics performance index (LPI)[2] in 2016 by World Bank | 3.66 (ranked 27th) | 3.42 (ranked 35th) |

[1] *Liner shipping connectivity index (LSCI) is computed based on five components: (1) number of ships, (2) their container-carrying capacity, (3) maximum vessel size, (4) number of services and (5) number of relevant companies.*

[2] *Logistics performance index (LPI) is weighted on six key dimensions: (1) efficiency of the clearance process, (2) trade quality and transport-related infrastructure, (3) ease of arranging priced shipments, (4) quality of logistics services, (5) ability to track consignments and (6) expected delivery time.*

**Table 2.** Policy and regulatory regime comparison between China and India in terms of port and intermodal development

| Comparison Factors | China | India |
|---|---|---|
| **Political system** | China is a centralized and autocratic political system:<br>(1) Central government uses the Five-Year Plans to develop economy.<br>(2) Central planning can help China easily make national decisions.<br>(3) Privatization in China is primarily the joint venture which will retain government's control.<br>(4) Intermodal development strategy has been added to China's national agenda as a means of environmental protection. | India is a democratic political system:<br>(1) Social distribution institution gets first priority in national decisions.<br>(2) Usually, government needs a long time for making a big decision.<br>(3) Privatization in India is not popular due to its social institution settings.<br>(4) A national intermodal strategy in India is missing. |
| **Major relevant policies** | (1) "Environmental Protection Law" enacted in 1989 is out of date and its amendment is on the way.<br>(2) "Western Development" strategy will shift investment attention to inland intermodal transportation.<br>(3) "Social Harmony" policy promotes the high-speed railway development, which leads to railway freight capacity's increase.<br>(4) 11th Five-Year plan (2006–2010) puts forward logistics and intermodal development as a national issue for the first time.<br>(5) The Belt and Road Initiative proposed in 2015 aims to use new intermodal routes to link Europe, Asia and Africa. New ports and intermodal components will be constructed. | (1) "Environment Protection Act of 1986" has helped India to protect its environment effectively.<br>(2) India's National Urban Transport Policy (NUTP) of 2006 highlights the need to reduce transportation emission.<br>(3) "Dualistic policies" proposed by government balance the conflict between foreign investment and social distribution institution on dry port development.<br>(4) "Major Ports Trust Act (MPTA)" has been criticized as the main stumbling block to the introduction of successful privatization in India, which may lag India's intermodal development. |

**Table 3.** Opportunities and challenges: Comparison between China and India in terms of port and intermodal development

| **Factors affecting port and intermodal development** | **China** | | **India** | |
|---|---|---|---|---|
| | Opportunities | Challenges | Opportunities | Challenges |
| Rapid economic growth | ✓ | | ✓ | |
| Unbalanced regional economic development | | ✓ | | ✓ |
| Political system | ✓ | | | ✓ |
| Systematic regulation and policy framework's missing in terms of intermodal development | | ✓ | | ✓ |
| Government' efforts in port and intermodal development | ✓ | | ✓ | |
| Large land area | ✓ | | ✓ | |
| Industrial sites far away from seaports | ✓ | | ✓ | |
| Large population | ✓ | | ✓ | |
| Geographical conditions for port and intermodal development | ✓ | | ✓ | |
| Trade type (China is export oriented while India is import oriented ) | ✓ | | | ✓ |
| Rapid urbanisation | ✓ | | ✓ | |
| WTO membership | ✓ | | ✓ | |
| The level of logistics management | | ✓ | | ✓ |
| Low degree of containerisation | | ✓ | | ✓ |
| Roadway links | | ✓ | | ✓ |
| Current railway freight capacity | | ✓ | | ✓ |
| High-speed railway links | ✓ | | | ✓ |
| | | | | |
| **Factors affecting port and intermodal development** | **China** | | **India** | |
| | Opportunities | Challenges | Opportunities | Challenges |
| Double stack railway system | | ✓ | ✓ | |
| Inland waterway links | ✓ | | | ✓ (almost not available) |
| Rapid growth of seaport traffic | ✓ | ✓ | ✓ | ✓ |
| Fierce seaport competition | ✓ | | ✓ | |
| Unbalanced seaport development | Better situation in China | | | ✓ |
| Seaport infrastructure development | ✓ | | | ✓ |
| Inland dry port infrastructure development | ✓ | | | ✓ |
| The number of inland dry port | | ✓ | ✓ | |
| Private investment in port and intermodal | ✓ | | | ✓ |
| The degree of privatisation in the entire transport sector | ✓ | | | ✓ |
| Insufficient electricity resource | Better situation in China | | | ✓ |

**Main sources for Table 1, Table 2 and Table 3: Compiled by authors based on (1) World Bank (2019), (2) International Monetary Fund (2018), (3) Carbon Tax Centre (2017), (4) Federal Highway Administration (2007), (5) OECD (2018), (6) Container Corporation of India (2017), (7) Central Intelligence Agency (2018), (8) Ding (2018), (9) United Nations Development Programme (2018), (10) Haralambides and Behrens (2000), (11) Pucher et al. (2007), (12) Postigo (2008), (13) Kim and Nangia (2008) and (14) Ng and Gujar (2009).*

## 5. Conclusion

This research is the first attempt in the literature to analyze and compare the opportunities and challenges in terms of port and intermodal development in China and India, the two fast-developing economies in the world. It bridges the research gap in this area with great significance. The in-depth comparative analyses presented offer a useful reference for the future direction of port-intermodal development in China and India, as well as other countries with similar backgrounds.

Sustainable port and intermodal development not only requires node improvement, such as seaports and dry ports, but also the upgrading of link connectivity in terms of roadway, railway and waterway. It finally achieves seamless integration upon node improvement and link connectivity. After a thorough investigation of China and India, it is clear that both fast-developing countries have a huge potential for demand in the foreseeable future. Inefficient infrastructure and logistics management and the absence of favorable regulation and legal support have been identified to be the common obstacles for their development. The disadvantages which are consequences from the social institution imply a bigger challenge faced by the Indian government than inefficient infrastructure, in most cases. On the other hand, the biggest challenge faced by China is that its dry port development is still in its infancy stage.

There are several elements for further research based on this review study. Firstly, it would be interesting to conduct an in-depth investigation on the status of the dry port operations in China and India with different contexts for a better comparison of their intermodality issues. More field studies need to be done and more statistical data need to be collected. Secondly, the comparison in terms of intermodal development among China, North America and Europe, which are three key trade poles, would be meaningful. Thirdly, future work should use quantitative methods to measure the benefits of dry port application and intermodal optimization in terms of cost minimization and carbon footprint reduction.

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