

COMPARISON SEA AND RAIL TRANSPORT OF CONTAINER

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Abstract

Container transport of goods between China and Europe, respectively between China and the Czech Republic, is an important part of trade between these countries and its volume is still increasing.

This contribution contains analysis of the current state of two modes of transport, namely maritime and rail transport between the Far East and Europe, respectively between the Far East and the Czech Republic. Both of these modes of transport are environmentally friendly and should be used for transport of goods in the future.

One part of this contribution contains comparison of selected aspects. Selected aspects are prices, time of transport and safety.

Comparison of the two modes, maritime and rail transport is reasonable, because prices, time of transport and safety are important for a decision, which mode of transport to use.

Keywords

container, maritime transport, railways, environment, safety

1 INTRODUCTION

This contribution presents a comparison of shipping containers using maritime transport and rail transport between the Czech Republic and the People's Republic of China. An important part is an analysis of specific conditions for containers in maritime transport and in rail transport in order to compare these two modes of transport, including identification of possible perils.

Growth of the People's Republic of China's economy follows a fact that the People's Republic of China produces about 25% of total world production of goods nowadays, compared to 1990, when this figure was around 3%. This development is also caused by a fact that many world-wide companies producing different kind of goods decided and still decide to place their producing plants into China due to cheap price of labour force there. Therefore, need of transport of goods between China and Europe and in the opposite direction is growing. Although transport between Asia and Europe will ever continue to be important, pressure on reducing costs leads to relocation of producing plants to other countries like Bangladesh or Cambodia. [1]

Imports from China (especially textile, electronics etc.) to the Czech Republic are several times higher than exports. This is valid also for other countries in Europe and all over the world. [2]

A major part of goods between China and the Czech Republic is transported by maritime transport, but amount of goods transported by rail increases. Air transport has a small share.

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2 TRANSPORT OF CONTAINERS BETWEEN CHINA AND EUROPEAN PORTS

In recent years, over 20 million TEUs have been shipped between Asia and Europe yearly (see Fig. 1). Trend of a curve follows rapid growth especially from 2002. This corresponds to growth of Chinese economy in this period, of course, with exception of temporary fall in 2009 as a result of global financial crisis.

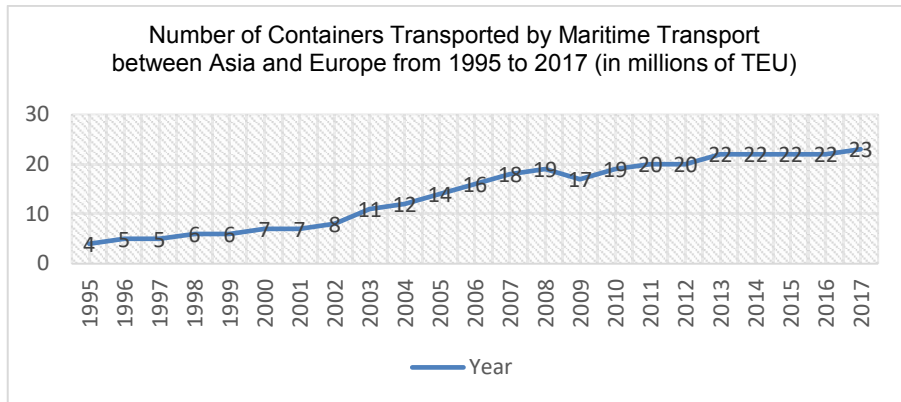


Fig. 1 Number of Containers Transported by Maritime Transport between Asia and Europe from 1995 to 2017
(Source: Authors using data from [3])

In a case of container transport to the Czech Republic, it is necessary to include into comparison a route from a European port to the Czech Republic using another mode of transport, namely road or rail mode, which enlarges time of transport and increases a price for transport. [7]

If we compile a table of WORLD TOP ports, ten of them are in China, but just three of them are in Europe (see Table 1). The size and utilization of Chinese ports is directly related to volume of exported goods to Europe and other continents.

Tab. 1 Ranking of the largest container ports in the world in 2016 (Source: Authors using data from [4])

Ranking	Port		2016	2015	2014	2013	2012
1	Shanghai, China	Mill. TEU	37.13	36.54	35.29	33.62	32.53
2	Singapore	Mill. TEU	30.90	30.92	33.87	32.60	31.65
3	Shenzhen, China	Mill. TEU	23.97	24.20	24.03	23.28	22.94
4	Ningbo-Zhoushan, China	Mill. TEU	21.60	20.63	19.45	17.33	16.83
5	Busan, South Korea	Mill. TEU	19.85	19.45	18.65	17.69	17.04
6	Hong Kong, S.A.R., China	Mill. TEU	19.81	20.07	22.23	22.35	23.12
7	Guangzhou Harbor, China	Mill. TEU	18.85	17.22	16.16	15.31	14.74
8	Qingdao, China	Mill. TEU	18.01	17.47	16.62	15.52	14.50
9	Jebel Ali, Dubai, U. A. Emirat.	Mill. TEU	15.73	15.60	15.25	13.64	13.30
10	Tianjin, China	Mill. TEU	14.49	14.11	14.05	13.01	12.30
11	Port Klang, Malaysia	Mill. TEU	13.20	11.89	10.95	10.35	10.00
12	Rotterdam, Netherlands	Mill. TEU	12.38	12.23	12.30	11.62	11.87
13	Kaohsiung, Taiwan, China	Mill. TEU	10.46	10.26	10.59	9.94	9.78
14	Antwerp, Belgium	Mill. TEU	10.04	9.65	8.98	8.59	8.64
15	Dalian, China	Mill. TEU	9.61	9.45	10.13	10.86	8.92
16	Xiamen, China	Mill. TEU	9.61	9.18	8.57	8.01	7.20
17	Hamburg, Germany	Mill. TEU	8.91	8.82	9.73	9.30	8.89

2.1 Perils

a. Security and Safety

Security

- Possibility of attack related to significant position in international trade and the value of transported goods
- Possibility of carrying containers with weapons, explosives and other dangerous objects
- Danger of transport of radioactive substances
- Smuggling people, drugs, chemicals, biological and other dangerous material [8]
- Possibility of attack by pirates (especially on South China Sea and Western Indian Ocean)

Safety

- Safety of cargo, crew, infrastructure and the environment
- Compliance with regulations and standards in shipbuilding, a safety test
- Minimizing risk of damage of a ship, damage to cargo, incorrect container fixing, loss of containers
- Stabilization of vessel

b. Reliability

Basic criteria, like delivery of goods to place of destination, delivery time, transport safety, a transport price and others, are applied.

Perils

- Human factor
- Technical condition of a ship
- Narrow throats (on busy routes and in ports)
- Climate conditions

c. Economic and Political Influences

Perils associated with economic impacts in particular are as follows:

- Increase or decrease of international trade
- Change of political situation in different parts of the world
- Manufacturing plants are moved inland in China and therefore, demand for rail transport is growing

d. Ecology

Maritime vessels use combustion engines burning diesel or heavy fuel oil. Low-quality fuel is used for marine engines in terms of environmental impact. As a result, high amount of emissions is deflated into air. Some states issued a low-emission zone along their coast, so cleaner fuel from additional tanks is burned in vicinity of harbours, but less quality and environmentally friendly fuel is burned on the open sea due to financial savings.

Another peril is probability of transferring biological material (animals, plants, bacteria etc.) from a source port to a port of destination or leak of fuel into a sea. [9]

3. TRANSPORT OF CONTAINERS BETWEEN CHINA AND THE CZECH REPUBLIC BY RAIL

Rail transport between China and Europe is possible with usage of Trans-Siberian Railway or using a route called “Silk Road”. Quantity of transported containers is constantly increasing. Around 2 000 TEU were transported in 2011, roughly 42 000 TEU were transported in 2016 and according to a forecast 100 000 TEU might be transported in 2020 [10].

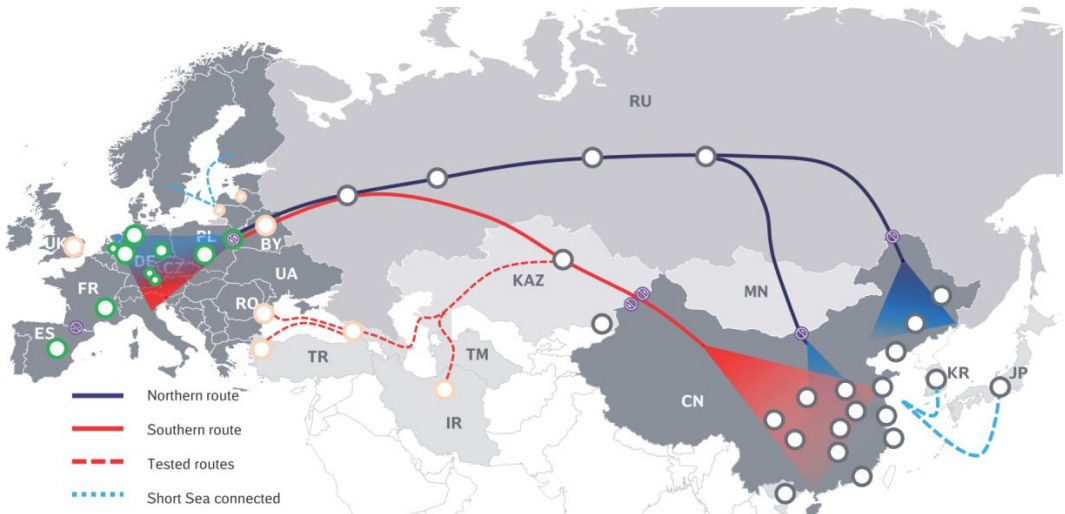


Fig. 2 Railway routes between China and Europe (blue – northern route, red – southern route) (Source: [5, 11])

3.1 Perils

a. Security and safety

Security

- Possibility of attack related to significant position in international trade and the value of transported goods
- Smuggling drugs
- Smuggling chemicals, biological and other dangerous material
- Smuggling people [11]

Safety

- Container damage during a transshipment
- Damage to goods, especially to perishable goods
- Technical condition of a railway line

b. Reliability

Basic criteria, like delivery of goods to place of destination, delivery time, transport safety, a transport price and other, are applied.

Perils:

- External influences (like weather)
- Transshipment when switching from one rail gauge to another rail gauge
- Narrow throats (on busy routes and in locations in repair)
- Danger of a traffic accident, a temporary closure of a route

b. Economic and Political Influences

Perils associated with economic impacts in particular are as follows:

- Increase or decrease of international trade
- Change of political situation in a state of departure or in a state of destination

c. Ecology

Rail transport is more environmentally friendly than road transport, but rail transport generates more transport externalities than maritime transport. Electric locomotives are more ecological than locomotives with combustion engine, but electric locomotives can't be used on every railway line, because not all of them are equipped for operation of electric locomotives.

However, negatives have to be taken into consideration of electric locomotives as well. Negatives are emissions and environmental burden in the place of electricity generation. Emission burden is higher in a case of usage of diesel engines.

4. COMPARISON

4.1 SWOT Analysis

A route from the Czech Republic to the People's Republic of China was chosen to compare container transport between maritime and rail transport.

SWOT analysis is proven method, which is used below in modified version (see Table 2 and Table 3).

Inner and auxiliary factors, namely "Strengths" and "Weaknesses", represent characteristics of the given modes of transport. The external and auxiliary factors, namely "Opportunities" and "Threats", represent perils and opportunities that these modes of transport may have in a future.

Tab. 2 SWOT analysis of maritime transport of containers (Source: Authors)

Strengths	Weaknesses
<ul style="list-style-type: none"> • Lower transport price • Higher offered capacity • Favourable for seaside regions • Transport of large quantities of goods 	<ul style="list-style-type: none"> • Longer time of transport • Longer routes • Possibility of container damage or loss during a voyage • Need of transshipment on railways or roads • High CO₂ emissions and sulphur oxides
Opportunities	Threats
<ul style="list-style-type: none"> • Reduction of CO₂ emissions thanks to recovery of waste heat • Container checking to improve safety • Use of "Smart containers" • Use of modern satellite navigation • Increase of traffic efficiency in ports • Use of other ports 	<ul style="list-style-type: none"> • Pirate attack • Terrorism • War conflict • Transport of dangerous substances and weapons • Congestion around large ports • Narrow throats • Unfavourable weather conditions

Tab. 3 SWOT analysis of rail transport of containers (Source: Authors)

Strengths	Weaknesses
<ul style="list-style-type: none"> • Shorter time of transport • Usually shorter route • Higher safety of transported goods • Possibility of direct transport from China to the Czech Republic by rail • Advantageous for Western and Middle China • Lower transport externalities produced by use of electric traction 	<ul style="list-style-type: none"> • Higher transport price • Transport of smaller quantities of goods • Need of transshipping when changing a gauge • Need of transshipment on a road for last mile service • Poor state of infrastructure in transit countries
Opportunities	Threats
<ul style="list-style-type: none"> • Upgrading the Trans-Siberian Railway • Electrification of routes in transit countries • Use of locomotives equipped with a "last mile" module • Relocation of producing factories inland • Transport of material for producing factories eastwards (back loading) • Transport of products to the West • Increase frequency of train connections • Building "Silk Road" 	<ul style="list-style-type: none"> • Termination of foreign trade support "One Belt, One Road" by Chinese government • Plunder of containers during a journey and during a transshipment • Uneven distribution of direction of container flows between China and Europe • Deterioration of economic cooperation between China and Russia, alternatively China and European states

4.2 Comparative model of container transport from China to the Czech Republic

It is important to compare price expediency of container transport between China and the Czech Republic using a comparative model of container transport between China and the Czech Republic.

Cities in the Chinese regions, from which containers are the most frequently transported into Europe or especially to the Czech Republic (see Table 4), were selected into the comparison. The selected cities are located on the east coast as well as inland in the People's Republic of China.

The most advantageous maritime and rail routes were determined in terms of pricing and time of transport from "Searates.com" application. Prices also include charges. The prices are "door-to-door". The following calculation is based on available data and on average weight of 15 tonnes of goods per container. The calculation is related to 27th July 2017. [5] The maritime route goes from Chinese ports via Suez to Hamburg.

Tab. 4 Distances and prices of maritime transport between cities in the comparative model

(Source: [5])

City of Origin	Destination City	Maritime Distance (km) to Port of Hamburg	Maritime Price per Container (USD)	
			20'	40'
Shanghai	Prague	20 576	3 343	4 564
Xian	Prague	23 634	4 239	5 649
Wuhan	Prague	21 573	3 525	4 446
Beijing	Prague	21 979	3 824	5 045
Urumqi	Prague	26 131	7 645	9 055

Road or rail transport is used for carriage from the inland to Chinese ports and for carriage from the port of Hamburg to Prague. [6] For transport from cities of Xian, Wuhan and Urumqi, inland river transport is partly used to maritime ports like Shanghai, Guangzhou and Tianjin.

The shortest distance from China to the Czech Republic is from coastal cities like Guangzhou and Shanghai. As the transport route continues further to the south, distances from cities in the south of the country, such as Wuhan, are shorter even though the cities are onshore. On the other hand, a maritime route from Beijing, which lies in the north of the country and which is relatively close to the coast, is longer.

The journey from cities like city of Urumqi, which are very far from the coast, is the longest one when using maritime way. This is caused by long distance from the cities to maritime ports. Such transports are relatively expensive and take long time.

Prices for maritime transports are on average from 3 000 USD/TEU to 4 000 USD/TEU. The lowest prices are reachable, when other mode of transport is used just little bit or not at all. Maritime transport is per kilometer significantly cheaper than rail transport or truck transport. Also inland river transport is relatively cheap. Anyway, transport of 40' container is about 30% more expensive than transport of 20' container. [5]

Rail transport is based on use of the southern route all along the route (see Table 5).

Tab. 5 Distances and prices of rail transport between cities in the comparative model (Source: [5])

City of Origin	Destination City	Distance by Rail (km)	Rail Price per Container (USD)	
			20'	40'
Shanghai	Prague	10 453	7 216	10 495
Xian	Prague	9 080	6 267	9 116
Wuhan	Prague	9 815	6 775	9 855
Beijing	Prague	9 317	6 432	9 355
Urumqi	Prague	6 558	4 527	6 584

The advantage of rail transport is possibility of stopping in more cities on a route, so larger number of cities can be connected.

Distances of railway routes have the opposite trend than distances of maritime routes, because distances to coastal cities are the longest for rail transport while cities like the city of Urumqi in northwest China is significantly closer than other cities in the middle or east of the country. The biggest distance is from Shanghai. The distance is more than 10,000 km long.

The price for rail transport is on average between 6 000 USD/TEU and 7 000 USD/TEU. Transport of 40' container is about 40% more expensive than transport of 20' container. [5]

Distance and price ratio of maritime transport compared to rail transport can be found in the following Table 6.

Tab. 6 Distance and price ratio of maritime transport to rail transport (Source: [5])

City of Origin	Destination City	Distance Ratio	Price Ratio	
			20'	40'
Shanghai	Prague	197 %	46 %	43 %
Xian	Prague	260 %	68 %	62 %
Wuhan	Prague	220 %	52 %	45 %
Beijing	Prague	236 %	59 %	54 %
Urumqi	Prague	398 %	169 %	138 %

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